SUSTAINABLE SEAS EXPEDITIONS

February 07, 2003

A VIEW FROM THE SANCTUARIES

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Current Events

The Sustainable Seas Expeditions (SSE) are now chronicled on a new Web site called, **NOAA Ocean Explorer**. During the 2001 field season, named "**Islands in the Stream**," scientists and educators explored protected and non-protected coral reef and hard bottom communities -- the "islands" -- of Belize, Mexico and the United States, as well as the currents -- the "stream" -- that connect the different habitats. You can also follow the **2002 SSE Mission**.

Underwater communities throughout the Gulf of Mexico, as well as those in the western Atlantic along the coast of Florida and Georgia, are connected by the Loop Current, its associated gyres, and the Gulf Stream. Beginning off the coast of Belize, the expedition team will ride the clockwise "stream" along the eastern edge of the Yucatan Peninsula, into the Flower Garden Banks sanctuary off Texas, continue downward along the west coast of Florida,

Live Events

Revisit the archives of the 21 **Live Events** led by the SSE Education Team over the past few years.

Did you know?

Since April 1999, 15 SSE missions have been conducted, 13 of them in NOAA's National Marine Sanctuaries. **Retrace the adventures of our explorers**.

During the 2000 field season, the exploration team conducted more than 100 successful submersible dives in the DeepWorker 2000. Most dives were 2 to 4 hours in length, and reached depths well beyond those accessible via scuba. One dive in the Channel Islands reached a depth of 2,004 ft.

Close to 100 contributors submitted materials for this site during the 2000 field season. Thanks!

through the Florida Keys sanctuary, up the east coast of Florida, and conclude off North Carolina in the Monitor sanctuary.

The SSE team has completed the 1999 and 2000 field seasons. You can revisit each mission in the **Sanctuary Log**.

Updated:September 05, 2002 | Disclaimer | Privacy Notice

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2001

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Biological Connections (May 17)

Natural vs. Artificial Reefs (June 26)

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Hawaiian Style (summary)

Live Events

2001 Events

April 23 **(Web chat),** *The New Era of Ocean Exploration*

May 17 **(Web chat),** *Biological and Cultural Connections Between the "Islands" and the "Stream"*

June 26 **(Web chat),** *Natural Reefs vs. Artificial Reefs*

2000 Events

June 8 **(Web chat/Video Uplink),** *International Oceans Day at Anacapa Island in NOAA's Channel Islands National Marine Sanctuary*

June 30 **(Web chat/Video Uplink),** *Explore Monterey Bay and NOAA's Monterey Bay National Marine Sanctuary*

September 26 **(Web Chat/ Video Uplink)** *2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific time) NOAA's Florida Keys National Marine Sanctuary: Coral Reef Health and Diseases*

1999 Events

1999 Live Events Archive

Communicating the adventures and discoveries of

VIDEO UPLINKS

2000

Channel Islands (June 8)

Monterey Bay (June 30)

Florida Keys (Sept. 26)

the Sustainable Seas Expeditions as they occur is one of the principal objectives of this Web site. Direct interaction with expedition participants is an important component of that communication. Over the course of the expeditions, we will host a series of about 15 interactive events.

Two types of events are planned. The first is a **Web chat**. This is an interactive Internet discussion in which participants pose questions and offer comments to expedition scientists or educators. Generally, the Web chats will have specific topics (e.g., Charting the Sea Floor), but several are more open-ended (e.g., Meet Dr. Sylvia Earle).

Interactive broadcasts are the second type. These are live **Video Uplinks** directly from the expedition vessel. These broadcasts also will include interactive questions and comments from viewers.

Active participation in these events may require prior registration. However, no registration is required to observe the events as they happen. Each event will be archived as a permanent record available to the public.

These events are sponsored by the **Oceanographic Program in the Earth Sciences (OPES)** of the National Aeronautics and Space Administration (NASA). They have been organized, and will be hosted and managed, as a partnership between **NASA's Quest Project** and **NOAA's National Marine Sanctuary System**.

Following is a listing of the events with links to a brief description, the time of the event, and access procedures for registration, participation, and observation.

For Further Information

For information on the live events of the Sustainable Seas Expeditions, contact:

Mr. John McDonough
Sustainable Seas Expeditions

NOAA's Special Projects
1305 East-West Hwy. #9431
Silver Spring, Maryland 20910
john.mcdonough@noaa.gov

For more information on NASA's Oceanographic Program in the Earth Sciences, or NASA's Quest Project, contact:

Ms. Andrea McCurdy
Internet Event Producer
NASA Quest
Ames Research Center
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Moffett Field, CA 94035
amccurdy@mail.arc.nasa.gov

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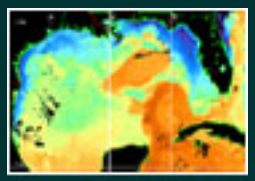
SUSTAINABLE SEAS EXPEDITIONS

SANCTUARY LOG



ABOUT THE SANCTUARY LOG

The *DeepWorker* will host many pilots. Read their updates in the Sanctuary Log.

Welcome to the Sanctuary Log of the Sustainable Seas Expeditions, where you can follow NOAA's National Marine Sanctuary team during the 2000 field season. In 1999, the SSE team visited nine of NOAA's 12 national marine sanctuaries. This year, they will visit a 10th sanctuary -- the Hawaiian Islands Humpback Whale National Marine Sanctuary -- and revisit three -- the Channel Islands, Monterey Bay, and Florida Keys -- for an extended period of time. They will also explore an area that is not a sanctuary, known as the West Florida Shelf.

Last year it seemed that every day of the expeditions held adventure, opportunity, or disappointment, and these experiences were captured in the Log. Science and discovery are this year's themes, and expectations are high.

But our silent partner, the sea, can be harsh when it comes to human expectations. The only certainty is that there will be more adventures and the participants will

Read about a Channel Islands shipwreck

HUMPBACK WHALES

Read about the Hawaiian Islands humpback whales

1999

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A diver recounts an amazing adventure on the Flower Garden Banks

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How was the Florida Keys sanctuary

Track the expeditions above and below the sea.

continue to share their stories as they unfold, here in the Sanctuary Log. Select the sanctuary of your choice to review background information, follow day-to-day happenings, and read a series of informative logs.

Background: This field season, the background essays discuss the specific goals and objectives of each sanctuary's SSE education and research projects. They describe the types of dives and events, and the importance of these activities to the ongoing work of the sanctuary. Other background essays describe particular research and education topics, such as krill or fish habitat, that relate to the particular thrust of an expedition.

A customized marine forecast, biographies, maps, and the essays developed for the 1999 field season are also included.

Sanctuary staff and partners will submit a series of reports from the field.

Expedition Update: Follow the daily updates in the center of the Sanctuary Log page for the most current information available on each mission. A member of the SSE team will provide a brief update every day of the expedition. More information often can be found in the log entries.

Sanctuary Log: The 2000 Sanctuary Log is a chronological set of reports, written by expedition participants, on ongoing SSE research and education efforts. Most logs also include several mission-specific photos. A set of summary materials will also be offered after each mission is completed.

Channel Islands

Olympic Coast

Stellwagen Bank

Gray's Reef

Florida Keys

Flower Garden Banks

established?

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Hear from the Gray's Reef manager

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Listen beneath the sea at Stellwagen Bank

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Learn about the Olympic Coast

CHUMASH ESSAY

A Native American perspective on the history of the Channel Islands

MONTEREY BAY

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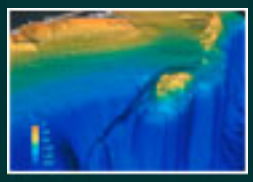
Venture to Monterey Bay in this interactive feature

NATURAL SETTING



Read about the natural history of Cordell Bank

EDUCATION

Educational efforts at the Gulf of the Farallones

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Cultural History of the Florida Keys

Bruce G. Terrell, Archaeologist
NOAA National Marine Sanctuary Program

Prehistoric and Native American Cultures

The Florida Keys are a series of coral reefs that cap Pleistocene-era limestone bedrock. It is unknown whether the region's continental shelf may have been inhabited during the low water of the last Ice Age, since the sea levels had probably already begun to rise by the time of earliest known human habitation (around 10,000 to 12,000 years B.P. [before present]).

Shipwrecks are interesting because of what they can tell us about history, who came before us, why they were here, and the difficulty they experienced in navigating these waters. They also serve as a home to many organisms. Often called artificial reefs, shipwrecks attract a plethora of animal life. (photo: Paige Gill - FKNMS)

Archaeological evidence of Southern Florida's earliest inhabitants begins to appear at about 7,000 to 4,000 B.P. The ocean probably reached its present level by 4,000 B.P., by which time the Keys were islands. The Calusa Indian people also appear in the archaeological record during this period. They subsisted by hunting and gathering from the marine and estuarine environments, often using dugout canoes. They were known to have a complex social and political culture, and, in addition to digging navigable canals between inland waterways, are believed to have traveled to Cuba and the Bahamas with their canoes. They eventually died out or disappeared, coincident with the Colonial Spanish era in the 16th and 17th Centuries.

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In the 19th Century, Seminole groups composed of refugee Creek Indians and runaway African-American slaves moved into South Florida. Like the Calusa before them, they were known for their canoe craftsmanship and navigation skills, and traveled to the Bahamas and Cuba. The United States waged three wars against the Seminoles in the 1830s and 1840s using amphibious war tactics that included small sailing vessels and canoes. In two incidences, the Indians attacked Keys outposts, including an attack on the fortified settlement at Indian Key in 1840.

European and American Eras

The City of Washington, shown here, sunk in July of 1917 while being used as a coal-transporting barge. (photo: Indiana University)

In the 16th and 17th Centuries, Spanish sailors perceived the Florida Keys as a dangerous and occasionally fatal navigation hazard rather than land to be settled. Spain-bound treasure fleets (flotas) sailing out of the Spanish capital at Havana found the waters around the Keys treacherous. Unpredictable hurricanes cast many a treasure-loaded ship onto the shoals and reefs. An entire year's shipment of the king's treasure would sometimes be lost, as was the case with the flota of 1733. Sailors called the Keys "Las Martires" ("The Martyrs"), apparently because the islands' wild appearance reminded the men of tortured Christian saints.

By the 1700s, English naval captains began to dominate the waters that had been the domain of the Spanish. Consequently, several British vessels were lost in what is now the sanctuary area. Two left their names on local landmarks: Looe Key for the wrecked *HMS Looe* and Carysfort Reef for the temporarily grounded *HMS Carysfort*.

Key West's fortunes were tied to America's national growth. Maritime shipping traversed the waters of the Keys with regularity in the early 19th Century, as New Orleans became a significant port exporting the agricultural bounty of the American interior. During this time, Key West (originally Cayo Hueso) was a fresh water stop. After the British lost possession of West Florida in the War of 1812, American maritime commerce increased, and Key West grew accordingly. Many local maritime industries evolved around Key

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West, such as regional fisheries, sponge harvesting and sea-turtle hunting. Key West was also the haunt of regional pirates, who hid their small watercraft in nearby islands from which they preyed on Gulf and Caribbean shipping. The town soon took on a character similar to towns of the Wild West.

Key West also became the center of a lucrative regional shipwreck salvage or "wrecking" industry. The "wreckers" salvaged the cargoes and hulls of ships that wrecked on the reefs and collected a portion of the salvage awards. During the 1820s, the U.S. Government took steps to establish a series of lighthouses along the Keys. A U.S. customs house was built at Key West to more tightly control the wrecking industry, while several wrecking stations were placed along the Keys chain. While these improvements doomed the wrecking industry, many of the wreckers continued to live in the Keys, constituting the "conch aristocracy" that is still a source of familial pride for longtime residents.

Built in 1873, Alligator Reef Light, was named for the *USS Alligator* that sank in the vicinity. At a 135' tall it still serves as a warning beacon for shipping traffic. (photo: Nicholas Tagliareni)

The Keys played a role in several American military conflicts. During the Civil War the U.S. Navy made Key West a resupply station to support the naval blockade against Confederate ports. Fort Taylor in Key West, and Fort Jefferson in the Dry Tortugas, were the main stations. These forts became important again during the Spanish American War in 1898. During this conflict Key West, was one of the main supply depots for U.S. actions against Cuba.

Key West proved its strategic naval value again in the 20th Century as a base from which to protect the Panama Canal. In World War I, the town was a submarine and naval aviation training base. The base was expanded during World War II for training and anti-submarine warfare to combat the German U-boats that sank Allied ships in and near the waters of the Florida Keys National Marine Sanctuary.

Archaeological Resources

The *Benwood* is located between French Reef and Dixie Shoals in 25 to 45 feet of water. She sank after a collision in 1942 with the *Robert C. Tuttle*. (Photo: Paige Gill/FKNMS)

The waters of the Florida Keys hold potential for the study of prehistoric human culture, although little research has been conducted to date. The discovery of any cultural remains of the Paleo-Indian and Archaic cultures of South Florida would be extremely significant to the study of paleoecology, human adaptation, and early native culture in the region.

At the same time, the Keys are famous for historic shipwrecks. They are a popular destination for both local and tourist divers. U.S. Highway 1, which runs the length of the Keys, is littered with the rusted refuse of salvaged but unpreserved anchors and cannon. The sanctuary now promotes the responsible management and protection of the Keys' historic submerged cultural heritage. To promote a preservation message to visiting divers and residents alike, the sanctuary has developed the Florida Keys Shipwreck Trail in partnership with the State Division of Historic Resources and numerous dive charter groups. Educational brochures and interpretive slates have been prepared to educate divers about the nature of the historic shipwrecks on which they dive, as well as to impart the importance of protecting and preserving these unique and valuable archaeological sites.

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Interview

Interview with Billy D. Causey, Superintendent
Florida Keys National Marine Sanctuary
June 2000

Click on a picture to view a short video clip of each response (Quicktime video).

What do you hope to accomplish as manager of the Florida Keys National Marine Sanctuary?

As the manager of the Florida Keys National Marine Sanctuary, I hope to protect this nation's only living barrier coral reef for future generations. I also want to raise the public's awareness about the global threats to coral reefs and the need to protect this extremely diverse ecosystem. I hope to implement effective and successful management tools that will ensure the sustainability of the Florida Keys marine environment for future generations. I also want to make people more aware of the National Marine Sanctuary Program and our network of 13 National Marine Sanctuaries.

What did the Sanctuary gain from last year's mission of the Sustainable Seas Expeditions?

Last year, during the SSE mission to the sanctuary, we explored, documented, and mapped the extensive area covered by Sherwood Forest, a unique coral reef community in the proposed Tortugas Ecological Reserve in the western end of the sanctuary. Additionally, our scientists surveyed and documented the condition and health of deep water coral formations. Some of the submersible pilots documented fish populations and assessed the immense diversity of some of our reef-fish communities. Additionally, some of our coral reef scientists were able to revisit coral monitoring sites that were established in the 1970s in the old Key Largo National Marine Sanctuary. And most exciting of all, today's technology, such as the Internet and satellite communications-- allowed us to take our educational messages directly to the classroom and to living rooms

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across the nation.

What are the Florida Keys Sanctuary's goals and objectives for the SSE mission this year?

Among the goals and objectives for this year's SSE is to explore the deep water habitats along the west coast of Florida, which will help us better understand the area's ecological and biological linkages to the Florida Keys. Additionally, we are going to continue some of the important projects that were initiated last year. Scientists will be investigating deep water corals, documenting deep water fish diversity and abundance, and assessing impacts to sanctuary resources from various types of fishing gear. Most importantly, our goal is to educate. As we learn more about the deep water environments of the sanctuary, we can, in turn, impart that information in our education and outreach programs.

What makes the Florida Keys National Marine Sanctuary unique?

The Florida Keys National Marine Sanctuary is the second-largest of the nation's 13 marine sanctuaries. It is 2,800 square nautical miles in size, and stretches for 220 miles from Miami south to the Dry Tortugas. It surrounds over 1,800 islands, or "Keys" as we call them locally. As a result, we have over 2,000 miles of coastline within the sanctuary.

The sanctuary protects the world's third-largest barrier coral reef. The living coral reefs comprise a biologically diverse marine community with over 520 species of fish, 55 species of stony corals, 30 species of soft corals, 50 species of sponges, and an entire host of other marine life. Altogether, more than 6,000 species of marine plants and animals live in the waters of the Florida Keys.

Tourism is our number-one industry, with over three million visitors spending 13.3 million "visitor days" here in the Keys every year. Commercial fishing is our second-largest industry, and we have over 6,000 commercially registered vessels using the waters of the Florida Keys National Marine Sanctuary. These activities present a unique challenge to management, as we strive to balance the continued use and enjoyment of sanctuary resources with their preservation and protection.

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What are some challenges you face in managing the sanctuary?

One of the major challenges I face as the sanctuary manager is continuing to balance the protection of sanctuary resources with constant pressures from people who want to use and enjoy the resources of the sanctuary. Our management has to err on the side of conservation if these resources are to remain for the use and pleasure of future generations.

Another major challenge is to be able to address the local, regional, and global problems that are affecting the health of coral reefs. Corals are in a steady state of decline from water quality degradation, pollution, overfishing, and direct physical impacts from human use.

Coral reefs have survived through 400 million years of global change. I wonder if we will see them disappear in our lifetime?

What do you think have been the most important achievements of the Florida Keys National Marine Sanctuary since its designation in 1990?

Two of the major achievements for the Florida Keys National Marine Sanctuary came in the Congressional Act that established the Sanctuary in 1990. The first was the establishment of an "Area to be Avoided" that keeps ships greater than 50 meters, or 164 feet in length, outside the sanctuary boundary. This helps to protect our coral reefs from major ship groundings.

The second was the prohibition of oil drilling and gas development within the boundaries of the sanctuary.

Another major achievement has been the implementation of this nation's first marine zoning plan. The plan includes 23 "no take" marine reserves, where marine life is protected from all forms of fishing, by both commercial and recreational fishers as well as divers.

The sanctuary was also the first to establish a Water Quality Protection Program, for which, obviously, focuses on improving water quality in the Sanctuary.

We've also implemented an integrated management plan that

assists us as managers in better ocean governance within the Sanctuary, and also promotes an ecosystem approach to management.

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Planned Education Activities

Mary Tagliareni, Education Coordinator
Florida Keys National Marine Sanctuary

Children enjoyed the activities during the SSE Open House at Mallory Square in Key West. (Photo courtesy of FKNMS)

What attracts over three million visitors to the Florida Keys every year? This island chain in a sub-tropical environment is comprised of over 1,800 islands and 2,000 miles of shoreline. There are more than 6,000 species of marine plants and animals, from the blue-striped grunt to the spotted eagle ray, and more than 85 species of coral, from the small and delicate rose coral that grows in seagrass beds, to the elkhorn coral with its branches reaching toward the sunlit surface. Tourism is the number-one industry in the Florida Keys, and three million visitors spend 13.3 million "visitor days" here in the Keys every year. Being a tourist destination presents a unique challenge to management as it is necessary to balance the continued use and enjoyment of sanctuary resources with their preservation and protection. Beginning in 1975 with the designation of the former Key Largo National Marine Sanctuary, education has been a key tool for sanctuary management in the preservation and protection of the coral reef ecosystem.

The 1999 Sustainable Seas Expeditions (SSE) mission to the Florida Keys opened the door for innovative education and outreach opportunities that helped us reach a diverse population in the Keys and beyond. We were able to utilize the Internet to reach into classrooms and living rooms around the world. We shared pictures of Sherwood Forest in the Tortugas region, a remote, highly ecologically important area 70 miles west of Key West. We brought together students from three different counties within Florida to

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debate hot marine management issues. They found it enlightening to hear arguments from both sides of an issue. During the mission, local high school students experienced firsthand the scientific research being conducted from the *DeepWorker* submersibles.

At the 1999 SSE Open House in Key West, Mary Tagliareni explains the mechanics and operations of the submersible to Ben Richards. (Photo courtesy of FKNMS)

Building on projects that were started last year, we will continue to utilize the innovative and technological advances of the Sustainable Seas Expeditions. We want to raise awareness about the Florida Keys National Marine Sanctuary, the network of National Marine Sanctuaries, the results of research, and management issues affecting the Florida Keys marine environment. Below are summaries of activities planned for the upcoming SSE mission in the Florida Keys. We hope you will join us.

Educational Research Dives
September 8 to 12, 2000

A week of the mission in the Florida Keys is dedicated to educational research objectives using the *DeepWorker* and other sampling oceanographic equipment. The educational *DeepWorker* dives will occur in the Tortugas region, approximately 70 miles west of Key West. The *DeepWorker* will be used to explore two different geographic areas, Sherwood Forest and Riley's Hump, of the Tortugas from depths of 80 to 400 ft. The tasks involved in these dives are 1) create a list of fish species

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observed during a 45-minute period of a dive, and recorded at 5-minute increments using the Great American Fish Count (GAFC) methodology; 2) estimate the number of each fish species observed in the categories of single (1 fish), few (2-10 fish), many (11-100 fish), and abundant (>100 fish); and 3) collect video and still images of unknown fish species.

Trumpetfish, *Aulostmus maculatus*, hunt throughout the day, only occasionally taking time out to visit cleaning stations. While on the move, they generally swim horizontally just above the bottom, but quickly assume a vertical pose to conceal their presence or position for a strike. (Reef Fish Behavior, Ned DeLoach.) (Photo courtesy of Tim Daily)

National Geographic Alliance
September 14 to 16, 2000

The National Geographic Society is sponsoring a group of Geographic Alliance teachers and their students from Washington, DC, and Miami, FL, to participate in a weekend field study at the Florida Keys National Marine Sanctuary. The session is being sponsored by the Society and NOAA, under the direction of Dr. Sylvia Earle. During the field study, students and teachers will participate in the Coral Reef Classroom and visit the NOAA research ship *Gunter* during the SSE Open House in Key West.

NOAA Ship *Gunter* Open House at Mallory Square in Key West
Saturday, September 16, 2000, 10 am to 2 pm

The public is invited to tour the NOAA ship *Gunter,* view the *DeepWorker* submersible, and meet with sanctuary and SSE staff and scientists to learn about SSE goals and activities. The Open House is scheduled from 10 am to 2 pm.

Students and Teachers-at-Sea
September 20, 2000

Selected high school students and their teachers will spend a day on the NOAA ship *Gunter* to experience and document the research expedition first-hand. Students will rotate through four stations and get hands-on experience tracking submersible navigation and communications on the bridge, video editing, and *DeepWorker* dive operations.

Live Interactive Webcast
Tuesday, September 26, 2000 , 2:00 pm EST

Bill Goodwin, Sanctuary Resource Manager, dons an aga mask in preparation for the underwater segment of the 1999 SSE Internet Uplink. (Photo courtesy of FKNMS)

Participate in a virtual SSE education activity without leaving your computer. The Florida Keys National Marine Sanctuary, together with the National Underseas Research Center (NURC), the University of North Carolina at Wilmington, and NASA, will host a live underwater broadcast on September 26 at 2 pm EST. The webcast will be from Conch Reef, six miles offshore of Key Largo and home of Aquarius, the world's only operational underwater laboratory.

Participants in the broadcast will learn about coral reefs, diseases that are infecting them, possible global and regional causes of the diseases, and what citizens around the world can do to help. The broadcast uplink is designed to be interactive. Participants will be encouraged to ask questions of the divers and scientists. To participate, **visit the live events page** for more information.

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Planned Research Activities

LCDR Dave Savage, NOAA Manager
Florida Keys National Marine Sanctuary
Upper Region

Dave Savage

The emphasis on this year's Sustainable Seas Expeditions in the Florida Keys is on general exploration, education, and outreach. Although general exploration will be emphasized, several preliminary research projects may be conducted with the submersibles in the deep reef environment. These projects are designed to complement the Florida Keys National Marine Sanctuary's research and monitoring program.

The first leg of the SSE 2000 mission will take place in the Tortugas region of the sanctuary on September 3-15. Walt Jaap of the Florida Marine Research Institute in Saint Petersburg is the principal investigator for the first scientific project in the Tortugas. His project will focus on the biological characterization of the Tortugas Bank and adjacent areas. Dr. Japp will also pilot the DeepWorker 2000 submersible for his project.

The second scientific project in the Tortugas will be led by Dr. Erich Mueller of Mote Marine Laboratory in Summerland Key, Florida. Dr. Mueller will also act as both principal investigator and DeepWorker pilot for his project, which will investigate potential coral diseases on the deep reef tract in the Tortugas region. The health of these reefs is affected by water quality in the Gulf of Mexico. We now know from extensive drifter studies that water travels

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Instead of scraping algae from the surface of dead corals and reef pavement, stoplight parrotfish, *Sparisoma viride*, use powerful jaws to gouge out the algae growing below the structure's surface. They generally forage on upper and lower reef slopes in depths from five to 75 feet. (Reef Fish Behavior, Ned DeLoach.) (Photo courtesy of FKNMS)

from the Gulf of Mexico off the coast of southwest Florida to the reefs of the Florida Keys and the Tortugas. We are concerned that nutrient-rich waters produced during flood episodes on the Caloosahatchee River of southwest Florida and the Mississippi River will periodically threaten the coral reefs of the Florida Keys National Marine Sanctuary. These reefs normally thrive in a low-nutrient, oligotrophic environment. When nutrient-rich waters reach the coral reefs, they can become overgrown with algae, which thrives in nutrient-rich conditions. This algae can prevent essential sunlight from reaching the coral colonies and can eventually cause the death of these reef-building (hermatypic) corals.

The Florida Keys National Marine Sanctuary is taking an active role in the South Florida Ecosystem Restoration Program and hopes to be the downstream recipient of the ecosystem's fresh water in the appropriate quality, quantity, and timing. Nearshore water quality problems in the Florida Keys are an additional threat to the nearshore patch reef communities. Enterococci counts, -- an indicator of pollution from human sewage, -- have been reported at alarming levels on several Keys' beaches during the past year. Steps are finally being taken to stem the tide of nearshore sewage loading in the Keys. Key West is upgrading its central sewage plant to include advanced wastewater treatment and deep well injection. In Key Largo, the Florida Keys Aqueduct Authority has negotiated a contract with Ogden Systems to sewer Key Largo and to treat the sewage to advanced wastewater treatment standards with deep well injection. Unfortunately, the contract may be determined to be null and void, because opponents of central sewage have pointed out to the State's Attorney that Florida Sunshine Laws may have been violated during the evaluation phase of the project (these laws protect the public's right of access to governmental meetings and

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records). The Florida Keys have come to a crossroads where nearshore water-quality issues need to be dealt with in a timely and effective manner. Central sewage with sound infrastructure, including lines that do not leak and plants that remove both pathogens and nutrients, is needed sooner rather than later.

The Florida Keys National Maine Sanctuary Water Quality Protection program has a significant research and monitoring component. This includes coral research, seagrass research, and coral monitoring, and is currently funded by the U.S. Environmental Protection Agency. The monitoring conducted by the EPA is closely integrated with the rest of the scientific monitoring that occurs in the sanctuary. The sanctuary's overall monitoring strategy currently is concentrated in the no-take zones, and is conducted on three different levels. Level 1 monitoring investigates coral reef ecosystem function and is designed to monitor changes in structure and function in the largest zones: the Western Sambos Ecological Reserve, Eastern Sambo Research Only Area, and Carysfort Sanctuary Preservation Area. Level 2 monitoring involves ecosystem structure and human activities. The EPA Water Quality Protection Program monitoring falls under Level 2. The objective of Level 2 monitoring is to study changes in ecosystem structure and human use due to closure. This includes the prohibition of consumptive activities in the Sanctuary Preservation Areas and the prohibition of entry in the Research Only Areas. Level 3 monitoring involves monitoring overall ecosystem health through the efforts of sanctuary volunteers. This work occurs throughout the sanctuary in the no-take zones and in selected reference sites.

Mated pairs of French angelfish, *Pomacanthus paru*, live in large territories spanning a broad range of depths, where they feed on sponges and, to a lesser extent, gorgonian polyps and algae. Juveniles act as cleaners until about three inches in length. (Reef Fish Behavior, Ned DeLoach.) (Photo courtesy of FKNMS)

The third scientific project in the Tortugas region has both a research and education component. Laddie Akins, Director of the Reef Environmental Education Foundation (REEF), will be piloting the DeepWorker submersible to survey fish populations in the deep reef environment in both the Upper Keys, near the Carysfort Sanctuary Preservation Area, and in the Tortugas at Sherwood Forest. A modified REEF roving-diver fish-count technique will provide the Florida Keys National Marine Sanctuary with invaluable fish population data in both areas.

Artificial reefs created by lighthouse towers, such as this one at Carysfort Reef, as well as shipwrecks and navigational markers, offer shadows and shelter for predators and prey alike. (Photo crourtesy of FKNMS)

The second leg of the SSE 2000 mission, which will take place from September 17-21, will focus on the Florida Keys National Marine Sanctuary Upper Region near Key Largo. I, Lieutenant Commander Dave Savage, Upper Region Manager of the Florida Keys National Marine Sanctuary, am the principal investigator for a project in the Upper Keys that will explore and document biological and cultural data on artificial reefs in the sanctuary. The video documentation on these ships, which are intentionally sunk to provide a haven for scuba divers away from the natural reefs, will be accomplished this year using a remotely operated vehicle (ROV). In subsequent years of the five-year SSE program, we hope to use the *DeepWorker 2000* submersible to follow up on the baseline observations that we will gather this year. I am slated to be the submersible pilot for the artificial reef project if the operation is deemed to fall within acceptable safety parameters.

The use of artificial reefs as a management tool is very controversial. I hope to obtain monitoring data over the next five years that will help the sanctuary make informed management decisions about the continued use of artificial reefs in an attempt to alleviate human pressure on the natural reefs. The U.S. Navy Maritime Administration ship *Spiegel Grove* is slated to be scuttled as an artificial reef in the sanctuary off of Key Largo in December 2000. The *Spiegel Grove*, which measures 510 feet, will be the largest artificial reef in the country accessible to scuba divers.

Other potential research projects in the Upper Keys include deep reef monitoring of coral health off of Carysfort Reef, and queen conch spawning aggregation studies off of the deep reef near Molasses Reef. Dr. Phil Dustin of the Cousteau Society is the principal investigator for the coral health study off of Carysfort, and Bob Glazer of the Florida Marine Research Institute is the principal

investigator for the queen conch study. Florida Keys National Marine Sanctuary Education Coordinator Mary Tagliareni and I will be the submersible pilots for these projects.

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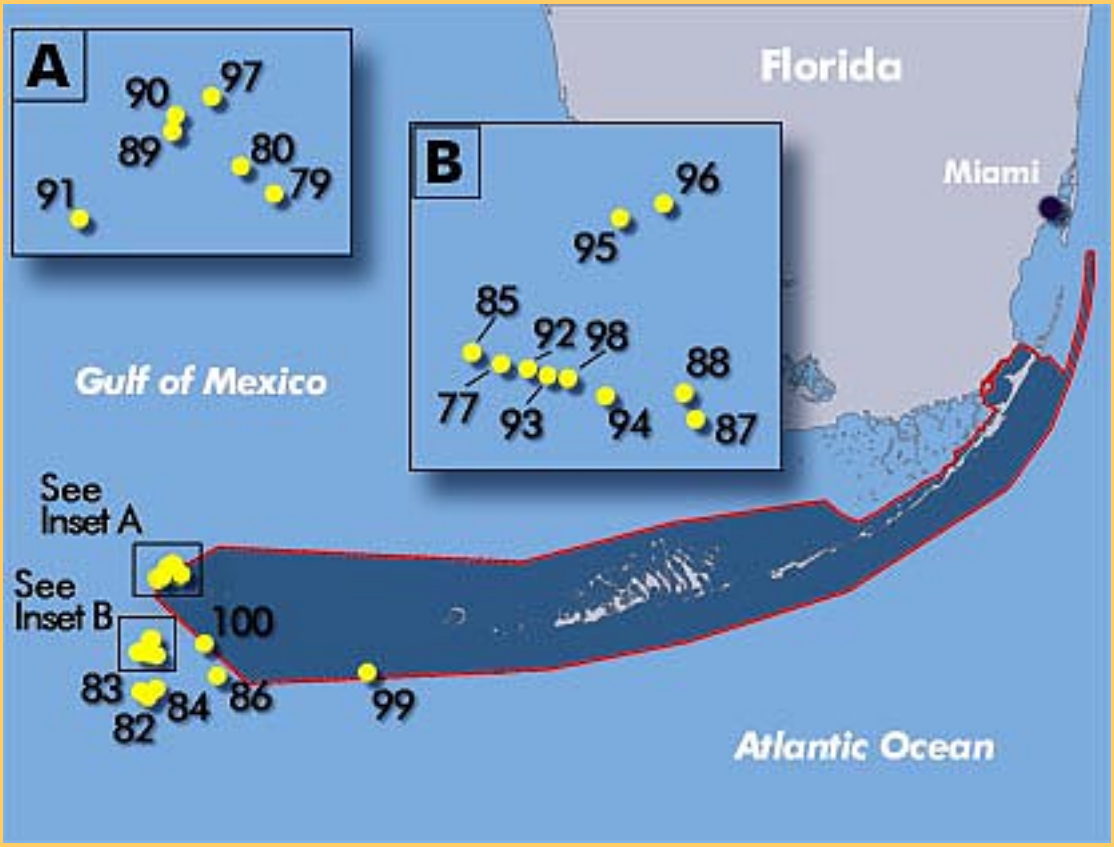
Dive Maps



View a series of dive maps produced during this expedition. Click on the reference map above to **link to the Dive Maps page**.

Sanctuary Boundary

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The Florida Keys National Marine Sanctuary protects an area of over 3600 square miles (2800 square nautical miles) of submerged lands and waters surrounding the Florida Keys. It includes parts of Florida Bay, the southwest continental shelf, the corals of the Florida Reef Tract that parallel the seaward edge of the Florida Keys, the Keys themselves, and the Straits of Florida. Sanctuary waters range from an average depth of four feet in Florida Bay to 2000 feet. Depth of the reef tract averages about 50 feet. The submerged lands of the sanctuary are part of a plateau of marine sediments that includes all of Florida and its adjacent continental shelves. The outer edge of the reef tract is subject to open tidal exchange of warm, clear waters of the Florida Straits that are low in nutrients and conducive to reef development. These coral reefs are intimately linked to a marine ecosystem that supports one of the most unique and diverse assemblages of plants and animals in North America. Cultural resources are also contained within the sanctuary. The proximity of coral reefs to centuries old shipping routes has resulted in a high concentration of shipwrecks and an abundance of artifacts.

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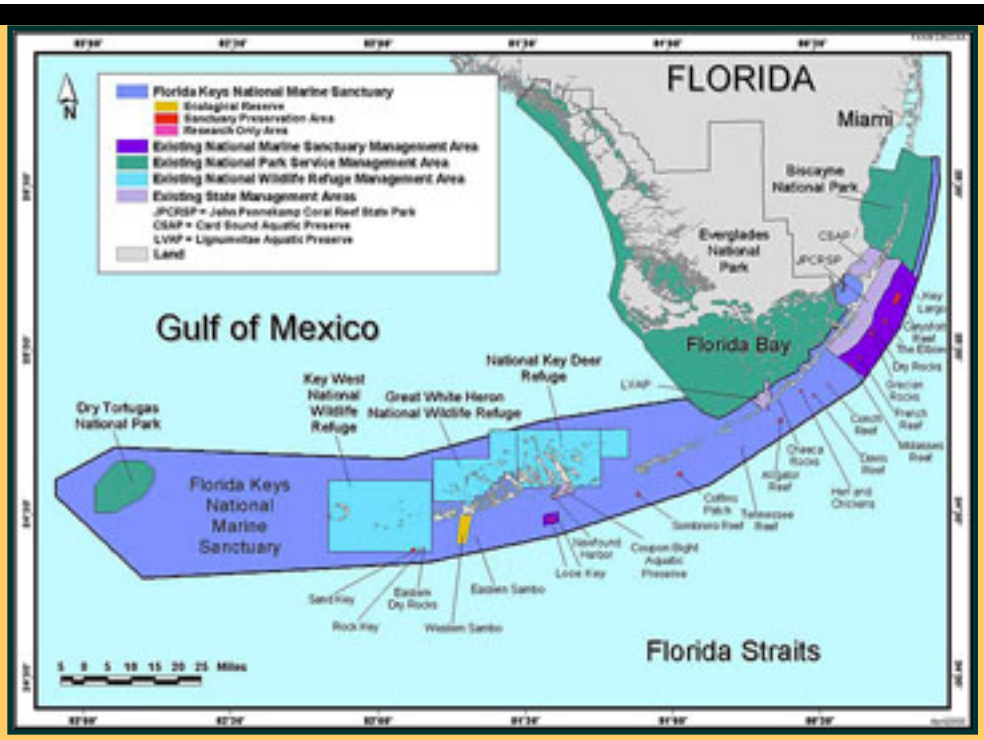
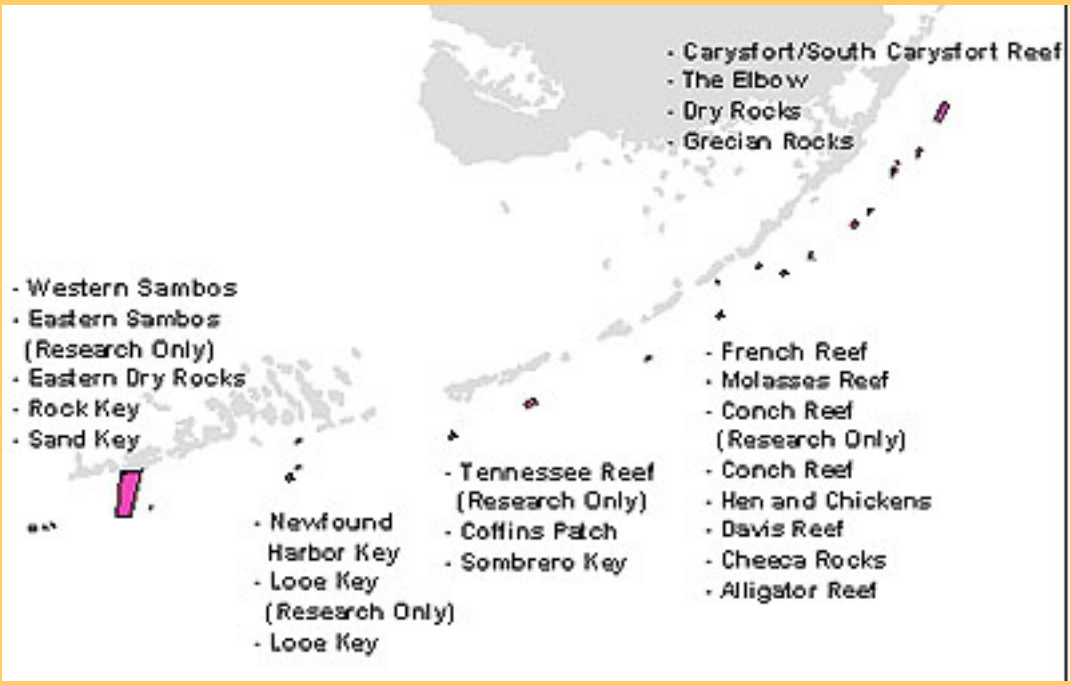
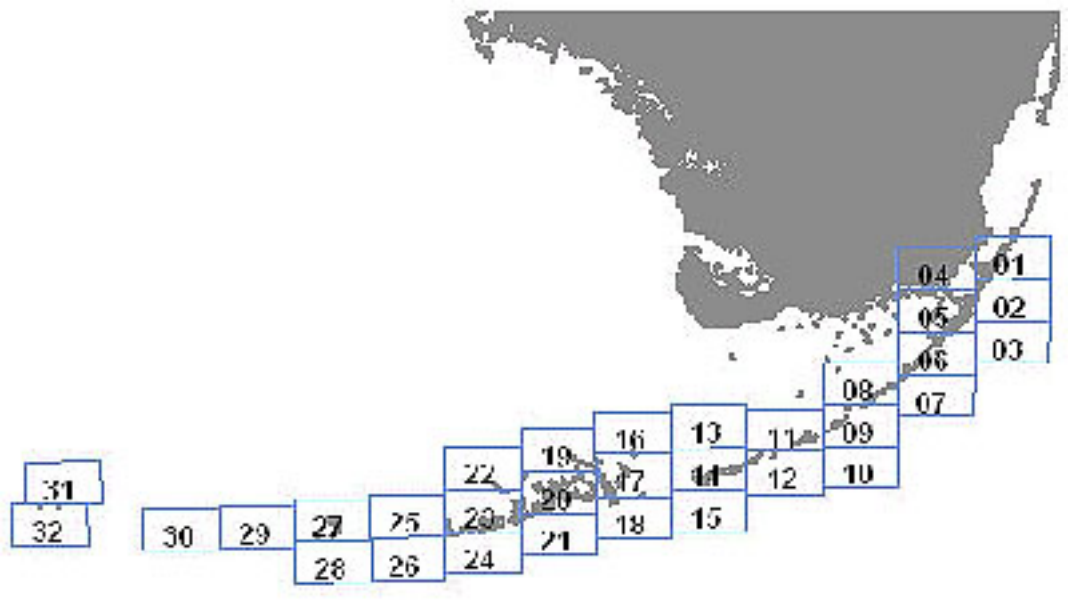


The Florida Keys National Marine Sanctuary has created an interactive map of the sanctuary and surrounding areas. From this map, you can access information about individual Sanctuary Preservation Areas or other particular zones, their location, regulations, as well as current research efforts being conducted there. Click on the above map to visit this reference page.

Benthic Habitat Maps





The two maps above link to Web pages containing the results of a seven-year cooperative effort between the National Ocean Service and the Florida Marine Research Institute (of the Florida Fish and Wildlife Conservation Commission of Environmental Protection) to map the types and extent of benthic (bottom) habitats within the Florida Keys. The top map offers benthic information according to Sanctuary Protected Areas; the bottom according to reference tiles. Click on the benthic map of your choice for more information. (To learn more about the Benthic Habitats of the Florida Keys mapping project contact **Steve Rohmann** at the NOS Special Projects Office.)

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The Florida Keys - A Very Special Place

James Fryer
Director, The Nature Conservancy of the Florida Keys and
Member, Florida Keys National Marine Sanctuary Advisory Council

James Fryer

Webster's New World Dictionary defines a "sanctuary" as, "a place set aside for worship; a place of refuge or protection; a reservation where animals or birds are sheltered for breeding purposes."

Clearly, a sanctuary is a very special place. In the Florida Keys, there is a place where the term sanctuary means all this and much, much more.

The Florida Keys is an archipelago of thousands of limestone islands that stretch in a crescent-shaped arc from the Everglades, at the southern tip of Florida, over 100 miles into warm, clear tropical waters. A visitor to the Keys may be immediately taken by their simple beauty. But beneath that simple beauty is a complex and sometimes mysterious ecosystem that has national significance for its biological and cultural resources. It ranks with our most treasured natural heritage sites.

The Florida Keys is a place where minute plankton-scale events are juxtaposed with large-scale processes that affect the entire planet. The Keys are located at the confluence of the Florida current and the Antilles current where they join to form the Gulf Stream, the mightiest flow of water on the planet. This flow of water

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Sea anemones are well known in aquariums for their association with the clown fish, a Pacific species. In the Florida Keys, anemones may be associated with cleaner shrimp, anemone shrimp, banded clinging crabs, and diamond blennies. (Photo courtesy of Mike White/FKNMS)

not only helps to seed the Keys reef tract with tiny larvae to perpetuate the local ecosystem, but also plays a critical role in regulating planetary climate. The Keys are also connected to the Everglades, the Gulf of Mexico, the Caribbean, and the Atlantic Ocean through biological, chemical, and physical processes. It is a crossroads and transition zone where both tropical and subtropical flora and fauna are found.

It is also a place where tropical storms and major hurricanes both wreak havoc and bring renewal and rejuvenation, rearranging giant coral boulders and changing coastlines to make room for new growth. Within hours, days of calm and glassy seas can turn wild with lightning, waterspouts and waves. Then, just as quickly, it will be sunny and calm again.

The Florida Keys is a place where, for eons, soft and stony corals have built massive and complex reefs structures that now harbor hundreds of species of dolphin, manatees, tropical fish, and invertebrates. Vast seagrass meadows provide food and nursing grounds for many of the rich diversity of species that live their adult lives on the coral reefs. There are places in the Keys where groupers and snappers, and other reef animals, come together to form great spawning aggregations, dancing a great dance that, almost against all odds, culminates the cycle of life and perpetuates future generations.

Hermit Crabs find homes for their soft bodies in seashells. When the crab outgrows its home, it must seek a larger shell, and may even fight with other hermits to gain access to this essential shelter. (Photo courtesy of FKNMS)

The Florida Keys is a place where tiny neon gobies go about their daily business setting up "cleaning stations" where large "client" fish line up to await their turn for the gobies to clean them of parasites. An observant diver may happen across such a cleaning station, where giant barracuda and other large fish line up awaiting their turn as if lined up at the local car wash.

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The Florida Keys is a place where fishermen have plied the waters for generations, bringing in a large portion of Florida's fish landings, and making a critical contribution to both the state and national economies. It is a place that for centuries has been located at a critical crossroads for shipping. Hundreds of shipwrecks, some still containing gold, silver, jewels, and other significant cultural resources, have met their misfortune in the Keys. Some of these wrecks have surrendered their secrets to make a few lucky individuals fabulously wealthy, and to provide the rest of us with a window into our historic heritage.

The Florida Keys is a place where nearly 90,000 people now live, many of whose ancestors have called the Keys home for generations. It is a place where, every year, more than 2.5 million visitors flock to enjoy the warm climate and spectacular marine resources. More than a million of them dive or snorkel on the coral reefs, making the Keys' reefs the most visited in the world.

The Florida Keys is a place where this writer, after visiting many times as a young man, was inspired to pursue a career in natural resources conservation.

The Florida Keys is a place loved by many. It is also a place that, like many of our most treasured natural heritage sites, is in danger of being loved to death.

Canoeing and kayaking are excellent ways to explore the Florida Keys National Marine Sanctuary's mangrove communities. This quiet mode of travel allows paddlers to observe wildlife with minimal disturbance, and is fueled only by elbow grease! (Photo courtesy of FKNMS)

It is fortunate that a group of remarkably dedicated resource managers, scientists, and other professionals have devoted themselves to the preservation and protection of the Florida Keys marine ecosystem. Known as the staff of the Florida Keys National Marine Sanctuary, this group works with local community members and leaders, and local, state and federal governmental agencies, to preserve this place that means so much to so many. The stakes are tremendous. It is not an easy task, as there are daunting challenges at work in such a complex environment. But thank God that they do what they do.

They are making a critical difference that will benefit not only those now living in the Keys, but future generations as well.

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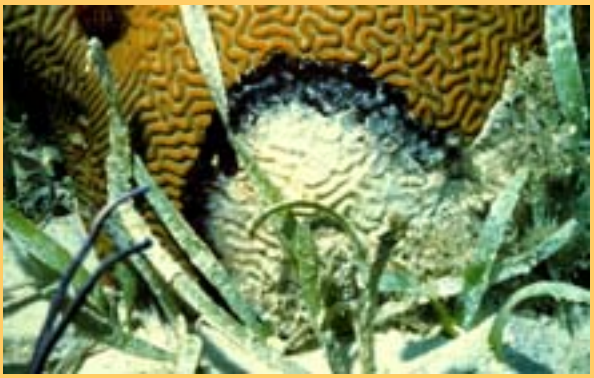
Coral Diseases of the Lower Florida Keys

Lauri MacLaughlin, Resource Manager
Florida Keys National Marine Sanctuary, Lower Region

Coral Diseases

A coral disease is defined as any impairment of the organism's vital bodily functions or systems, including interruption, cessation, proliferation or other malfunction, originating from either biotic or abiotic sources. Diseases of corals and other reef organisms may be increasing as global and local ecological changes occur, and, therefore, may serve as indicators of such changes.



Black-band disease, a complex of cyanobacteria and other micro-organisms, is destroying the living tissue of this brain coral located at Bird Key in the Dry Tortugas. (Photo courtesy of Don DeMaria)

Coral growth rates range from 10 centimeters per year for the branching corals *(Acroporids)*, to 1 centimeter per year for the brain and star boulder corals. Coral disease mortality rates, under ideal conditions, can be as high as 1 centimeter per day for white plague disease, and 1 millimeter per day for black-band disease. You can understand why scientists are very concerned about the presence of diseases in coral reef ecosystems when the disease rates for a single day challenge the coral's annual growth rate.

Coral Diseases in the Florida Keys National Marine Sanctuary

Coral diseases were observed in the tropical western Atlantic such as "black line disease" and "plague" and described as far back as the early 1970s. Traditionally, scientific studies have focused on the incidence of a single disease within a small geographic area.

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This elliptical star coral, at Sand Key Reef, is infected with a white plague type II pathogen. The yellow-orange area is the remaining living tissue not yet effected by the disease. (Photo courtesy of G.P. Schmahl)

Scientists began to focus increased attention on coral diseases in the Florida Keys National Marine Sanctuary during the summer of 1995 due to reports from the National Undersea Research Center in Key Largo, and in 1996 due to reports from Craig Quirolo at Reef Relief. Both groups were concerned that disease outbreaks were occurring along the reefs at alarming rates. A group of scientific experts and resource managers were promptly called upon to conduct a rapid assessment of disease outbreaks in the Lower Keys, including field observations and collections. Dr. Deborah L. Santavy of the U.S. Environmental Protection Agency (EPA) was involved in this work and her research and monitoring in the sanctuary continues today. While coral reefs are in decline throughout the world, disease and bleaching appear to be among the leading contributing factors in the Florida Keys.

The objective of Dr. Santavy's survey is to use quantitative assessment methods to characterize the distribution and frequency of coral disease in the Lower Florida Keys. The EPA has conducted research cruises each summer since 1997, sampling 36 sites on the reefs between Key West and the Dry Tortugas. The study utilizes a circular (10 meter radial arc) transect method developed by Edmunds in 1991. Coral counts, diseased coral counts, and bleached coral counts are recorded to determine the distribution and frequency of disease. Data reveals 11 disease conditions affecting 18 species of stony corals and sea fans. According to research completed in 1998, the greatest incidence of disease and bleaching was found on the Key West reefs, where approximately 22% of the corals were diseased and 26% were bleached.

The focus of the sanctuary's involvement in coral disease work includes assessment, treatment, and ongoing monitoring. For example, sanctuary staff supports the EPA disease cruises each summer, and the sanctuary funded the development and implementation of the Marine Ecosystem Events Response

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Assessment (MEERA) rapid-response program at Mote Marine Lab.

The MEERA program encourages the public to report unusual or significant biological events that adversely affect marine organisms, such as disease outbreaks, coral bleaching, fish kills, and algal blooms (including red tides). These reports will help scientists and resource managers coordinate the early detection and assessment of such events by sending out response teams.

Harold Hudson, FKNMS Coral Reef Restoration Biologist, is seen aspirating the black band from the surface of a brain coral using a vacuum operated apparatus of his own design. (Photo courtesy of FKNMS)

The sanctuary staff of Looe Key National Marine Sanctuary began monitoring a severe outbreak of black-band disease on the sanctuary's fore reef in 1986. Harold Hudson of the U.S. Geological Survey initiated an experimental treatment program in 1987. He removed the black band, which appears as the interface between live tissue and dead skeleton, with a vacuum technique that used air to lift the black band of disease off the surface of the coral skeleton. As some microscopic filaments inevitably remained, he discovered that applying modeling clay (by pressing it into the coral skeleton) would successfully smother the unseen pathogen. Today, this work continues, as severe outbreaks were observed again in 1995, 1996 and 1999. Monitoring to determine the success of treatment is under way.

Coral Bleaching Coral colonies among the coral reef appear in a variety of colors due to the presence of a microscopic algae that lives within their tissues. Through the process of photosynthesis, the algae provide oxygen that fuels respiration in the coral. Likewise, the coral produces carbon dioxide that is utilized by the algae. The two work cooperatively in a beneficial relationship,

which is described as "symbiotic," to maximize growth.

Coral bleaching is described as the loss of symbiotic algae or algal pigments from the coral tissues (gastrodermal cells), which results in the appearance of the white coral skeleton through the translucent coral tissue. The corals appear white, as though it has "snowed" on the reef, and tissue loss may occur if the condition

This star coral has lost its symbiotic algae, giving it a white appearance. Coral can survive for a short time without this algae, but if they remain expelled for an extended period of time, the coral will die. (Photo courtesy of FKNMS)

persists for a period of time. Coral bleaching is a generalized stress response to extremes of temperature, salinity, ultraviolet radiation, changes in the level or quality of light, sedimentation and turbidity, and possibly, carbon dioxide increases. In the Mediterranean, scientists have isolated a *Vibrio* bacterium that causes bleaching. By definition, coral bleaching is considered a diseased condition of corals.

Coral bleaching observations have been recorded and monitored by the Keys sanctuary staff since a severe bleaching event in 1988. Sanctuary Manager Billy Causey has documented coral bleaching events at Looe Key in September 1990, and throughout the Keys in 1998. These periods were characterized by doldrum, lake-like conditions resulting in warm water temperatures, as high as 93 ° F, along the reef tract. During the 1990 event at Looe Key, the staff conducted surveys and collected bleaching data. A range of 75%to 90% of all coral species located in the reef crest zone were bleached. While corals are often able to survive bleaching events, sometimes the tissue dies back. Mortality had occurred, in this case, shortly after the bleaching event, which affected mostly fire coral and elkhorn coral. The sanctuary staff continues to document the reef's condition, in collaboration with EPA, during the annual research cruise.

For More Information on Coral Diseases Descriptions of coral disease types and their symptoms can be found in a the paper entitled "Microbial Pests: Coral Diseases in the Western Atlantic" by D.L. Santavy and E.C. Peters (1997 Proceedings of the 8th International Coral Reef Symposium 1:607-612.) or on **The Coral Disease Page Web site**.

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Coral Spawning: 'Romance' Under a Starlit Sky

David R. Eaken
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Coral Reef Monitoring Project

A colony of Elkhorn coral, (*Acropora palmata*), is one of the large reef-building corals in the Florida Keys that spawns each year after the full moon in August. (Photo by John Halas, FKNMS)

Participating in a night dive over a coral reef during the height of the summer is an ideal way to spend an evening in the midst of one of the hottest months of the year. But once a year, for a very brief period of time, the coral reefs of the Caribbean become truly magical. On the eighth day following August's full moon, many species of coral will spawn. This phenomenon, which was only discovered in 1982 on Australia's Great Barrier Reef, has been witnessed by very few divers and scientists. Matt Patterson, a Park Ecologist for Biscayne National Park, describes a coral spawning event he experienced in the Dry Tortugas as "an upside-down snowstorm of iridescent orange, white and red egg sacs and sperm floating toward the surface for a chance rendez-vous."

Coral researchers have now been able to document that most large, reef-building boulder corals use this strategy of the precise and simultaneous release of sperm and eggs. Although corals reproduce by many other means, mass spawnings are probably the most unusual, and certainly the most exciting method, to observe. Biologists believe that corals developed this cooperative approach for a number of reasons. A mass spawning event allows all of the colonies of one species to mix genetically and to maximize the

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This mature colony of boulder coral, (*Montastrea cavernosa*), began life as a single polyp that reproduced asexually to form an entire colony. The original polyp resulted from sexual reproduction when an egg and sperm united in the water column after a mass spawning event in boulder corals. (Photo courtesy of FKNMS)

chance for fertilization. Many fish take advantage of the spawning event to feed unmercifully on the released sperm and eggs. However, during a spawning event, there is such an incredible amount of food available that it is believed that the predators become overwhelmed with more food than they could ever consume.

No one really understands what factors contribute to triggering a spawning event or how corals synchronize to spawn all at the same time. Nevertheless, because spawning events can be effectively predicted from closely observing the lunar phase, this is undoubtedly an important influence. Scientists also believe that water temperature, tidal fluctuations, and length of the daylight period may contribute to corals spawning on cue.

Most of the corals that reproduce by mass spawning are hermaphrodites. Hermaphroditic corals possess both sperm and egg in each individual polyp. When a hermaphroditic coral begins to spawn, each polyp releases both sperm and egg in a bundle that resembles a BB or a small seed. Once this fragile bundle is released, it floats freely, slowly traveling toward the surface. Upon reaching the surface, it easily ruptures and breaks apart, where it adds its gametes to the genetic "soup." Although

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most mass spawning corals are hermaphroditic, a lesser number of mass spawners are gonochornic. Unlike their hermaphroditic cousins, gonochornic corals release either eggs or sperm, but not both. Gonochornic corals depend on a neighboring colony of the opposite sex to complete the fertilization process.

Close-up of Boulder coral (*Montastrea cavernosa*) polyps. Hermaphroditic corals simultaneously release both sperm and eggs from their polyps into the water column where fertilization takes place. (Photo by Paige Gill, FKNMS)

Every year, some coral colonies die from either natural or human influences. Natural impacts affecting health of coral reefs include occasional hurricanes, extreme cold or warm seawater events, algal blooms, and other reef-dwelling animals that feed on the tissues of corals. Human influences having an impact coral reef health can be very diverse, but include anchoring damage, boat groundings, and coastal runoff that affects water quality. The successful spawning, fertilization, and eventual settlement of a coral that begins life as a single polyp are all necessary to maintain and enhance coral reefs.

Although the spawning period may last only for a few hours each year, the event is of incredible importance to the viability of coral reefs around the world. Future generations of corals are dependent on the success of these spawning events. Tens, or perhaps hundreds of years ago, these large parent corals also began life somewhere in warm ocean waters, under the light of a setting August moon. Their legacy will be found gently floating to the surface each summer, in a colorful "upside-down snowstorm," for a chance to colonize the reefs of tomorrow.

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CORAL DISEASE

Protecting Ocean Wilderness in the Tortugas

Cheva Heck, Public Outreach Specialist
Florida Keys National Marine Sanctuary

Cheva Heck

" . . . wilderness is not a luxury but a necessity of the human spirit . . " Edward Abbey, *Desert Solitaire*, 1968.

Sixty-five feet below the surface . . .we descend to the top of Black Coral Rock, some 20 feet above the seafloor. Atop the pinnacle looms a multicolored cluster of star corals. Despite the depth, their colors remain vivid -- rose, lavender, mint. Dotting their sides are

sponges in every vibrant color of the rainbow. Feather duster worms snap closed as they sense our approach, cautiously opening like marine flowers when they sense that the danger has passed. Immediately above the coral, hundreds of tiny neon blue chromis and yellow damselfish twinkle like lights on a Christmas tree. At the pinnacle's edge, a school of creole wrasse provides a backdrop to this mesmerizing scene, their showy purple and yellow markings dimmed only slightly by distance in the clear blue water. I turn my gaze just in time to see a southern stingray shake itself free of the sandy bottom. Nearby, a large red

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They may look like plants, but they're comprised of tiny animals -- Bushy tendrils of black coral on a deep reef in the Tortugas (photo: Larry Benvenuti - FKNMS)

grouper perches, curious and unafraid.

Nothing on the surface of these waters suggests what lies below. Out here in the exposed waters of the Tortugas Bank exist none of the trappings that lure millions to the Florida Keys each year. No tiki bars, no sandy beaches, not even any islands. Only water, albeit of a stunning shade of blue. But beneath the waves lie the most luxuriant and most abundantly alive coral reefs in the Florida Keys National Marine Sanctuary.

Coral formations on Tortugas reefs often form a false floor, offering hiding places for predator and prey alike. (photo: Larry Benvenuti - FKNMS)

Clean, clear water and powerful ocean currents fuel the diversity of life in the Tortugas. Coral here is healthier and more abundant than anywhere else in the Florida Keys. On a reef known as Sherwood Forest, a lush coral carpet covers the true bottom several feet below, stretching several miles. Crevices and holes riddle the coral veneer, offering refuge for some small creatures and the undersea equivalent of a duck blind for their predators. Scientists suspect that low light conditions and strong currents cause coral to grow in the strange mushroom and plate formations seen here. Coral cover on this reef exceeds 30 percent, compared to an average of 10 percent on other reefs in the Keys. Underwater, colors normally fade as depth increases. But here in Sherwood Forest, the corals retain their stunning shades at 80 feet, thanks to florescent pigments.

Currents bring the larvae of fish and other creatures to the Tortugas from both the Gulf of Mexico and the Caribbean Sea. As a result, more than 400 species of reef fish inhabit the region, including all species of grouper. A small population of sargassum, or red-tailed, triggerfish is among the unique species found in the area.

All species of gorgonians, corals that lack hard outer skeletons, occur in the region. Black corals, rarely found in the Florida Keys, thrive in the strong currents that circle the walls of coral pinnacles. Plantlike in appearance, their yellow to red outer layer disguises a hard black skeleton. Jewelers consider the skeleton a semiprecious

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material, and collectors have wiped out these creatures in many areas. Also seldom seen, the ancient and graceful creatures known as crinoids, or feather stars, lurk in narrow crevices or inside sponges, rewarding the observant diver.

Coral cover on some Tortugas reefs climbs in excess of 40 percent. (photo: Don Kincaid - FKNMS)

Many species of sponges, corals, algae and other animals and plants account for the riot of color on Tortugas reefs. (photo: Larry Benvenuti - FKNMS)

Pelagic species cruise the deep waters, lured by the warm, swift current of the Gulf Stream. Research suggests that some tuna species may use the Tortugas as a spawning ground, and about 40 species of sharks pass through the region.

The Tortugas region owes its very name to the sea turtles once found here in abundance, but decimated by commercial fishing in the late 1800s and early 1900s. Green, loggerhead, Kemp's Ridley, hawksbill and leatherback turtles still travel these waters, protected now from capture. The islands of Dry Tortugas National Park host the largest remaining loggerhead and green turtle rookeries in the Florida Keys.

Seabirds depend on the clear water of these foraging grounds to sight the small, fast-moving fish upon which they prey. The islands of the Tortugas serve as the only breeding ground in the continental U.S. for sooty terns, brown noddies, masked boobies and the magnificent frigate birds.

Strange coral formations, such as this mushroom shape, grace the deep coral reefs of the Tortugas. (photo: Larry Benvenuti - FKNMS)

Despite the threats that confront the region, the Tortugas remain an ocean wilderness. Now, the Florida Keys National Marine Sanctuary and our partners hope to create a seascape of promise by extending full protection to the undersea riches of this magical place.

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Every Shipwreck Tells A Story

Nancy Diersing, Education Specialist
Florida Keys National Marine Sanctuary

Nancy Diersing

"Many ships that sailed the waters of the Florida Keys lie broken on the ocean floor amid the corals and seagrasses. Today, their wooden and metal remains, adorned with colorful sponges and corals, serve as shelter for a host of tropical fish and invertebrates. Scuba divers and snorkelers have the opportunity to swim around these structures that once served a variety of purposes on the intact ship. Anyone who has observed artifacts from a shipwreck has wondered about the function and original form of the objects found in the wreckage. They may have even asked themselves about the lives of the people who were aboard the ship at the time of its misfortune. What drove these people of the past to explore the vast oceans and lands of the world, and what conditions led to the sinking of the ship that today lies scattered on the seafloor?

Every shipwreck tells a story, and every story provides insight into our history as human beings--clues about the way people lived, their foods, their tools, the things they treasured, and how they viewed the sea and the world around them. A shipwreck holds the secrets to the everyday world of seafaring folks. Artifacts convey knowledge about the technology of the period, making them a treasure of information. As President Harry S. Truman once noted, "There is nothing new in the world except the history you do not know."

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Schoolmaster snappers, *Lutjanus apodus,* make their home around the *Benwood* wreck, located off Key Largo. (photo: Indiana University)

The shipwrecks of the Florida Keys tell many tales worthy of our attention. They recount stories of Spanish galleons with cargoes of gold tossed upon the coral reef by violent storms, and American clipper ships trading goods between the Old and New Worlds. One shipwreck even tells the story of ships under the threat of submarine attack, colliding in the dark of night off Key Largo.

The history of nine wrecks found in the waters of the Florida Keys has been preserved in the Shipwreck Trail, an educational program developed by the Florida Keys National Marine Sanctuary education staff in cooperation with underwater archeologists, historians, and divers. The program provides opportunities to learn about our nation's rich maritime history, and seeks to foster an appreciation and understanding of these irreplaceable remnants of our past. Guides with site maps and historical information are available to those who want to learn more about Keys maritime history.

The wrecks of the Shipwreck Trail fall into three broad periods of Keys maritime history: European Colonial, American, and Modern. The oldest shipwreck in the system, the San Pedro, is an 18th century Dutch-built galleon that represents the European Colonial period. The San Pedro was only one of the many ships in Spain's Treasure fleet destroyed in 1733 by a hurricane shortly after leaving Cuba with a

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cargo of gold, silver, and other valuables. In 1989, the State of Florida designated the San Pedro as an Underwater Archeological Preserve. To enhance the visitor's experience, replica cannons and an authentic 1733 anchor were placed near the ballast stones that mark the wreck site. When the ship was afloat, these stones, held in the hull of the boat, provided added stability in rough seas.

Lost in 1842, large sections of the wooden hull and ballast stones from the square rigged vessel *North American* lay off the Middle Keys. (photo: David Whall)

Sunken in 1889, a metal water tank, wooden timbers and a portion of the mizzenmast is all that remains of the *Adelaide Baker*. (photo: David Whall)

The North American and Adelaide Baker were both sailing ships from the American period. At this time, European shipping tapered off, while American shipping was expanding rapidly. The *North American,* a square-rigged vessel, was lost in 1842 while en route from New York to Alabama. Keys wreckers from nearby communities aided in the three-day salvage effort to save the crew and dry goods. Wreckers also assisted in the salvage of the *Adelaide Baker,* a three-masted vessel that went down off the middle Keys in 1889 with a load of sawn timber. Wooden timbers, a metal water tank, and a portion of the mizzenmast can still be seen today on the *Adelaide Baker* site.

Despite improvements in navigation, shipwrecks still occur in modern times. The *Benwood,* a merchant marine freighter armed with rifles, a gun, depth charges, and bombs, sank off Key Largo in 1942 after colliding with another vessel, the Tuttle. Rumors of German U-boats in the area required that both ships travel blacked out, without lights. In

the collision, the *Benwood's* bow was crushed and her keel was broken. Her bow and much of her hull now lies in 25 to 45 feet of water. Another modern wreck occurred when the *City of Washington* sank in 1917 while being towed by a tugboat. Although she was built as a sailing vessel 1910, she was refitted with a high-powered steam engine that greatly reduced her sailing time. The *City of Washington's* moment in history came one night in Havana Harbor in 1898, when her crew came to the immediate aide of survivors of the explosion that destroyed the *Maine*. This incident

was the final event leading to the Spanish American War during which, the *City of Washington* carried troops and supplies.

The remaining wrecks in the trail, the *Thunderbolt*, *Duane*, *Amesbury*, and the *Eagle*, were all sunk intentionally for use as artificial reefs. Like the other wrecks in the trail, each of these vessels has a rich and varied history. The *Thunderbolt* tended coastal minefields for the Amery's Coast Artillery Corps during WW II. The *Duane*, a 327 foot Treasury Class cutter built under President Andrew Jackson, had an impressive wartime and peacetime record. She participated in four rescues at sea, picking up a total of 346 survivors. In 1985, the *Eagle*, a conventional hull freighter, caught on fire while en route to Venezuela. Although two U.S. cutters responded to her call, the structure of the ship had been destroyed. After being purchased by the Keys Association of Dive Operators and The Florida Keys Artificial Reef Association, she was sunk off Key Largo and now lies in two main pieces in 110 feet of water. The remains of the steel-hulled *Amesbury*, a U.S. naval vessel, are found in two sections lying 200 yards apart in 25 feet of water off Key West. One section contains the remains of the bow and port side, while the other consists of the stern and starboard side.

Lying in 25 feet of water off of Key West, a diver observes the encrusting marine life that has grown over the hull of the *Amesbury*. (photo: Eastern Carolina University)

Divers and snorkelers are encouraged to visit the sites of the Florida Keys National Marine Sanctuary Shipwreck Trail, but are reminded that these resources are the shared legacy of the people of the United States. Removing or damaging artifacts from sanctuary waters not only violates the public trust, but is prohibited by law. Mooring buoys are provided to keep anchor damage to a minimum and divers are asked not to touch the shipwreck structures themselves.

For more information on these cultural wonders, **visit the Shipwreck Trail Web page.**

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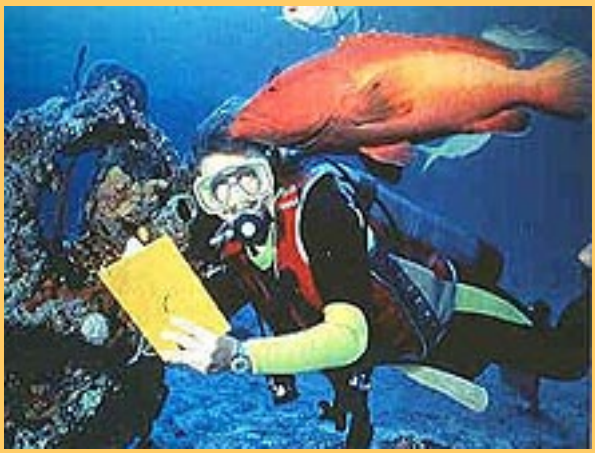
The Reef Environmental Education Foundation (REEF)

Laddie Akins
Executive Director, Reef Environmental Education Foundation

Laddie Akins

During this year's Sustainable Seas Expedition (SSE) mission to the Florida Keys, I will conduct fish assessments in the Dry Tortugas and at Carysfort Reef. REEF's history of data collection in these areas dates back to 1993. I will utilize the materials and methodologies developed for and by the REEF volunteer fish survey program. This program allows and encourages volunteer divers and snorkelers to conduct fish distribution and abundance surveys anytime they dive. The REEF program evolved in the Florida Keys and spread to the greater Caribbean, the Gulf of Mexico, the U.S. West Coast, and Canada, and the tropical eastern Pacific. All data are managed by REEF and publicly accessible on the **REEF Web site**.



During a REEF volunteer fish survey, a diver identifies and documents the relative abundance of fish species he sees. (photo: Michael Lawrence)

The methodologies that REEF uses were tested last year in the *SSE'sDeepWorker* submersibles. The technique for surveying is called the RDT, or roving diver technique (or roving sub technique in the case of the *DeepWorker*). The primary objectives are to record as many species as possible from a specific site and then assign each species into a relative category of abundance. In contrast to more rigorous transect methods, the RDT allows more flexibility in exploring

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new habitats. While less statistically maneuverable, the data tend to provide a more complete picture of the fish assemblages with fewer samples. This fits in perfectly with the SSE objectives to explore new areas, document the occurring species, and define the overall fish assemblage.

During the 1999 SSE, I used both transect and RDT methods in the Gray's Reef, Florida Keys, and the Flower Garden Banks National Marine Sanctuaries. Interesting observations and sightings included three mola mola (ocean sunfish) at Gray's Reef, and the first look at a deep offshore site named Sapelo Scarp, where groupers were the dominant species. In the Florida Keys, species were documented in the Sherwood Forest area and in the newly developing third reef off Craysfort Reef in the Upper Keys. Longsnout butterflyfish, coronetfish, and a huge school of cottonwick grunts were unusual sightings on the deep reef. In the Flower Gardens, manta rays and sharks were common sightings, as were large numbers of grouper and gray snapper on the sloping drop at 170 feet.

The most commonly observed shark in Florida Keys waters, the nurse shark often rests under reef ledges. Their powerful jaws enable them to feed on well-armored invertebrates such as spiny lobster, other crustaceans, and mollusks. (photo: FKNMS)

REEF's Advanced Assessment Team conducts surveys to collect data on fish populations in the Florida Keys National Marine Sanctuary. (photo: FKNMS)

This year's survey effort will focus on generating larger samples in the Sherwood Forest and off Carysfort Reef. When data are entered, two sets of information are output. The first set of data is the sighting frequency, or how often the species is seen. This is represented by the number of surveys in which a species is recorded over the total number of surveys. The second output is the average of the abundance categories; i.e. when the species was sighted, the average of the abundance categories that were recorded. The objective in the upcoming fish surveys is to increase the sample size to more than 20 surveys in each area. This will

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enable us to look at species composition and assemblage in the Keys in a broader perspective in relation to other areas in the Dry Tortugas and around the Caribbean. We expect to find a very different community in the Sherwood Forest area than in the surrounding reef sites due to the different habitat and extremely high coral cover. Just how different the fish composition is will be determined once the data are recorded and entered. More information on REEF's methodologies and data management is available on the REEF Web offering.

REEF Volunteers review fish data collected during a fish count survey dive. (photo: FKNMS)

More than 25,000 surveys have been entered into the REEF data base. These data are becoming increasingly valuable as a management and science tool for describing and comparing fish assemblages at the same sites over time, or at different sites. Most of the data have been provided by volunteer divers and snorkelers, and the opportunity to help gather this valuable information is a strong incentive for many underwater recreationalists to join the effort. Membership in REEF is free, and complimentary survey report forms are provided to any interested divers. Beginning survey materials and courses are also available through REEF. Visit their Web offering for more information.

Read Laddie Akins' log entries summarizing his SSE dives.

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Reflections: What the Sanctuary Means to Me

Fran Decker, Middle Keys Citizen-at-Large Representative
Florida Keys National Marine Sanctuary Advisory Council

Fran Decker

The Florida Keys have long been recognized as a special area. A climate that never experiences freezing temperatures has allowed a variety of unique plants and animals to flourish. The clear, warm waters surrounding the Keys are home to the largest North American coral reef. This special area is not an isolated, desolate place; instead, it is in the middle of world activities. Shipping traffic from the Gulf of Mexico and the Panama Canal pass within miles of the fragile coral reef. Oil is believed to be located below. The Keys are at the bottom of one of the world's major watersheds -- the Everglades. This watershed also abuts an enormous agricultural area. A major metropolis, Miami, is just to the north.

This natural treasure is as valuable as anything in our national parks. This fantastic area deserves protection and good, science-based management. A special area deserves special consideration, and the National Marine Sanctuaries Program provides the means. So, what can the sanctuary do to protect these special resources?

One example is the Tortugas Ecological Reserve Working Group that facilitated the establishment of the nation's

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Brilliantly accented blue tang, *Acanthurus coeruleus*, are excellent "tour guides" for snorkelers who follow their leisurely path. (Photo courtesy of Alan Bunn/FKNMS)

largest marine protected area (MPA). This MPA, as a part of the sanctuary, will set aside a portion of pristine habitat and protect it from all consumptive activities. Many opponents of the MPA concept asked why if the area is so pristine and has such a low level of fishing activity, does it need "official" protection? Why didn't we focus on trying to protect troubled, over-fished areas? To be able to preserve an area before damage to the environment has been done is a unique opportunity, and one that only the sanctuary could provide.

Simply establishing a National Marine Sanctuary doesn't mean that the job is done and that all the problems are solved. There are many vital issues facing the sanctuary, such as water quality, personal watercraft, and enforcement. Unlike a national park, the Sanctuary has 80,000 residents, and more than a million tourists visit each year. Their impact is unavoidable. In fact, the sanctuary has a responsibility and a mandate to work with this "human component" of the ecosystem. To this end:

- The Florida Keys National Marine Sanctuary Advisory Council is an effective way for the public to communicate their concerns directly to the sanctuary staff.
- Volunteer programs provide opportunities for people to get involved in a hands-on way with sanctuary projects.
- Education programs and public workshops are other means for people to have a say in sanctuary issues.

Mooring buoys have greatly reduced anchor damage in the Florida Keys National Marine Sanctuary. Properly used, the floating "pick-up line" attached to the buoy is tied to a boat's own line so that a proper amount of "scope" is maintained. (Photo courtesy of FKNMS)

It is hoped that the Sanctuary Management Plan will be a dynamic one, changing as new and different issues become important, and serving as a useful tool to help resolve them.

Interaction between the people and the sanctuary is vitally

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Raiding parties of large yellow jack, *Caranx bartholomaei,* and bar jack, *Caranx ruber,* are masters of pandemonium. The packs circle schools of grunts, attempting to splinter the groups before slashing through the escaping fishes. (Reef Fish Behavior, Ned DeLoach.) (Photo courtesy of Mike White/FKNMS)

important. It is how the staff knows what is on the minds of the people who live, work, and play in the fabulous Florida Keys. For me, personally, the sanctuary is essential to preserving the fantastic and unique natural resources of the Keys and the surrounding waters. As a member of the Sanctuary Advisory Council, I am proud to be an active participant in the ongoing process of sanctuary management.

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Seagrass: Every Square Foot Counts

Captain Tad Burke
Florida Keys Fishing Guides Association

Healthy seagrass beds are important habitat and home to hundreds of different species. (Photo courtesy of Paige Gill/FKNMS)

Across the nation, the headlines of every major newspaper announced that Yellowstone National Park was burning. The Photographs said it all--thousands of acres charred. Visions of the magnificent park being destroyed tugged at the heartstrings of every American citizen.

Every year, thousands of acres of our undersea forests are scarred and destroyed by unknowing, or, too often, careless watercraft operators. Due to the fact that our undersea forests are not as visible, their destruction goes unnoticed. Yet one square foot of seagrass houses more life than one square foot of forest. The majority of this devastation takes place in water that is less than three feet deep--a depth that constitutes the majority of Florida Bay and Everglades National Park.

As professional fishing guides, we understand the importance of seagrass to a healthy aquatic environment.

Continued destruction not only jeopardizes a way of life, but will rob

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The root system of seagrasses is damaged after destruction by a boat propeller. (Photo Courtesy of Harold Hudson/FKNMS)

future generations of the chance to enjoy these wonderful resources. Guiding is more than just pursuing fish for clients. We must be caretakers of this special place. We live a tidal life and feel the pulse of this aquatic wonderland. Through our daily observations, we see firsthand the changes that are taking place. Ruination of habitat is a chief factor in the reduction of fish populations. We can reduce bag limits and practice catch-and-release, but without a place for the fish to live, we're going backwards. We must do what we can to protect these undersea gardens of Eden that are home to such a variety of life, from small crustaceans to giant tarpon. Our existence is intertwined with theirs.

In every community, there is a battle to save a piece of this precious planet.

We must save the seagrass, as it is a barometer of Florida Bay's health, and, consequently, our own. As we progress, we must realize that we are at the top of the food chain only because we are sustained by what is below us.

Proper use of deeper water channels can help save our seagrass beds. (Photo courtesy of Curtis Kruer)

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Key Largo's Sanctuary Preservation Areas (SPAs): 21 Years of Observations

Stephen Frink
Diver and Photographer

Author Stephen Frink (photo: Wayne Blevins/ Waterhouse)

I have been diving the reefs off Key Largo since 1978. Unfortunately, these reefs have suffered all too many negative changes during the past 21 years, but there have been some significant successes as well, thanks to the stewardship of NOAA via the National Marine Sanctuaries Program.

Photographer Jerry Greenberg is a good friend, and he has been diving these reefs much longer than I. He tells stories of how they looked in the late 1950s, with acres of totally intact elkhorn gardens, massive star coral boulders, and an abundance of marine life that was inspirational to behold.

Spearfishing, coral collection, and proximity to an urban population have threatened and damaged this wondrous marine environment.

But we are grateful that a group of insightful conservationists generated sufficient public and government support for the creation of the John Pennekamp Coral Reef State Park in 1960. This, at least, began a conservation mind set that has served this area well through the proceeding years.

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Commercial dive boats offer residents and visitors the opportunity to dive or snorkel on the beautiful coral reefs of the Florida Keys. Currently, there are approximately eighty dive shops located throughout the Keys, which take approximately nine hundred thousand divers and snorkelers to Keys reefs annually. (photo: Paige Gill - Florida Keys NMS)

The State of Florida's jurisdiction extends only three miles offshore, but by an accident of geography, the coral reefs that needed protection here in Key Largo were four to Six miles offshore. Thus these reefs required Federal Protection. Fortunately, NOAA was able to step in with the creation of the Key Largo National Marine Sanctuary. The Prohibition of spearfishing and coral collection provided a philosophy of protection, but other creative conservation measures were also inaugurated. Mooring buoys are a good example.

In the early years of the Key Largo commercial dive industry, the captains would have to find dive sites by triangulating with shore ranges. Admittedly, finding sites around the Elbow or Molasses Reef wasn't too difficult with their large lighted towers, but finding the Benwood or Pickles, or even the Christ of the Abyss statue, could be tough.

Then, once they found the site, they'd have to drop an anchor. They were usually careful to drop the hook in the sand, but anchors drag, even on calm days. The line could entangle and abrade coral heads, or worse, the chain and anchor could uproot and destroy large sections of coral.

Located in 20 feet of water at Key Largo Dry Rocks, Christ of the Abyss is a duplicate of a statue placed in the Mediterranean off Genoa, Italy. Growths of fire coral, sea fans, and algae provide a deep-sea ambiance to the bronze statue, and it is the site of many underwater weddings. (photo: Bill Keogh)

If, despite their best efforts, even the commercial dive boat captains had problems keeping the hook from impacting the coral, imagine what happened when an inexperienced or indifferent pleasure boater was at the helm. Sometimes we'd see them actually target a stand of coral with their anchor just to make sure the hook got a good bite. When the wind direction shifted or intensity increased,

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there were anchors dragging everywhere.

Boat captains might want to pick up and reset their anchors, but by then, divers could be climbing up the ladders. The captain couldn't go into gear or maneuver, and if the reef got damaged, there was simply no other solution at that moment. It was generally becoming a bad situation, made ever worse by the increasing popularity of the Key Largo National Marine Sanctuary for visiting scuba divers. Then, the mooring buoy program was implemented here.

The Halas Mooring Buoy System, designed by Sanctuary Resource Biologist John Halas, is a way to prevent anchor damage to the reefs. This system is now used around the world, including more than 400 buoys that the Florida Keys National Marine Sanctuary maintains in its waters. (photo: FKNMS)

Mooring buoys are now prevalent in marine parks worldwide, but in the mid-1980s they were a revolutionary, trend-setting concept. Boaters could now find the best dive sites because large white boys marked them, and they could tie off easily without ever having to drop an anchor. Mooring buoys were secure and easy to use, and, ultimately, so many were installed in the Key Largo National Marine Sanctuary that anchor damage was largely eliminated on our core reef areas.

Of course, damage still occurs from diver impact, and degrading water quality has become a huge problem over the years. Storms like Hurricane Georges in the fall of 1998 wiped out large stands of elkhorn and toppled boulder corals. Actually, I think Georges made the most profound impact of any single incident over in my recollection. But storms are part of the natural sequence. There is nothing NOAA or the Florida Keys National Marine Sanctuary can do about them. They devote their resources and attention to the things they can change, like enhancing the amount of marine life on the reefs.

The concept of "zoning" is integral to the management plan of the Florida Keys National Marine Sanctuary. The sanctuary is a massive resource to control, but NOAA recognized that within these 2,800 square nautical miles, there should be zones in which specific recreational and scientific purposes are allowed, and other zones in which specific activities are prohibited.

Spearfishing and hook-and-line fishing are popular recreational uses of the sanctuary that we are mandated to accommodate. But what if a few areas were designated "no take" in which hook-and-line, spearfishing, and even lobstering were prohibited? This was the grand experiment authorized under the Florida Keys National Marine Sanctuary Act of 1990, and, to my mind, one of the past decade's grand successes in marine resource management.

There are more than 106,000 boats registered in South Florida, making boating one of the most popular activities in the Florida Keys. (photo: FKNMS)

The Sanctuary Preservation Areas (SPAs) are located throughout the Keys, but I am most familiar with the SPAs off Key Largo, so will restrict my observations to them. Large yellow buoys mark SPA zones, and within these SPAs, a "no-take" environment has been established, thereby removing human consumption factors. The natural predators of the coral reef still exist, and, in fact, are more prevalent, because the food chain is less disrupted by human impacts.

Within six months after the SPAs were established, the increase in marine life was extraordinary. There are more fish, friendlier fish, and a greater diversity of marine life now encountered within the SPAs. We are seeing large schools of snapper and grunt, jacks, and, of course, the big predators like barracuda and even shark. Grouper are making a comeback as well.

Spearfishing has been illegal off Key Largo since 1960, but almost immediately, we began to get a sense of how profound the effects of hook-and-line fishing had been on

The most colorful member of the grunt family, the porkfish, may be seen in large or small schools seeking the shelter of the reef by day, and feeding throughout a larger range at night. (photo: FKNMS)

our reefs over the years. In fact, seeing what these few SPAs have done for selected reef areas in Key Largo, I would support the entire Key Largo reef tract, including the shipwrecks *Bibb* and *Duane*, being protected as SPAs. While that may never happen, due to the demand for access to recreational sportfishing, the concept of the SPA is alive and well in Key Largo, and has clearly proven successful, and should be expanded to include larger areas than the tiny percentage of the sanctuary currently protected.

When the *Spiegel Grove* shipwreck is sunk off of Dixie Shoals, I hope that it too can be designated as an SPA. Then, not only will we have more marine life to observe, the scientific question of how well a shipwreck attracts and retains marine life will be better answered.

This aerial shows the development in the Key Largo area. (photo: FKNMS)

Clearly our reefs are continually being challenged by natural and manmade threats to their very existence, but NOAA, through the National Marine Sanctuaries program, continues the fight to sustain our coral reefs and marine resources. As one who has made his living capturing the beauty of our reefs on film, I appreciate the agency's efforts.

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Biographies

These biographies identify partners in the Sustainable Seas Expeditions' mission to the Florida Keys National Marine Sanctuary. They are listed alphabetically.

Laddie Akins, Executive Director
Reef Environmental Education Foundation (REEF)

Laddie Akins

Laddie Akins is the Executive Director of the Reef Environmental Education Foundation (REEF), a nonprofit organization referred to as the underwater equivalent of the Audubon Society. A multi-agency scuba instructor and U.S. Coast Guard-licensed captain, Laddie has worked extensively in developing educational and fish survey programs for the Caribbean, Florida, Gulf of Mexico, California and Pacific northwest. He has lectured extensively on marine life issues and field identification. His dive experience includes logging thousands of scuba dives over the past 17 years and serving as team leader on over 40 field survey expeditions.

Steve Baumgartner

Steven V. Baumgartner, Operations Officer
Florida Keys National Marine Sanctuary

After graduating from St. Petersburg College and San Jacinto College, receiving degrees in both Physical Therapy and Pre-Medicine, Steve Baumgartner attended the Texas College of Chiropractic Medicine. After completing a internship and residency in both Houston, TX and Tampa, FL he opened a private practice in Tampa, Florida. A career shift in 1986 led Steve to pursue a career in Marine Science. He taught Marine Science at the Tampa Marine institute until 1988. I relocated to Summerland Key, Florida and became a full-time charter boat captain, as well as a fishing and dive guide. During his time as guide, he observed a steady decline of the Florida Keys ecosystem and decided to take

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on the personal mission of protecting this fragile environment. He began this quest by volunteering for the Looe Key National Marine Sanctuary in 1993. Eventually he was hired as a part-time employee in 1994 in the education department. From there, he accepted a position as an Environmental Specialist, eventually becoming the Operations Officer, in the Key West office.

Billy D. Causey, Superintendent
Florida Keys National Marine Sanctuary

Billy Causey

Billy Causey is currently the Superintendent of the Florida Keys National Marine Sanctuary. He was appointed to the position in 1993, following two years as Sanctuary Project Manager. As the lead National Oceanic and Atmospheric Administration (NOAA) official in the development of the management plan for this 2800 square nautical mile marine protected area, he serves as the liaison with local, state and other federal agencies responsible for management of natural resources in the Florida Keys. Mr. Causey received a Bachelor of Arts degree from the University of Corpus Christi in 1967, and a Master of Science degree from Texas A&I University in 1969. Three years of post graduate work at the University of South Florida introduced him to the Florida Keys coral reef ecosystem. Causey has served with the National Park Service as a Park Ranger and has also worked as a commercial diver and research assistant. From 1972 until 1983 Mr. Causey owned and managed Aplysia Aquarium Collecting and Research Center in partnership with his wife Laura. Between 1983 and 1991 Mr. Causey managed the Looe Key National Marine Sanctuary.

Sylvia Earle

Sylvia Earle, Explorer-in-Residence
National Geographic Society

Marine biologist Sylvia Earle is an Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion--the oceans--and is the project director of the Sustainable Seas Expeditions. Her research places special emphasis on marine plants and developing technology to access and conduct research in the deep sea. Named one of *Time Magazine's* "Heroes for the Planet" in 1998, Dr. Earle pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She also holds numerous diving records. In the 1980s, Dr. Earle

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founded her own company, Deep Ocean Exploration and Research Inc., and cofounded Deep Ocean Engineering Inc. She is also a former chief scientist of the National Oceanic and Atmospheric Administration. She has authored more than 100 scientific and popular publications, including the 1995 book, *Sea Change*, and three 1999 books related to the SSE: *Wild Ocean: America's Parks Under the Sea*, *Dive*, and a children's book, *Hello Fish*. As the spokesperson for SeaWeb, a conservation initiative of the Pew Charitable Trusts, she strives to increase public awareness of the pressures facing the world's coastal and oceanic realms. In early 1999, she played a key role in the Clinton administration's decision to double the budget of NOAA's national marine sanctuaries. She holds a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as well as nine honorary doctoral degrees.

Kip F. Evans, Expedition Photographer
Sustainable Seas Expeditions

Kip Evans

As the official photographer for the Sustainable Seas Expeditions, Kip Evans captures the visual splendor of scientific discovery, exploration and outreach. For 10 years, he has worked as both a still photographer and an underwater cinematographer. Since 1985, he has logged over 1,000 hours underwater documenting marine life, performing research and participating in search-and-recovery operations. Mr. Evans has worked on a variety of documentaries, including a recent special on the life of Dr. Sylvia Earle, *Her Deepness*, for CNN, and a Discovery Channel news story on the declining squid fishery off the California coast. His photographs have appeared in Rodale's *Scuba Diving*, *Dive Training*, *Coast & Ocean* and *Aqua* magazines, and on the front covers of such newspapers as *USA Today*, the *San Francisco Examiner*, *San Diego Tribune*, and *Santa Cruz Sentinel*. His clients include NOAA's National Marine Sanctuary Program, the National Geographic Society, Oceanic Diving Equipment, and the UnderWater World Aquarium in San Francisco. He holds a bachelor's degree in environmental studies emphasizing marine biology from the University of California at Santa Barbara.

Laura Francis, NOAA SSE Education Coordinator
NOAA's National Marine Sanctuaries Program

Laura Francis has been the education coordinator of the Channel Islands National Marine Sanctuary since 1994, and is currently coordinating the educational components of the Sustainable Seas

Laura Francis

Expeditions. She develops educational materials for teachers and students, produces teacher workshops and student summits, coordinates live SSE Webcasts, and is the principal investigator of two of this year's SSE research projects in the Channel Islands. She holds a B.A. in zoology from Berkeley and a master's in deep-sea biology from the University of California at Santa Barbara. With more than 10 years of professional experience in marine science education and research, she finds her work most rewarding when she discovers innovative ways to integrate the two disciplines.

John Halas, Resource Manager, Biologist
Florida Keys National Marine Sanctuary

John Halas

John Halas has been employed by the National Marine Sanctuary (NMS) Program in the Florida Keys since October 1980. He first served as a State of Florida Park Biologist in the Key Largo National Marine Sanctuary, then as Sanctuary Biologist and Resource Manager in the Key Largo NMS and Florida Keys NMS. John helped develop and currently implements the FKNMS management plan with specific duties tied to the following action plans: Zoning, Mooring Buoy, and Submerged Cultural Resources. He also documents impacts on natural, recreational, and commercial activities. Mr. Halas developed, improved and deployed a unique coral reef mooring buoy system for reducing environmental anchor damage in the Florida Keys. In addition, he has assisted over 30 overseas regions (countries, U.S. territories, and Hawaii) during more than 40 separate projects with mooring buoy training and/or installation to help alleviate environmental anchor damage on coral reefs worldwide.

NO PHOTO AVAILABLE
Jane Hawkridge, Ph.D., Post-doctoral Fellow
Mote Marine Laboratory

Jane Hawkridge is a post-doctoral fellow at Mote Marine Laboratory's Center for Tropical Research in the Florida Keys. Her research focuses the physiological and biochemical responses of scleractinian corals to both natural and anthropogenic environmental stressors such as increases in sea water temperature and pollution. In addition, she is also interested in the potential for disruption of reproduction and development of corals caused by environmental stressors.

Cheva Heck

Cheva Heck, Public Outreach Specialist
Florida Keys National Marine Sanctuary

As the public outreach specialist for the Florida Keys National Marine Sanctuary, Cheva Heck works with local, regional and national print, radio and television to spread the word about the fascinating projects underway to protect the coral reef ecosystem of the Florida Keys. Heck received a bachelor's degree in anthropology with an archaeology concentration in 1990 from The George Washington University in Washington, DC. Upon graduating, she spent several years as a reporter and editor covering federal agencies. In 1994, motivated by a desire to live close to the ocean, she moved to Key West and served as a grassroots organizer for local and national conservation groups before coming to work for the Sanctuary in 1997. An avid scuba diver and frustrated marine biologist, she particularly appreciates the opportunities her work provides to join researchers and resource managers in the field.

NO PHOTO AVAILABLE
Erich Mueller, Ph.D., Director
Mote Marine Laboratory

Dr. Erich Mueller is the Director of Mote Marine Laboratory's Center for Tropical Research in the Florida Keys. His research is focussed on scleractinian corals including mechanisms of calcification, environmental controls of growth, reef restoration and patterns of coral disease occurrence. He primarily works in the Florida Keys and Bahamas with experience in Jamaica and Australia. He has been a visiting scientist at the Observatoire Océanologique Européen (Monaco) since 1993.

Lcdr. Dave Savage, Manager, Upper Region
Florida Keys National Marine Sanctuary, Key Largo

Dave Savage

Dave Savage is a NOAA Commissioned Corps officer who currently manages the Upper Region of the Florida Keys National Marine Sanctuary in Key Largo, Florida. He is also a Deepworker 2000 submersible pilot for the Sustainable Seas Expedition. Dave has been with NOAA for 15 years and has been involved in a wide variety of operational and scientific activities. He started his career as an officer aboard the fisheries

research vessel NOAA Ship Miller Freeman, which does most of its research in Alaska. Dave then worked as a fishery biologist in the Northwest and Alaska Fisheries Science Center in Seattle, Wa. He then continued his support of fisheries research as Executive Officer of the NOAA Ship Cobb, which supports the Auke Bay Fisheries Laboratory in Juneau, Alaska. Following the work in Alaska, Dave became an aircraft pilot for NOAA. In his capacity as pilot, he has flown numerous research missions, including aeronautical charting, coastal mapping, remote sensing, and fisheries surveys. He hopes to complete his NOAA Corps career flying the high altitude hurricane reconnaissance mission. Dave is also a certified NOAA divemaster and diving medical technician.

Mary Tagliareni

Mary Tagliareni, Education Coordinator
Florida Keys National Marine Sanctuary

Mary Tagliareni has been living and working in the field of education in the Florida Keys for the past fifteen years. She is currently the education coordinator at the Florida Keys National Marine Sanctuary and has held prior positions at the Sanctuary as a Law Enforcement Officer and Volunteer Coordinator. She designs educational materials and programs including brochures, posters, videos, and Team OCEAN. The State of Florida Department of Environmental Protection recognized her achievements in 1997 by presenting her the "Sustained Exemplary Performance" award. In 1999, she was recognized as the "Outstanding Team Member" of the Florida Keys National Marine Sanctuary. She holds a Bachelor of Science degree from Western Illinois University.

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SUSTAINABLE SEAS EXPEDITIONS

WEATHER

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Current weather conditions and coastal marine forecasts are essential to the careful planning and implementation of the Sustainable Seas Expeditions. Weather and sea state often determine if the DeepWorker and other scientific equipment can be safely launched from the host ship. Large sea swell, high wind, waves, rain or dense fog may force the cancellation of dives until conditions improve. Updated weather information helps the SSE team make better informed decisions about launch, operations, and recovery.

This page offers two types of weather information:

1. **Current Weather**. The current weather conditions (temperature, wind, sea state, etc.), using data extracted from the National Data Buoy Center, will be available for each sanctuary. Due to their size, some sanctuaries contain more than one buoy.

2. **Coastal Marine Forecast**. The coastal marine forecast (wind, waves, swell, advisories, etc.), using data extracted from NOAA's National Weather Service, will be available for the general vicinity of each sanctuary.

For more information visit the Web sites of the **NOAA National Weather Service** and the **National Data Buoy Center**.

Current Weather

Select the sanctuary of your choice for their current weather conditions. Since some sanctuaries are very large, several buoys can be found. Location maps are provided for each buoy.

Channel Islands (**46053**, **46054**, **46063**)	Hawaiian Islands Humpback Whale (**51002** (buoy in for repair), **51003**)
Cordell Bank	**Monitor**
Fagatele Bay (No buoys present)	**Monterey Bay**

Florida Keys (**DRYF1**, **FWYF1**, **MLRF1**, **LONF1**, **SMKF1**, **SANF1**)	**Olympic Coast**
Flower Garden Banks	**Gerry E. Studds Stellwagen Bank**
Gray's Reef	**Thunder Bay Proposed**
Gulf of the Farallones	

Coastal Marine Forecast

Select the sanctuary of your choice to view a recent coastal marine forecast. Due to their size, several forecasts may be offered.

Channel Islands (all buoys have same forecast)	Hawaiian Islands Humpback Whale (**51002**, **51003**)
Cordell Bank	**Monitor**
Fagatele Bay	**Monterey Bay**
Florida Keys (**DRYF1**, **FWYF1**, **MLRF1**, **LONF1**, **SMKF1**, **SANF1**)	**Olympic Coast**
Flower Garden Banks	**Gerry E. Studds Stellwagen Bank**
Gray's Reef	**Thunder Bay Proposed**
Gulf of the Farallones	

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SEN. BOB GRAHAM

EXPEDITION UPDATE

August 16 - August 29, 1999

The Florida Keys National Marine Sanctuary is the nation's second largest sanctuary, and home to our only barrier reef system. It is a beautiful and magical warm water paradise, but also very fragile, and vulnerable to a wide variety of human-caused threats, including pollution, overfishing, and direct damage to the coral by boats.

The first week of the Florida Keys mission will take us to the Dry Tortugas, 80 miles west of Key West. In addition to the NOAA ship FERREL, we'll have the Sanctuary's research vessel the DANTE FASCELL onsite, and another boat, the Cool Hand, with observers and project participants aboard.

We'll be doing site characterization, biological inventories, and geological studies in this remote and largely unexplored area, and we'll also examine the effects of waters from the Gulf of Mexico on the deep reef tract west of the Tortugas.

During the second half of the mission, we'll be working our way from Key West along the upper Keys towards Key Largo. Habitat characterization, fish counts, studies of artificial reefs, and coral and sponge health surveys, will keep us very busy during this week of the mission.

Sunday, August 15. VIP day kicked off the beginning of the Florida Keys mission. Terry Garcia, Assistant Secretary for NOAA, U.S. Department of Commerce, and Sally Yozell, Deputy Assistant Secretary for NOAA, U.S.

LOG

August 15-16, 1999

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Department of Commerce, had the opportunity to dive the sub, as did Rick Allen, President of National Geographic Ventures, and Mark Shelly of Sea Studios, Producer of a major National Geographic television series called "The Shape of Life." Sunday night, the FERREL headed out to the Dry Tortugas, 70 miles beyond Key West, to begin the project's science dives.

Monday, August 16. In the morning, Sylvia Earle completed a dive on De Maria's Hump, a reef near an area known locally as "Sherwood Forest" for its magnificent, diverse, and dense coral formations, and for the cone-shaped corals that are unique to this area. In the afternoon, one of our scientists, Walt Japp, completed another dive nearby.

We finished out the first week of the Florida Keys mission with more successful dive days. Friday, August 20 included both sub dives, and a live satellite broadcast from the reef.

Saturday, August 21 was a day to regroup and prepare for upcoming activities.

Sunday, August 22 we had a very successful open house in Key West, Florida with over 800 visitors touring the FERREL and getting an up close look at the subs.

On August 23, renowned National Geographic photographer, Emory Kristof, dove the sub at Molasses Reef off Key Largo. A film crew from German television did a scuba dive to join Emory on the reef and capture images of his dive.

On August 24, we had more successful science dives, and photographer Kip Evans, along with John McDonough and myself, took a ride in a Coast Guard Dauphine helicopter to shoot aerial video of the sub and ship.

The remainder of the week saw additional science dives, and a special dive bringing the DeepWorker to the Aquarius underwater habitat. Overall, we felt we were able to accomplish a great deal during this mission, and we are eagerly looking forward to next year's visit to this

August 27, 1999

Summary of Education

Summary of Investigations

sanctuary.

The scientists from the Flower Garden Banks have flown to Key West so they can transit with the ship to the site of the next mission. This will save the ship more than a day of additional transit time that would be required if they had to pull into port in Texas to onload the science party. The next mission begins on September 1. We hope you'll join us!

- Gale Mead, Expedition Log Editor

Interview

Interview with Billy D. Causey, Superintendent
Florida Keys National Marine Sanctuary
August 1999

What are your objectives for the Sustainable Seas Expedition in the first year?

Click here for audio response. (RealAudio), for help see About this Site

Billy D. Causey (photo credit: FKNMS)

For the first year of the Sustainable Seas Expedition in the Florida Keys National Marine Sanctuary, a primary objective is to focus local and national attention on the importance of the ocean environment and how technology can help us learn more about the ocean. We will also be able to use the Sustainable Seas Expedition to explain how people are affecting the oceans; but more importantly, how people can help protect and preserve the ocean environment.

The Sustainable Seas Expeditions (SSE) will also give us the opportunity to focus attention on the diverse underwater resources contained in the 12 National Marine Sanctuaries, and on the similar threats that these resources face.

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Another objective of the SSE is to help demonstrate the need to protect habitat in the sea, just as we do on land in our national and state parks.

Another objective of using this cutting-edge underwater technology is to launch several multiyear research projects that will help raise awareness about our ocean environment and help us protect resources in the nation's National Marine Sanctuaries.

As the expeditions progress, we hope to deepen people's understanding and awareness of our nation's most significant marine treasures.

What is the most important part of your job as Sanctuary Superintendent?

Click here for audio response.

The most important part of my job as Sanctuary Superintendent is to assure the implementation of Sanctuary Management Programs that will help protect, preserve, and conserve the sanctuary's resources for the use and enjoyment of future generations.

Another important aspect of my job is to gain the trust and cooperation of stakeholders in the sanctuary by enlisting them as partners in helping us protect sanctuary resources. By listening carefully to those who live, work, and play in sanctuary waters, and communicating with them in a variety of ways, we all become better stewards of the marine environment.

As the Superintendent it is important for me to work with a very diverse group of stakeholders, including other government agencies

In 1992, Hurricane Andrew damaged some of the corals in north Key Largo. Sanctuary Biologist Harold Hudson transplanted pillar corals, *Dendrogyra cylindrus*, immediately after the storm, and is measuring their growth rate in this photo. (photo credit: FKNMS)

at the local, state and national levels; commercial and recreational fishermen; dive operators and divers; conservation groups; and citizens who either make their living on the water or simply use the ocean for their recreation and pleasure.

A very important aspect of my job is to balance the use of sanctuary resources with their protection. One of my greatest challenges is to consider how to accommodate multiple uses while still meeting the primary goal of resource protection. Balancing the protection of sanctuary resources with the continued use of those resources requires hands-on, continuous management that errs to the side of conservation.

How will the Sustainable Seas Expeditions help you better manage the resources of the Florida Keys National Marine Sanctuary?

Click here for audio response.

(top)

The Sustainable Seas Expeditions will help us better manage the resources of the Florida Keys National Marine Sanctuary in a variety of ways.

First, consider our research and monitoring program. The Sustainable Seas Expeditions will allow us to visit parts of the sanctuary that it would be difficult to reach using conventional

scuba-diving equipment. The DeepWorker gives us the luxury of time underwater--time to explore, time to collect more complete information than a brief dive would allow. Research can, of course, be done from the surface--our scientists do it all the time--but what they see from the surface is but a "snapshot" of what they may observe from inside the DeepWorker.

The SSE will help us document and assess deep-water habitats. We will be able to explore deep-water coral reef communities and determine their role in the overall functions of coral reefs in the Florida Keys. The deep-water coral habitats are the most plentiful of the coral reef community in the Keys, yet they are the ones we know the least about.

The brightly colored porkfish, Anisotremus virginicus, is at home on the coral reef. (photo credit: FKNMS)

By knowing what's down there, we will be able to manage the sanctuary more effectively. The multiyear component of the Sustainable Seas Expeditions will allow us to collect several years of data, which, in turn, will give us a more complete picture of the Keys' coral reefs, and enable us to determine trends and changes that take place in the dynamic marine environment.

The Sustainable Seas Expeditions will also help us manage our outreach and education programs. To communicate effectively to the public about the important and special resources of the sanctuary, we must know and understand what those resources are, and what affects them.

If you had to envision the Florida Keys in 50 years, what do you see and how does the Sanctuary make a difference in that picture?

Click here for audio response.

Fifty years from now? I expect to see in the Florida Keys a healthy, thriving coral reef ecosystem, complete with healthy fish populations and all the other marine life that is so important to a coral reef community. The crystal clear waters will have returned to our coast, and pollution will no longer be a problem. This is what I would expect, primarily because of the role of the Florida Keys National Marine Sanctuary, where people value marine sanctuaries as treasured places that must be protected for future generations.

Sanctuary education and outreach will have been effective at getting critical messages out to the residents and visitors, who view themselves as stewards of the ocean environment. I would also expect to see the overwhelming success of marine reserves as a management tool, which has helped us reach true sustainability in the use and enjoyment of sanctuary resources.

The sanctuary will be making a difference through hands-on management and resource protection with innovative techniques such as mooring buoys, coral reef and seagrass restoration, and marine reserves. Sanctuary managers will be making wise management decisions based on cutting-edge research, such as that provided by the Sustainable Seas Expeditions. And every sanctuary manager and scientist will have routine access to submersibles such as the DeepWorker.

What are some of the major challenges for research in the Sanctuary?

Click here for audio response.

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A major challenge for research is the sanctuary's size and location in the South Florida Ecosystem. The Florida Keys National Marine Sanctuary covers 2,800 square nautical miles--a lot of territory--and includes a wide range of habitats, yet it is only a small portion of the overall ecosystem. The coral reefs of the Florida Keys are located downstream of a major population center that is home to 6.5 million people--a population that is expected to triple by the

year 2050. Even today, people are changing the environment quickly, and scientists still don't have a clear understanding of how our ecosystem functions in a pristine state. We need practical research that facilitates good management decisions. We need research that will help explain how water serves to link the natural system, and how people adversely affect those linkages. We need to understand the impacts of changes due to global warming and rising sea levels. We need to explore and conduct research in deep-water habitats to see if the answers of the future lie in the depths of the past. We need to use research to help us open the doors to the future.

Do you think that there has been a shift in the perspective toward ocean management in the last 50 years?

Click here for audio response.

Yes. People have discovered the value of the oceans during the last 50 years, and are beginning to realize that the ocean is a finite resource that is not immune to human activities. We now know that something must be done to save the oceans from pollution, overfishing and habitat loss. It has become clear that we need to view ocean health on a broader ecosystem level, and focus on various interrelationships. We have learned that we can't manage species in isolation from the rest of their environment.

We will be most successful when people living in Middle America realize that they have an impact on the ocean, and that they, too, can make a difference in its health.

In managing the Florida Keys National Marine Sanctuary, what other agencies do you work with, and how will these groups benefit from the Sustainable Seas Expeditions?

Click here for audio response.

(top)

In managing the Florida Keys National Marine Sanctuary, we work with other agencies at the local, state, federal and tribal levels. We

also work with local conservation and environmental groups, as well educational groups and schools.

All of these groups will benefit from the research generated by the Sustainable Seas Expeditions and from the increased awareness of ocean issues generated by the project. The results of the SSE will help these groups to better understand the deep-water resources of the Florida Keys, and thus, will help further their own missions.

Local schools and nonprofit educational organizations will benefit from the educational opportunities offered as part of the Sustainable Seas Expeditions&emdash;a Web chat, an uplink to the research vessel, a student summit and an open house, to name just a few. The SSE will give these groups a chance to learn about the ocean and the technology that allows us to explore it.

Name some of the important partnerships in which the sanctuary is involved.

Click here for audio response.

The sanctuary's most important partnerships are with the local community and the State of Florida. One of the ways we work with the local community is through a 19-member Sanctuary Advisory Council, which is extremely important to the sanctuary. The council provides advice and helps the sanctuary team keep a finger on the pulse of what's happening in the community.

The National Marine Sanctuary Program in the Keys has been in partnership with the State of Florida since 1980. This has been a very effective state-federal partnership that has continued to focus on resource protection as opposed to agency jurisdictions.

Additionally, the sanctuary has been supported enormously over the years by an effective environmental and conservation community in the Keys. We owe a lot of our success to these groups and their efforts on our behalf.

Other effective partnerships are those with various sectors of the business community, especially the fishermen, dive operators, boat rental businesses, and others who make their living in the sanctuary. Working with the business community through programs such as Team OCEAN and Sea Smart has allowed us to reach visitors and teach them about the importance of our resources and

how they can minimize their impact. These programs also help us work with businesses in such a way as to enlist their help in protecting sanctuary resources.

The Florida Keys National Marine Sanctuary has many excellent partners. It is these partnerships that make us feel confident that we can and will achieve our mission, which is to serve as the trustee for the nation's system of marine protected areas, and as such, to conserve, protect and enhance their biodiversity, ecological integrity and cultural legacy.

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A Tour of The Coral Reef Ecosystem

Benjamin Haskell, Science Coordinator
Florida Keys National Marine Sanctuary

Our local economy depends on it. We rely on it for food to nourish our families and our guests. We use it for our recreation and entertainment. It helps cleanse the water. It provides shelter to thousands of species of organisms. We even built our houses, hospitals and offices on its remnants. Welcome to the coral reef ecosystem of the Florida Keys National Marine Sanctuary. I'd like to take you on a tour of the sanctuary to give you a sense of its diverse habitats and the life they support.

The principal purpose of the Florida Keys National Marine Sanctuary is to protect this ecosystem for its own sake, for our sake and for the enjoyment and use of future generations. However, the uses must be sustainable, which means they can't diminish future generations' ability to enjoy or use the resources.

Stunning scenes of mangrove islands, turquoise waters and billowy clouds are common in the Florida Keys backcountry. (photo credit: FKNMS)

The sanctuary is a special place--a place dominated by nature. Looking down from high above, one sees an incredibly beautiful archipelago swinging in a slow arc from the east, just south of Miami, to the west, spanning a distance of 200 miles. The arc terminates in the Dry Tortugas, some 70 miles west of Key West. The waters surrounding the archipelago form the sanctuary. Comprising 2,800 square nautical

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miles of ocean, it is the second largest National Marine Sanctuary (the largest being Monterey Bay, CA).

Whenever I leave the Florida Keys by plane, my face is always plastered against the window so I can peer into the wilderness we call the "backcountry," where thousands of mangrove islands dot the seascape, surrounded by brilliant turquoise waters and bone white sand. The juxtaposition of verdant mangroves against the turquoise waters, set off by a big blue sky filled with billowy clouds, is stunning. I search the waters hoping to see a large animal like a shark, ray, tarpon or turtle.

If we were to take a snorkel trip starting in the backcountry, which is in the Gulf of Mexico north of the Keys, and swim south toward the Atlantic Ocean, we would pass over a diverse array of habitats, from seagrass beds to hard limestone substrate (commonly called hardbottom) to the coral reef. These habitats and the organisms they support are all connected by the ebb and flow of the tide, and form one big ecosystem.

(top)

One of the most noticeable things about the backcountry is the shallow water. Depths are generally less than four feet, making it an extremely tricky place to run a boat. It takes a lot of experience and a keen eye to be able to successfully navigate through the backcountry. The backcountry provides one of the most exciting recreational fishing areas in the country, where flatsguides take anglers out to catch tarpon, permit, bonefish and a variety of other gamefish.

Seagrass beds are the most abundant habitat found in the sanctuary, covering approximately 85% of the bottom. The seagrass beds in the sanctuary, combined with the seagrasses to the north in Florida Bay, create the largest seagrass bed in the world.

Hidden among the seagrass blades are a plethora of juvenile fish and invertebrates taking cover from predators as they mature. The spiny lobster is one important invertebrate that begins its postlarval life in the seagrass bed and on algae. As it matures and grows larger, the lobster heads south with the prevailing flow of water and moves from the seagrasses to the hardbottom habitat. Here, it finds refuge around large sponges, or in crevices in the limestone bottom.

Hardbottom is prevalent in the channels between the Keys, where the ripping currents have scoured the bottom, exposing the

Seagrass offers a place of refuge for small creatures hiding from hungry predators. (photo credit: FKNMS)

underlying limestone. Growing on this hardbottom are sponges, beautiful soft corals that sway in the currents, and a variety of mounding or encrusting-type hard corals. It's fun snorkeling the hardbottom habitat because a surprise always awaits you, like a resting green turtle wedged in a hole, or a large boulder coral surrounded by juvenile fish.

We've now made it to the Atlantic Ocean side of the Keys, where seagrass beds are abundant and the hardbottom is punctuated by inshore coral patch reefs that extend the whole length of the Keys. Patch reefs are delightful places to visit because they are like oases in that the three-dimensionality of the coral heads attracts a huge diversity of fish life. One can easily swim around the perimeter of a patch reef, absorbing all of the wondrous sights it has to offer.

Beyond the inshore patch reefs are the deeper waters (30 to 40 feet) of Hawk's Channel. This channel parallels the Keys and serves as the dividing line between nearshore waters and offshore waters. The channel is often turbid due to the muddy bottom, which is easily stirred up by wind-driven currents. However, within this channel is one of the sanctuary's hidden habitats: the mid-channel patch reef. Rising from the muddy sea floor some 20 to 30 feet high are coral patch reefs packed with mounding and boulder corals, and interspersed among these coral heads are giant soft corals the size of small trees. Huge sponges also thrive in this turbid, high-current environment. These coral patch reefs challenge the dogma that corals require low-nutrient, clear waters to thrive.

(top)

Offshore of Hawk's Channel, about 2 to 3 miles from land, the bottom rises up again to about 18 feet, and here we come across another band of patch reefs surrounded by seagrass beds. These offshore

patch reefs serve as another important refuge for migrating fish and lobster on their way to the coral reef tract. Some of the richest coral cover in the sanctuary is found on these patch reefs. Some of these patch reefs have 35 to 40% coral cover, as compared to an

average of about 14% for the reef tract.

Looe Key typifies the spur-and-groove pattern of the reef tract. (photo credit: FKNMS)

Finally, we arrive at the reef tract, which parallels the Keys approximately 4 to 5 miles offshore. It is not a true barrier reef, so we call it a reef tract. The reef tract is a discontinuous line of coral reefs that started growing on an outcropping of limestone some 7,000 years ago. The better developed reefs are found in the Upper and Lower Keys, where water from Florida Bay does not impede coral growth nearly as much as in the Middle Keys.

Along the reef tract the coral grows in a spur-and-groove formation. The spurs are broad fingers of coral situated perpendicular to the shore and the prevailing wave direction, and the grooves are channels between the spurs that help export excess sand off the coral reef and into deeper water. At the top of the spur, in about four feet of water, is the reef crest; here, in this wave-dominated environment, branching elkhorn coral thrives.

Constant wave action helps branching corals to thrive in the shallow water of the reef crest. (photo credit: FKNMS)

Behind the reef crest, in even shallower water, is the reef flat, where few corals survive due to the high wave energy. As the spur gradually descends into deeper water (15 to 30 feet) the reef crest becomes the fore reef. A more delicate branching coral called staghorn coral grows in these deeper, calmer waters, as do many of the boulder and mounding corals.

The sanctuary has more than 44 species of corals. In the 30- to 50-foot depth range, the fore reef segues into the intermediate reef, where the spur-and-groove formation becomes less pronounced. At the foot of the spurs, in what is called the buttress zone, you can find huge mounds, or heads, of coral rising 10 to 15 feet from the sea floor.

Beyond the buttress zone is the deep reef, extending from 50 to about 80 feet. Coral in the intermediate and deep reef zones are abundant, but low in profile, and have taken on more of a platelike or encrusting morphology due to the lower light conditions.

The reefs have been fairly well studied down to about 100 feet, which is safe scuba depth, but beyond that, we know very little about the health and abundance of corals. Corals don't grow much below 130 feet in the Keys because there isn't enough light to sustain them. One of the primary objectives of the Sustainable Seas Expeditions is to extend our ability to assess coral health and monitor it over time.

The corals in shallow water have been severely affected by diseases during the past several years. We are wondering whether disease is as prevalent in deeper waters. We are also still discovering new coral reefs in the westernmost portions of the sanctuary around the Tortugas. The Sustainable Seas Expeditions will help us explore and document these areas.

I hope this tour of the ecosystem has given you a sense of the variety of habitats in the sanctuary and the diversity of life they support. It is the only coral reef ecosystem in the United States, so it's up to us to treat it with respect and to use it sustainably.

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Maps

The Sanctuary

The Florida Keys National Marine Sanctuary protects an area of over 3600 square miles (2800 square nautical miles) of submerged lands and waters surrounding the Florida Keys. It includes parts of Florida Bay, the southwest continental shelf, the corals of the Florida Reef Tract that parallel the seaward edge of the Florida Keys, the Keys

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themselves, and the Straits of Florida. Sanctuary waters range from an average depth of four feet in Florida Bay to 2000 feet. Depth of the reef tract averages about 50 feet. The submerged lands of the sanctuary are part of a plateau of marine sediments that includes all of Florida and its adjacent continental shelves. The outer edge of the reef tract is subject to open tidal exchange of warm, clear waters of the Florida Straits that are low in nutrients and conducive to reef development. These coral reefs are intimately linked to a marine ecosystem that supports one of the most unique and diverse assemblages of plants and animals in North America. Cultural resources are also contained within the sanctuary. The proximity of coral reefs to centuries old shipping routes has resulted in a high concentration of shipwrecks and an abundance of artifacts.

(top)

The Mission

The Florida Keys expedition team will travel to several locations within the sanctuary. The general activities they will be conducting are as follows:

1. Deep reef exploration and habitat characterization off of Tortugas Bank, Sherwood Forest, Black Coral Rocks, and Riley's Hump;

2. Deep reef and sponge habitat health assessment in Eastern Sambos;

3. High school education/research effort from fore to deep reef on Conch Reef / Molassas Reef; and,

4. Video transects and fish counts along Carysfort Reef.

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Research in the Florida Keys National Marine Sanctuary

LCDR Dave Savage, NOAA Manager
Florida Keys National Marine Sanctuary Upper Region

The Sustainable Seas Expeditions, slated for the Florida Keys National Marine Sanctuary from August 15 to 27, 1999, will undoubtedly help to unravel the mystery of what lies in the depths of the poorly charted waters to the west of the Dry Tortugas. The DeepWorker 2000 manned submersible will help explore the vast underwater coral reefs of the proposed Ecological Reserve on the Tortugas Bank, Sherwood Forest, and Riley's Hump areas of the Florida Keys National Marine Sanctuary. A significant portion of these remote reefs have never been seen by human eyes.

The proposed Tortugas Ecological Reserve, which the Florida Keys National Marine Sanctuary hopes to have in place by the Summer of 2000, is a 185 square nautical mile "no-take" zone which will help to replenish the entire Florida Keys reef tract with the larvae which are so essential to recruit new life on the fragile coral reef ecosystem.

The reefs of the Tortugas offer spectacular examples of a healthy coral reef ecosystem. (photo credit: Steve Baumgartner, FKNMS)

There are two primary gyres, the Tortugas Gyre and the Portales Gyre, which interact with the Florida Current to create a giant "conveyor belt" to transport these crucial fish, crustacean, and coral larvae throughout the Florida Keys reef tract. If we do not set aside a large area in the Tortugas to supply these seeds of life for the rest of the reefs in the Sanctuary, the long-term

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consequences of overexploitation of the resource will be inevitable.

Three of the scientific projects for the first leg of the mission, from August 15 to 21, will focus on the proposed Ecological Reserve. Dr. Sylvia Earle, the Explorer-in- Residence of the National Geographic Society, will be the first to take the plunge into this beautiful and mysterious realm. Dr. Earle's dives will focus on exploring and ground-truthing the most interesting features of this intermediate and deep reef environment.

Dr. Sylvia Earle, project director of the Sustainable Seas Expeditions, prepares to descend in the DeepWorker, a one-person submersible from Nuytco Research Ltd. that can descend to 2,000 feet. (photo credit: Natalie Fobes, National Geographic Society)

Dr. Pamela Hallock-Muller of the University of South Florida is the principal investigator for the second major scientific project in the Tortugas region. Her project will focus on the biological and geological characterization of the Tortugas Bank and adjacent areas. Walt Jaap of the Florida Marine Research Institute in Saint Petersburg will be the submersible pilot for Dr. Hallock-Muller's project.

The third major scientific project in the Tortugas will be led by Dr. Erich Mueller of Mote Marine Laboratory in Summerland Key, Florida. Dr. Mueller will be acting as both principal investigator and submersible pilot for his project, which will investigate the influence of Gulf of Mexico water on the deep reef tract to the west of the Tortugas. We now know from extensive drifter studies that water travels from the Gulf of Mexico off of the coast of southwest Florida to the reefs of the Florida Keys and the Tortugas.

(top)

We are concerned that nutrient-rich waters produced during flood episodes on the Caloosahatchee River of southwest Florida and the Mississippi River will periodically threaten the coral reefs of the Florida Keys National Marine Sanctuary. These reefs normally thrive in an oligotrophic or low-nutrient environment. When nutrient-rich waters reach the coral reefs they can become overgrown with algae which thrives in nutrient-rich conditions. This algae can prevent essential sunlight from reaching the coral colonies and can

eventually cause the death of these reef-building or hermatypic corals.

The Florida Keys National Marine Sanctuary is taking an active role in the South Florida Ecosystem Restoration Program and hopes to be the downstream recipient of the ecosystem's fresh water in the appropriate quality, quantity, and timing. Nearshore water quality problems in the Florida Keys and most recently in Dry Tortugas National Park are an additional threat to the nearshore patch reef communities. Coliform counts, an indicator of pollution from human sewage, are at alarming levels in the Key West area and in the mote surrounding Fort Jefferson. Most of the Key West beaches and the beach at Fort Jefferson remain closed.

The Florida Keys have come to a crossroads where nearshore water-quality issues need to be dealt with in a timely and effective manner. Central sewage with sound infrastructure including lines which do not leak and plants which remove both pathogens and nutrients is needed sooner rather than later.

The second leg of the Sustainable Seas Expeditions, which will take place from August 23 to 27, will focus on the Florida Keys National Marine Sanctuary from Key West up the reef tract to Key Largo. There are five primary projects for this portion of the SSE mission.

Mary Tagliareni, the Education Coordinator for the Florida Keys National Marine Sanctuary, will pilot the submersible through two dives which will profile a large portion of the sanctuary's ecosystem in conjunction with hypotheses developed by local high school students. Mary will be examining the communities which comprise our coral reef ecosystem from the seagrass beds to the offshore patch reefs, the reef flat, the fore reef and out to the intermediate and deep reefs. Her dives will take place at the Conch Reef Research Only Area and the Western Sambos Ecological Reserve.

Laddie Akins, Director of the Reef Environmental Education Foundation (REEF), will be piloting the submersible to survey fish populations in the deep reef environment in both the Upper Keys, near the Carysfort Sanctuary Preservation Area, and in the Tortugas at Sherwood Forest. The REEF roving-diver fish count technique has provided the National Marine Sanctuary Program with invaluable fish population data throughout the country.

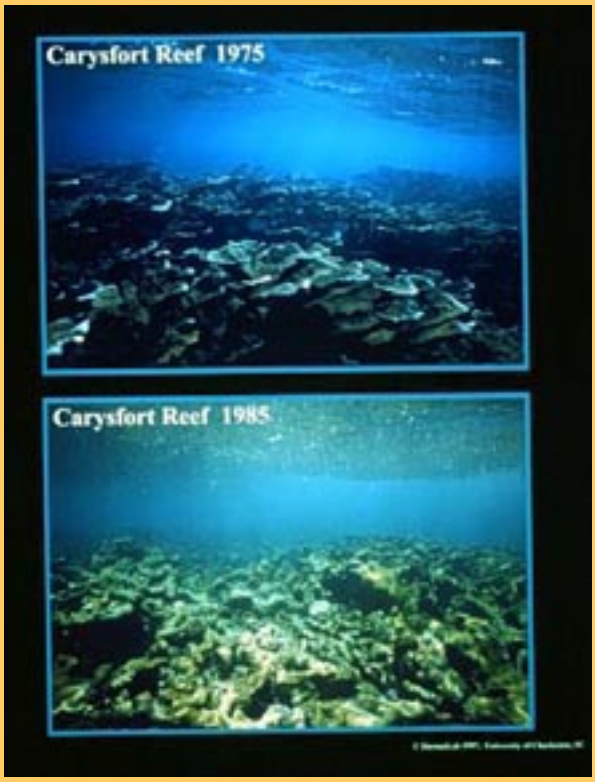
(top)

Ben Haskell, Science and Research Coordinator of the Florida Keys National Marine Sanctuary, is the principal investigator for a project that will explore and document biological and cultural data on

artificial reefs in the Sanctuary. The video documentation on these ships, which are intentionally sunk to provide a haven for scuba divers away from the natural reefs, will be accomplished this year using a Remotely Operated Vehicle or ROV. In subsequent years of this five year expedition we hope to use the DeepWorker 2000 submersible to follow up on the baseline observations which we will gather this year.

Lieutenant Commander Dave Savage, the sanctuary mission coordinator for SSE and a NOAA Corps aviator, is slated to be the submersible pilot for the artificial reef project. The use of artificial reefs as a management tool is very controversial. LCDR Savage hopes to obtain monitoring data over the next five years which will help the sanctuary to make informed management decisions about the continued use of artificial reefs in an attempt to alleviate human pressure on the natural reefs. The U.S. Navy Maritime Administration ship Spiegel Grove is slated to be scuttled as an artificial reef in the Sanctuary off of Key Largo in the Fall of 1999. The Spiegel Grove, which measures 510 feet, will be the largest artificial reef in the country accessible to scuba divers.

Dr. John Ogden of the Florida Institute of Oceanography is the principal investigator and submersible pilot for a project which will document sponge health in the deep reef environment. Dr. Ogden's dives will take place near the Molasses Reef Sanctuary Preservation Area and the Eastern Sambo Research Only Area.



Dr. Phil Dustan of the University of Charleston is the principal investigator and submersible pilot for a project which will document deep reef health near the Carysfort Sanctuary Preservation Area. Dr. Dustan has been doing coral monitoring studies for the USEPA in the shallow reef environment near Carysfort. The DeepWorker 2000 will enable him to extend his monitoring work into deeper

areas which he has not yet been able to study.

Populations of the elkhorn coral, *Acropora palmata*,have deteriorated at an unprecedented rate on Carysfort Reef during the past 20 years. (photo credit: Dr. Phil Dustan)

The steady deterioration of branching coral colonies in the shallows off of Carysfort and other sanctuary reefs has been documented for the past 20 years. A hypothesis that will be tested throughout the SSE mission in the Florida Keys is that deep coral reef health is generally better than the health of shallow coral reefs. This is an observation made by scientists doing research in the Aquarius Underwater Habitat, which is maintained by the National Undersea Research Center and is located in the sanctuary at the Conch Reef Research Only Area.

The Sustainable Seas Expeditions in the Florida Keys National Marine Sanctuary have the incredible potential to give the American people an underwater view of the unexplored reaches of North America's largest living coral reef, and to educate them about the challenges of preserving the ecosystem for the public trust in the new millennium. The baseline data obtained from marine scientists during this first year of deep reef exploration will undoubtedly lead to more detailed investigations in the upcoming years of the expedition.

(top) **RETURN**

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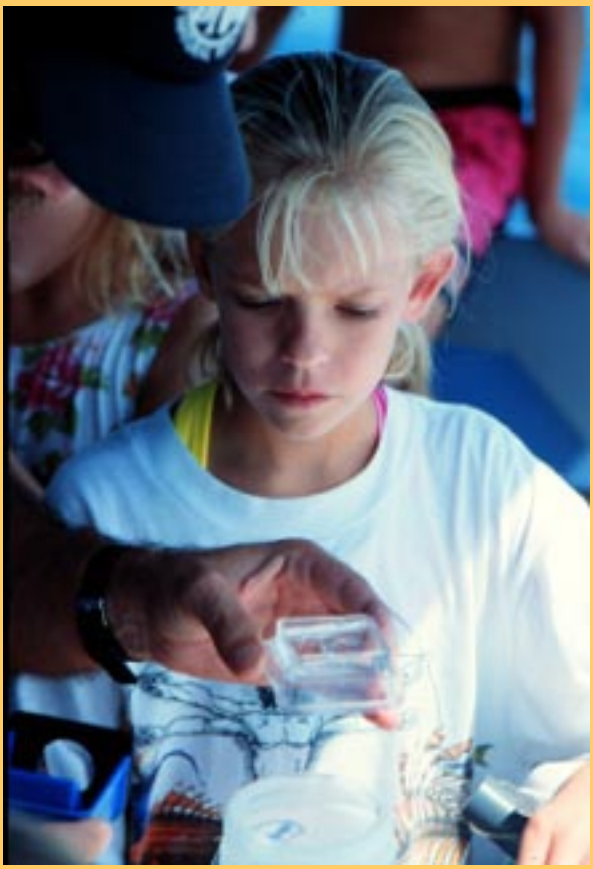
SEN. BOB GRAHAM

Education and Outreach

Cheva Heck, Community Outreach Coordinator
Florida Keys National Marine Sanctuary

Mary Tagliareni, Interim Education Coordinator
Florida Keys National Marine Sanctuary



Students identify plankton using microscopes during Coral Reef Classroom. (photo credit: FKNMS)

The Florida Keys National Marine Sanctuary protects 2,800 square nautical miles of mangrove, seagrass, hardbottom and coral reef habitats. To the west of the upper Keys lies Florida Bay. The Gulf of Mexico borders the lower Keys on the west. To the east lie the Atlantic Ocean and the Bahamas. Cuba is eighty miles to the south of the southernmost island, and the Everglades lie to the north.

The splendors of the coral reef occupy center stage in the Keys. But the health of the coral reef is linked inextricably to the less known parts of the ecosystem. Snapper hide in the cool, dark tunnels formed by the roots of the red mangrove. Lush underwater seagrass beds provide a home for the endangered queen conch and Bahama starfish.

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This complex ecosystem, which thrived for thousands of years before humans arrived, now faces many threats. Some are local. Five hundred boat groundings each year chip away at the reefs and leave scars in the seagrass. Boaters drop anchor in the coral. Divers and snorkelers damage the reef with equipment, hands and fins. Poorly treated wastewater and stormwater load nearshore waters with nutrients. Overfishing alters the system's natural balance. Others originate further afield. Coral reef researchers now believe that global climate change may be the culprit behind coral bleaching and an alarming increase in coral disease.

Until the 1960s, only a few tourists braved the treacherous road and hoards of mosquitoes to visit the Florida Keys. Fishing enthusiasts and the hardy native "Conchs" of Bahamian descent had the islands to themselves. The 1970s saw improvements to highways and tourism facilities, growth in America's economy and an increase in disposable income, and national and international advertisement. These cultural changes, coupled with year-round sunshine, pleasant temperatures and warm, clear water, began to draw people to the Keys to visit and to live.

Now the Keys sanctuary surrounds an island chain with a resident population of around 80,000. "Snowbirds" during the winter months swell this population to over 135,000, and the Keys serve as a backyard playground for neighboring Miami-Dade, Broward and Collier counties, especially on weekends and holidays. But the isolation and expense of living in the Keys lead to a high rate of turnover among residents. Of children who begin school in Monroe County, only an estimated thirty percent graduate here.

The Keys wealth of natural resources has led to the establishment of four national wildlife refuges, nine state parks, three national parks, five state preserves, and one national marine sanctuary. This sometimes bewildering array of different agencies and different jurisdiction raises many questions: Where does one boundary end and another begin? What rules overlap and what is unique for each area? Who do I contact for information? How do I know which area I am in? Why have all of these protected areas been set aside?

A changing population, 2.5 million visitors each year, multiple jurisdictions and the lack of a central contact point make communicating the fragility and interconnectedness of the Keys environment a challenge.

Sanctuary education and outreach faces this challenge head-on by enlisting both residents and visitors as partners in protecting the marine environment. By instilling a sense of stewardship for the coastal environment, the education and outreach program strives to lessen human impact on our resources and protect the treasures of

the coral reef for the future.

Unlike a national park or a land-based site, the sanctuary has no entrance gates, no surefire ways to reach those who use the waters. Visitors and residents enter the sanctuary from the water on all sides and from many access points on US 1. Dive operators, bait and tackle shops, boat ramps, and the reef itself become classrooms where education about the sanctuary and its resources takes place.

The highly successful Team OCEAN (Ocean Conservation Education Action Network) program typifies this approach. Team OCEAN volunteers act as floating information booths at heavily visited reefs.

Every year, volunteers contact more than 1000 boaters, distribute hundreds of information packets, and prevent more than forty groundings. But more important and extremely difficult to measure is the pride and stewardship of the resources the volunteers have and share with their neighbors, relatives, co-workers, and visitors even when they are not on an official Team OCEAN day.

Team OCEAN volunteers pass out information to boaters at the reef on busy days. (photo credit: FKNMS)

Team OCEAN staff also work to reach residents and visitors before they journey out on the water, maintaining a brochure route with more than 400 stops, including hotels, dive charters, bait and tackle shops, boat rental businesses, marine supply stores and visitor information centers. These stops also offer an invaluable opportunity to establish a solid relationship with the business community and to exchange information with those who work on the water.

Television offers the sanctuary an opportunity to reach a broader audience. The sanctuary, Everglades National Park and the United States Environmental Protection Agency join forces to produce Waterways, a program that explores the South Florida environment, as well as research and management underway to protect the resources. The shows airs twice weekly in Monroe County and on public access stations throughout Florida. In 120 episodes to date, it has addressed topics such as wastewater

treatment in the Keys, the installation of Racon beacons to protect reefs, and the 50th anniversary of Everglades National Park.

Working with Monroe County Schools is critical to the success of the sanctuary. Today's schoolchildren are tomorrow's commercial fishermen, dive shop owners, marina managers, marine biologists and elected officials. The sanctuary's Coral Reef Classroom program gives

kids a chance to learn about the Keys ecosystem, conduct basic scientific field work, and snorkel on the coral reef. For many of these children, the Coral Reef classroom trip marks the first time they ever see the wonders of the coral reef that lies just offshore from their homes.

Sanctuary staff visit classrooms and do interactive presentations such as Build an Ocean. (photo credit: FKNMS)

Partnerships form a key element in nearly all sanctuary education and outreach programs. The examples above demonstrate how the sanctuary works with volunteers and with the business community. Sanctuary educators also work with staff from other protected areas using an ecosystem approach, which leads to better products and programs. Pooling of staff, expertise, and monetary resources has eliminated waste and redundancy and led to more effective education and outreach efforts than each agency could establish working alone.

Local nonprofit organizations also have helped the sanctuary meet its education and outreach goals. The Nature Conservancy assists the sanctuary in finding volunteers to make programs such as Team OCEAN and Coral Reef Classroom succeed. Sanctuary education staff are working in partnership with the Center for Marine Conservation and dive and snorkel operators to launch SeaSmart, aimed at helping divers and snorkelers become protectors of the reef, rather than threats to it. Local grassroots group Reef Relief is working with the sanctuary to produce informative site brochures.

There are many challenges for the sanctuary education staff, but we prefer to view them as opportunities. Opportunities to make a difference, nourish partnerships, change an opinion, and protect a resource that we appreciate and love.

(top) RETURN

The Sustainable Seas Expeditions and the Florida Keys National Marine Sanctuary: Working Together to Preserve a National Treasure

U.S. Senator Bob Graham of Florida

In the fall of 1989, three successive freighter groundings ravaged the coral reefs of the Florida Keys and produced a national outcry for protective action. In order to address these and other threats to the United States' most extensive living coral reef system, then-U.S. Congressman Dante Fascell and I introduced the Florida Keys National Marine Sanctuary and Protection Act.

In the 10 years since, citizens of Monroe County have worked with the state and federal governments to develop a management plan for the marine sanctuary that accommodates a variety of commercial, recreational, research, and education activities while at the same

U.S. Senator Bob Graham of Florida (photo credit: Senator Graham staff)

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time protecting the unique natural resources of the Keys.

The Florida Keys National Marine Sanctuary covers 2,800 square nautical miles and encompasses the third-largest coral barrier-reef system in the world. Extending from the southern tip of the Florida peninsula to a point just 90 miles north of Cuba, the Keys link Biscayne Bay National Park with Dry Tortugas National Park. They are an important part of the South Florida ecosystem, which also includes four national wildlife refuges and Everglades National Park.

The marine environment of the Keys supports one of the largest seagrass communities in this hemisphere and more than 6,000 species of plants, fish, and invertebrates. The diversity of this reef ecosystem is considered the underwater equivalent of the tropical rainforests. As a result, more than four million visitors come to the Keys each year to fish, swim, boat, snorkel, scuba dive, and enjoy the unique culture of the islands.

But the Keys still face challenges--such as the need for improved wastewater treatment--that will require our best efforts. The inadequate sewage systems on the islands allow pollutants to travel quickly into canals and nearshore waters. These pollutants also act as fertilizers by increasing algae growth and reducing visibility.

The Florida Keys National Marine Sanctuary's water quality steering committee has drafted a water quality protection program to address problems like wastewater treatment and

preserve the marine ecosystem of the Keys. For the next two weeks, the Sustainable Seas Expedition will visit the region to supplement those efforts.

During one of Senator Graham's workdays, he accompanied a biologist on the boat to conduct research. (photo credit: Senator Graham staff)

This program, a collaborative effort of the National Geographic Society and the National Oceanic and Atmospheric Administration, will bring state-of-the-art exploration equipment to the Florida Keys National Marine Sanctuary to document the quality of the water and the variety of organisms that inhabit the reef.

Senator Graham experiences what it is like to be a marine biologist in the Florida Keys. (photo credit: Senator Graham staff)

Expedition researchers will also participate in an open house, a live video uplink, and a live Web chat to inform local residents and sanctuary visitors of their findings.

The greatest gift we can give to our children and grandchildren are environmental treasures that they can enjoy for years to come. The Florida Keys National Marine Sanctuary and the Sustainable Seas Expedition both constitute shining examples of private citizens working together with the government to achieve this goal by helping us understand and preserve our precious natural resources.

(top) RETURN

Establishment of the Florida Keys National Marine Sanctuary: More than a Little Bit of Controversy

June Cradick, Sanctuary Project Manager
Florida Keys National Marine Sanctuary

The Florida Keys National Marine Sanctuary is one of twelve National Marine Sanctuaries that are managed as a system throughout the coastal United States. National Marine Sanctuaries are designated to promote comprehensive management of their special conservation, recreation, ecological, historical, research, educational or aesthetic resources. The 2800 square nautical mile Florida Keys National Marine Sanctuary includes the only barrier coral reef ecosystem in the United States.

In the late 1980s the Florida Keys were facing threats of oil drilling and deteriorating water quality, as well as coral bleaching, the loss of living coral cover on reefs, a major

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seagrass die-off, declines of reef fish populations, and the spread of coral diseases. The final insult was three groundings of large ships on the reef tract within 18 days in the fall of 1989.

The bluestriped grunt, Haemulon sciurus, is wary of divers but with patience and slow movements a diver can get a close-up view. (photo credit: FKNMS)

In recognition of these issues, President Bush signed into law the Florida Keys National Marine Sanctuary and Protection Act on November 16, 1990. The Act immediately addressed two major concerns of the residents of the Keys, first by prohibiting any oil drilling, including mineral and hydrocarbon leasing, exploration, development or production within the sanctuary, and second, the Act prohibited the operation of tank vessels (ships) greater than 50 meters in length in an internationally recognized Area to be Avoided within the boundary of the sanctuary.

Congress, recognizing the critical role of water quality in maintaining sanctuary resources, directed the Administrator of the Environmental Protection Agency to work with the Governor of the State of Florida and the Secretary of Commerce, to develop a comprehensive Water Quality Protection Program for the sanctuary. The Act also called for the Department of Commerce to work with the appropriate federal, state and local government entities and with a citizen Sanctuary Advisory Council to develop a management plan and implement regulations to protect and preserve the living and other resources of the Florida Keys Marine environment.

Sounds reasonable, you say? You have read four paragraphs that give you a feel for what the sanctuary is and why it was designated. Pretty straight forward, right? So why was the sanctuary so controversial and how did we resolve the controversial issues?

The reefs in the Florida Keys are home to many fish, crustaceans, and invertebrates. (photo credit: FKNMS)

The sanctuary was controversial in part because it was designated by Congress and the President and there was no public involvement in its establishment. Most Sanctuaries go through a lengthy designation process that includes a tremendous amount of public involvement in determining the

need for a sanctuary and the site's boundaries. That wasn't the case with the Florida Keys Marine Sanctuary because Congress was anxious to immediately limit oil and gas extraction activities in the Keys and stop the major vessel groundings.

Congress directed the National Oceanic and Atmospheric Administration, within the Department of Commerce, to work with the relevant federal, state and local agencies as well as the public to develop a management plan and implement regulations to protect the resources.

Since approximately 65% of the sanctuary lies in state waters and numerous state and federal areas of jurisdiction overlap or lie adjacent to the sanctuary boundary, it was imperative that the planning process for the sanctuary be an inter-agency effort. The National Oceanic and Atmospheric Administration and State of Florida established a partnership to manage the sanctuary.

Due to the high level and diversity of public use of the resources in the Florida Keys and the importance of tourism to the economy of the Keys, it was equally important that the public have a strong role in development of the comprehensive management plan for the sanctuary.

Sanctuary staff established a working group that included representatives of the various federal, state and local agencies responsible for protecting and managing the resources. This group, known as the Interagency Core Group, included scientists as well as managers. At the same time, the first Florida Keys National Marine Sanctuary Advisory Council was established. This citizens advisory group included representatives from the fishing and diving industry, the environmental community, the general public, and the research and education communities.

It took more than four years of meetings for these two groups and the public to identify and clarify the issues, and develop a strategy to manage and protect the coral reef ecosystem of the Florida Keys. In 1995 the Draft Management Plan and Environmental Impact Statement for the Florida Keys National Marine Sanctuary was issued.

The Draft Management Plan for the sanctuary was very innovative and it caught the attention of not only residents of the Florida Keys, but the nation. The plan introduced marine zoning, a new approach to protecting biodiversity and habitat, which focuses intensive protection on the most significant portions of the coral reef ecosystem. Zoning reduces user conflicts and lessens the concentrated impact to marine organisms on heavily used reefs. On

a national basis it was heralded as an innovative concept that would protect the coral reef for current and future generations.

Many of the resource users in the Keys were either skeptical or furious. "What do you mean you want to zone the water?" was a common cry. Concerns ranged from whether the sanctuary would limit the number of private boats allowed in the Keys, to whether the sanctuary would regulate land use, and whether the sanctuary would eliminate fishing in the Keys. Of course, the answer to those questions was no.

Another source of controversy was the sanctuary's submerged cultural resource management program which protects cultural resources, guarantees public access, and permits private commercial recovery by treasure hunters in a manner which is consistent with federal historic preservation laws. Many people had a hard time accepting that submerged cultural resources are national historic resources, and not just for private collections.

The public was given an enormous opportunity to provide their input on the draft plan. The Advisory Council established working groups to help the public review the management plan. These groups had multiple meetings in various parts of the Keys. Sanctuary staff spent months explaining the proposed management plan, its strategies and the proposed regulations.

The christmas tree worm, *Spirobranchus giganteus*,is a favorite among divers due to its bright and varied colors. (photo credit: FKNMS)

The nine month public review of the draft management plan included numerous public meetings and public hearings, and resulted in over 6,400 written and oral comments. Some reviewers thought the plan went too far with the proposed zones, while others felt the sanctuary wasn't doing enough to protect the resources.

The sanctuary staff, with the advice of the Sanctuary Advisory Council, developed a final management plan that reflects the broad range of public comments and balances resource protection and the economy of the Florida Keys. The zoning was established, creating 23 no-take areas, comprising less than one percent of the sanctuary, but protecting much of the critical coral reef habitat.

The final management plan and regulations for the Florida Keys National Marine Sanctuary were put in place effective July 1, 1997. Most of the controversy has died down. Our monitoring program, along with anecdotal information from the public, is already showing that the zoned areas are working--the fish populations in the zoned areas are increasing.

We are working closely with the submerged cultural resources industry to implement permitting processes that are predictable and fair. It is very common for members of the public to contact us and ask for increased enforcement of our regulations or ask what they need to do to have a zoned area created at a favorite spot in the sanctuary. We recently received unanimous support from an Advisory Council Working Group and the entire Council for a new zoned area in the Tortugas. There has been a lot of controversy over the years, but public support for the sanctuary is increasing every day.

(top) **RETURN**

Commercial Fishing in the Florida Keys

Don DeMaria, Commercial Fisherman

An increasingly rare sight, commercial fishermen unloading grouper onto a dock in Key West. (photo credit: FKNMS)

Commercial fishing in the Florida Keys and southwest Florida dates back to at least the 1770s when Spaniards from Cuba sailed north to harvest fish for the Havana market. During this period, salted mullet and live sea turtles were two of the main species exported to Havana. By 1819, fishing smacks (live well sloops) from as far away as New England were fishing the Florida Keys. Some of these vessels were large enough to hold 12,000 pounds of live grouper bound for the Havana market. As early as the 1880's, there were reports that some of the fishing grounds were becoming "fished out".

Today, spiny lobster is a major commercial fishery in the Florida Keys. Prior to World War I, however, spiny lobsters were caught mainly for fish bait used to catch grunts and other bottom fish.

The most valuable fishery in the Florida Keys today is the Tortugas pink shrimp fishery. The fishery was not discovered until late 1949 and by February 1950, there were about 300 vessels from different southern ports trawling for "pink gold" in the Tortugas and waters north of Key West. Shortly afterwards, a shrimp processing plant was established in Key West and hundreds of shrimp trawlers were docked at the facility, creating a scene that has often been described as a "gold rush."

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Times have changed since the Spaniards sailed north from Havana in search of sea turtles and mullet. Sea turtles are now considered an endangered species and Florida has enacted a controversial net ban aimed at protecting inshore fish such as mullet. Spiny lobster is no longer used for bait to catch grunts and although the pink shrimp fishery continues, there is not a single shrimp boat to be found docked in Key West.

Turtles like this one were once a major fishery in the Florida Keys. Legislation protecting them has been instrumental in beginning the recovery of their populations. (photo credit: Don DeMaria)

When I first began commercial fishing in the Key West/Tortugas areas in 1978, the price of grouper was 60 cents per pound, which seemed a fair price considering what I thought was an abundance of fish. However, when talking with old time commercial fishermen, it is my understanding that the price of grouper was about 6 cents per pound in the 1940's and the fish were even more plentiful. Looking back further in time it appears that by the 1880's, commercial fishermen considered some grounds to be fished out. It is a ratchet effect. Each new group thinks the resource is in great shape and can only remember back so far. Presently, grouper is close to $3.00 per pound and is no where near as plentiful as I remember it being in 1978. Yet, there is a whole new group of fishermen on the scene today who claim there are plenty of grouper. More than they can recall in years!

The truth of the matter is that many of our fisheries are in poor shape and are considered to be in an overfished state by the National Marine Fisheries Service. The recent advances in technologies combined with an increased demand for fresh fish have led to declines in many fish stocks. Many species that were considered underutilized until recently are now in an overfished state. Sharks are a classic example. In the mid 1980s, sharks were considered an underutilized species. Fishermen were then encouraged to target sharks for a growing food and fin market. Today, many shark species are closed to all fishing as a result of overfishing.

Not only are fish stocks in serious decline, those people who depend

on a healthy, sustainable resource for their livelihoods are also falling on troubled times. In the not too distant past, commercial fishermen were as common a sight along Florida's coast as were the pelicans, seagulls, and herons. Today, it is difficult to find a working commercial fisherman. Fish houses have been replaced with marinas, condominiums, and trendy boutiques. Yachts and sportfishing boats crowd docks once filled with commercial fishing vessels. The pelicans, seagulls, and herons are still a common sight, but not the commercial fisherman.

Commercial fishermen in the Florida Keys and southwest Florida often complain about grand conservation and government conspiracies aimed at putting them out of business. The truth of the matter is that today's commercial fisherman is just on the wrong end of a 250 year long mismanaged fishing spree. There are no real bad guys, just a lot of ignorance over time on both sides.

Until we become serious about managing our fisheries in a sustainable manner, more and more fish species will be classified as overfished and taking them in any manner will eventually be prohibited. Commercial fishermen who depend on these species will be forced out of business. Marinas, condominiums, and boutiques will replace the fish houses. Yachts and sportfishing boats will replace commercial fishing vessels and Florida will have lost an important part of its history and culture, the commercial fishing industry.

(top) **RETURN**

The South Florida Ecosystem

David E. Guggenheim, Ph.D.
President & CEO, The Conservancy of Southwest Florida
Florida Co-Chair, Everglades Coalition

David Guggenheim trains in the DeepWorker

"DeepWorker, DeepWorker, this is topside," the voice crackled loudly in my headset, right on schedule. "DeepWorker, please provide your life support readings." My eyes panned the instruments, struggling to focus through a torrent of sweat from my brow. "Cabin pressure is minus 0.5, oxygen is 20.9, CO_2 is 0.45, starboard scrubber is operating normally," I replied from the cabin of the single-person submersible known as DeepWorker. "I am now stationary on the bottom, communications are loud and clear," I added.

"DeepWorker, topside, Roger that. What do you see?" I toweled my forehead and peered out the acrylic dome at a disorienting vortex of swirling sediment and forbidding dark green water. "Topside this is DeepWorker. I see nothing!" was my predictable response. For although the DeepWorker is rated to dive to 2,000 feet below the surface, I was sitting squarely in the mud at the bottom of Key West harbor, an impressive 17 feet below the surface, just off the port beam of the Navy vessel Acoustic Pioneer from which I had been launched 15 minutes earlier on my very first mission as submarine pilot.

As I twisted and contorted myself in the tiny cabin to complete my safety check, I began to appreciate how the early astronauts felt,

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David Guggenheim prepares for his first DeepWorker dive.

sealed tightly in their tiny crafts with barely enough room to access the control panels or scratch an itch. But claustrophobia was far from the biggest challenge. Between my knees I tightly squeezed what at the moment seemed the most important piece of safety equipment I had brought aboard - a 2-liter bottle of solid ice, affectionately dubbed the "ice torpedo." The modest depths of Key West harbor offered no relief from the heat of a typical Florida Keys summer, especially after DeepWorker baked on deck between dives. In my tiny steel pressure cooker, cabin temperature was more than 100 degrees Fahrenheit, with, needless to say, no ventilation.

I was completely saturated with sweat, struggling to keep my burning eyes clear and the onboard computer dry, trying to maintain my assigned heading in zero visibility while avoiding collisions with an assortment of underwater debris, all the while navigating with a wrist compass that was spinning furiously and didn't appear to understand the concept of "North." I was having the time of my life.

This was a training mission. On board the Acoustic Pioneer, submarine veteran Larry Shumaker was my lifeline, supervising my dive and responsible for training four of us on a two-day training course. Nearby stood Dr. Sylvia Earle, National Geographic explorer-in-residence and project director for the Sustainable Seas Expedition (SSE). Sylvia kept a steady eye on our project, a constant ear on her cell phone, and her warm, trademark smile upon her face.

SSE is a five-year research and public education project including visits to each of our twelve national marine sanctuaries. The project is a collaborative effort of the National Geographic Society, the National Oceanic and Atmospheric Administration (NOAA), and the Goldman Fund. Thanks to Sylvia and the folks at Florida Keys National Marine Sanctuary, I was invited to participate in this unique and important project.

SSE's use of cutting edge technology like the DeepWorker makes it possible for scientists like myself - who have had no naval or prior

submarine experience -- to participate in research and public outreach like never before. DeepWorker is straightforward to operate, safe, compact, versatile and inexpensive. It will dramatically extend the reach of science.

David Guggenheim and Sylvia Earle pose in front of the DeepWorker

But why am I a participant in this project? As president & CEO of The Conservancy of Southwest Florida , a 35-year-old nonprofit environmental organization based in Naples, and as Florida co-chair of the Everglades Coalition, representing 40 national, state and local environmental groups, I spend most of my time working to protect and restore the Everglades.

The Florida Everglades

But the Everglades lies miles to the north of the Florida Keys -- what does the Everglades have to do with the health of Florida Keys National Marine Sanctuary?

Today this is a critically important question, and researching its answer is one reason my organization is a participant in SSE. We're also involved to help raise awareness for the restoration of the Everglades, the largest environmental restoration ever attempted in history, a restoration that very definitely has the coral reefs in mind.

When most people think of "Everglades" they think of Everglades National Park and Florida's southeast corner. But the Everglades Ecosystem is much, much larger. It is immense and complex, stretching from the headwaters of the Kissimmee River near Orlando to Lake Okeechobee, across both coasts southward, across Florida Bay and Ten Thousand Islands to the Keys and the reef tract.

Today the Everglades is our nation's most endangered ecosystem. Our mistakes and lack of foresight over the past century have left the Everglades in a devastated condition that threatens not only the splendid wildlife that live within, but the very way of life for millions of people who call South Florida their home.

On July 1, 1999 in a ceremony at the Capitol with Vice President Al Gore presiding, the U.S. Army Corps of Engineers delivered to Congress the master plan for restoring the Everglades,"The Restudy". The principal goal of this massive restoration is to restore the natural functioning of the Everglades Ecosystem, a system unlike any other on Planet Earth.

It is a system that is uniquely dependent upon water, dependent upon a specific cycle of flood and drought, a system where water flows almost imperceptibly as a broad and shallow river of sheet flow, the "River of Grass", a system where land and water are inseparably linked, where sawgrass marshes and cypress give way to rich mangrove estuaries and coral reefs teeming with life.

The Everglades and the Keys' magnificent reefs are linked by water. There is great concern that the changes in water flow and water quality that have occurred in the Everglades are having profound impacts downstream in the Keys. Waters from the Gulf of Mexico and the southwestern coastal Everglades enter Florida Bay, as does the drainage from much of the adjacent mainland marsh immediately north. Water from Florida Bay in turn flows through the Florida Keys and over the reef tract and northward via Hawk Channel into Biscayne Bay. This means the health of the reef is dependent on how we manage water far to the north, and means that land use decisions in the rapidly developing Southwest Florida may also be contributing to water quality issues far downstream.

Fifty years ago, the original Central and Southern Florida (C&SF) project drained and fragmented much of the Everglades. The primary system includes about 1,000 miles each of levees and canals, 150 water control structures, and 16 major pump stations.

Today, a mushrooming population is placing increasing pressure on a system still managed by an antiquated infrastructure that was never meant to serve such a large population. Roughly 50 percent of the Everglades have been lost to development. The number of wading birds has been reduced more than 90 percent.

The Restudy is the work of more than 30 federal, state, local and tribal agencies working together and includes 68 separate projects covering an area encompassing approximately 18,000 square miles from Orlando to Florida Bay. The project will cost $7.8 billion dollars

and take more than twenty years to complete.

It is water that gives the Everglades life, and it is the management of water in the Everglades that is the central theme of restoration. The following goals have been identified for the project:

Capture & Store Water

South Florida receives an abundance of rainfall every year, more than sixty inches. However, every year, because of limitations in the current water management system, an unimaginable one trillion gallons of fresh water are dumped from Lake Okeechobee into the Atlantic Ocean and the Gulf of Mexico. This is water that is desperately needed by the Everglades as well as South Florida's growing population, and agriculture. Thus, a major element of the restoration plan is the capture and storage of this water.

Re-establish Natural Flow

The Everglades Ecosystem depends upon a very specific hydrologic cycle. A major goal of restoration is to ensure that the natural flow is restored, so that the right amount of water is delivered to the right places at the right time. By diverting water into canals, "slow water" has been transformed into "fast water." Under natural conditions, fresh water might have taken days or weeks to make its way to coastal estuaries. Today, it can get there in minutes. These estuaries depend upon a specific balance of fresh and salt water and their inhabitants are not adapted for large pulses of fresh water. Ironically, we have managed to make fresh water a pollutant. Excess stormwater discharged to the Gulf of Mexico and the Atlantic through the Caloosahatchee and St. Lucie rivers has had devastating impacts. The restoration seeks to greatly reduce these discharges by storing excess runoff, which can then be used to augment flow to the estuaries during dry periods.

Improve Water Quality

The natural systems of the Everglades depend upon clean water -- very clean water. This means levels of nutrients measured in parts per billion. Even a bottle of Perrier contains more phosphorous than the Everglades can tolerate! Over the years, water quality has degraded, and water polluted with nutrients and other chemicals from agricultural and urban areas has had serious impact. Growing levels of nutrients have allowed cattails to overrun sawgrass, leading to a decline in wildlife. The restoration seeks to dramatically improve water quality in the system that will involve treating both urban and agricultural runoff water before it is discharged to the natural areas throughout the Everglades.

Reconnect the System

The original C&SF project badly fragmented the Everglades Ecosystem. Now the natural system must be reconnected by removing more than 240 miles of canals and levees within the Everglades. This will help to reestablish the natural sheetflow of water through the Everglades.

Enhance Wildlife Habitat

A goal of the Restudy is to enhance the Everglades' ecological health by increasing the extent of natural areas and improving the quality of wildlife habitat. By recreating the natural conditions of the Everglades, wildlife will once again be able to flourish, with increases in native plant and animal abundance and diversity.

Develop a Sustainable Water Supply

The Everglades were damaged in the mistaken belief that we could supply human needs at the expense of nature. Now both are in jeopardy. The restoration must supply water to the natural system as well as provide for municipal, industrial and agricultural needs, provide flood control, provide recreational opportunities, and protect cultural and archeological resources and values. Billions of dollars of the South Florida economy, including $400 million from tourists visiting Everglades-related parks and preserves, depend on a healthy, functioning Everglades, and restoration will help ensure that these activities are protected.

Protect the Entire System

One of the major mistakes 50 years ago was the failure to recognize the fact that the Everglades Ecosystem is an integrated, interdependent system. The Restudy recognizes this and includes important follow-on studies in key geographic areas of the system. One follow-on study will concentrate on the Florida Keys, where changes in water flow and poor water quality threaten the health of Florida Bay and the coral reef tract. The study will evaluate and determine the types of modifications that are needed to successfully restore water quality and ecological conditions in the region.

Today the fastest growing part of the Everglades Ecosystem is on Florida's West Coast, yet there is a serious lack of information available on the region's water and natural resources. A follow-on study for Southwest Florida will address the health of the region's wildlife and water resources and will help Southwest Florida avoid

the same mistakes (and need for restoration) of the Southeast coast.

Marjorie Stoneman Douglas said, "The Everglades is a test. If we pass, we may get to keep the planet." Indeed, the restoration is the "mother of all tests." It is completely unprecedented in size and scope. When completed, this will be the largest environmental restoration in the history of civilization.

- It tests our ability to comprehend and manage an impossibly complex and unusual natural system.
- It tests the very limits of our engineering and technology.
- It tests our ability to work on the cutting edge, across traditional disciplines of science.
- It tests our common concept of government, breaking the mold and creating a new model of interagency cooperation.
- It tests our resolve to stay the course, requiring us to work intensely for more than two decades.
- It tests our unity of purpose as a nation, working in partnership to restore a national treasure.
- It tests our strength and endurance on a task that sometimes seems overwhelming and impossible.
- It tests our human spirit and our ability to embrace a future of hope for a beloved ecosystem, for our planet, and for our descendants.

As we embark on this historic restoration effort, the hard work of SSE will help raise awareness and contribute to our understanding of the southernmost jewel of the Everglades Ecosystem: Florida Keys National Marine Sanctuary.

As I thumb through my training manual, I think about the hard work of the SSE team in running a program that will truly make a difference for our marine environment. I look forward like a kid to my next mission in DeepWorker. Maybe next time I'll get a bit deeper -- where the cool water is.

(top) **RETURN**

The Facts of Life

Marilyn Tarnowski, Journalist
Florida Keys World Wildlife Fund

"Mommy, Where did I come from?"

All life originated in the sea. (photo credit: FKNMS)

When I first asked that question, I was probably about five years old. For six or seven years thereafter, I never wearied of asking the question again and again in order to elicit my mother's wonderful response. The question was her cue to take me on her lap to retell our favorite story.

"Well, sweetie, where you came from is a long, long story that began about three or four billion years ago, when the earth was covered with a watery ocean. You came from the salty sea, like everything that lives."

"Once upon a time, Mommy," I'd prompt, to get her started on the right track. And so she would begin: "Once upon a time, Earth was completely covered with a warm and shimmering ocean and wrapped in a blanket of blue air. The ocean and the air were made up of almost all the molecules that ever were or ever would be on Earth. These were the very same molecules that would eventually, after millions and millions of years, make algae, fungus, plants, animals, people and even little girls."

Her story transported me from the Archeozoic era to the Pleistocene epoch. (I was becoming an avid reader and loved the phonetic challenges of my mother's "names of time" in much the same way

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kids today love the names of dinosaurs.) Her story of my origin began deep in the "dark and stormy nights" that churned Earth's prehistoric oceans of salty water and fizzing gasses. Her story moved forward to "the big surprise," when suddenly one morning there appeared in the ocean lots of very tiny, little green molecules. These, she said, had possibly been struck by lightening the night before and warmed by the sun during the day ("But, of course, no one really knows," she always cautioned.) The lightening-struck, green molecules gave rise to the brand-new process of photosynthesis, a way to make food from sunlight. Her voice would rise with wonder and excitement.

The ocean is full of odd looking creatures, like this arrow crab (Stenorhynchus seticornis). (photo credit: FKNMS)

My mother punctuated descriptions of life's steady progress with delightfully drawled renditions of the phrase "millions and millions of years," foreshadowing astronomer Carl Sagan's signature line, "billions and billions of stars," by decades and decades! She took care to describe one-celled plants floating on briny seas and collecting near the relatively calm shores of emerging islands. Mutation became the magic wand that made things happen. The ocean's green molecules, she said, "after millions and millions of years, of course," mutated to make two-celled plants, and then after more millions of years, mutated again to make four-celled plants, then many more millions of years, became 16-celled plants, and then changed again to form 256-celled plants. The numbers were magical and so specific to her story that I had to reach the fifth grade in order to discover she had been squaring numbers!

My mother's saga progressed through the epochs, describing at each step the extraordinary variety of life that took hold in the oceans and all along the edges of that vital, salty soup. She never failed to include Cambrian sponges, Ordovician fishes, Silurian scorpions, Carboniferous corals, Permian reptiles, and - of course - Triassic dinosaurs and Jurassic birds. As I grew, the story expanded, and at one telling or another, eventually covered nearly the full range of life that emerged from the ocean.

My mother also made sure that her oft-told story was not just a fantasy for me. As it happened, we lived just a few miles from

Sandy Hook, New Jersey, a three-mile sandbar that pokes a foot or two above the Atlantic Ocean. The salty shallows are home to swarms of thriving but prehistoric horseshoe crabs with their beautiful clutches of sky-blue eggs. The edge of the ocean tosses up myriad fossils -- trilobites and other odd and old creatures, long extinct but lending their shapes and names to my mother's history of how life, and I, began. She showed me how to watch flocks of shore birds that came and went with the seasons. The visible, vital seaside readily confirmed her explanation of where I came from.

Of course, in due time, my mother did share the prosaic, literal details of my conception. But the complete and true story, for me, will always be the first one she told and retold. Where does any living thing come from? We come from the ocean.

Nothing can be without the sea. (photo credit: FKNMS)

It has been 50 years since my mother first told her children the multi-chaptered story of how the seas gave rise to life itself. Since then, I have listened to fishermen, sailors, scientists, and everyday people who look to the oceans for livelihoods, information, pleasure, and peace of mind. All acknowledge dependence upon the ocean. Few are confident that things are ok out there. Nearly all deplore the squander that is the result of intense fishing, relentless hunting, thoughtless polluting, widespread dumping, and careless or planned destruction.

Thus, when I had the opportunity recently to tell a youngster the story that my mother told me, I found myself adding a chapter about the very real potential for "using it all up." My young friend listened carefully, and at the close of my version of the story said, "I know. Nothing can be without the sea." Smart kid.

(top) **RETURN**

Geologic History of Florida Reefs: Many Unanswered Questions

Dr. E. A. Shinn, Geologist
United States Geological Survey

About 125,000 years ago, polar ice caps melted and the surface of the world's oceans rose at least 20 ft higher than at present. With higher sea level and strong tidal currents, shoals of shifting sands composed of oolites (tiny, spherical, calcium carbonate precipitates) created the future foundations of Miami, the city of Key West, and the entire lower Florida Keys.

At the same time, a string of coral reefs grew between the oolite sand shoals, inland from the shelf edge. The reefs eventually linked to form what are now the upper and middle Keys. Windley Key, the highest island in the Keys is 18 ft above sea level. Because corals built the keys the ocean had to be at least 20 ft (probably more) higher then than it is today. After development of these ancient reefs, the sea fell as expanding polar glaciers took up water and converted it to a layer of ice more than 1 mile thick.

Detailed records from deep-sea sediments and ice cores show that sea level fluctuated many times since the 125,000-year-old coral reef formed. Sea level dropped, leaving the reef high and dry. Later, around 80,000 years ago, sea level rose again to within about 25 ft of present level. This time a second chain of reefs grew along the shelf edge. The new reefs were bathed in the adjacent Gulf Stream waters. Minor sea-level rises and falls continued until about 25,000 to 30,000 years ago when glaciers expanded again, causing the sea to fall about 400 ft (more than the length of a football field).

Then, about 10,000 years ago, a mere flick of the eye in geological time, glaciers began melting and the sea rose rapidly, punctuated by brief, more rapid, rises attributed to water displacement when

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The author with a cross-sectional model showing a 5-mile long slice of the limestone that underlies the Florida Keys. Coral reefs and sediments are not shown. To the left is the 125,000 year-old reef (Key Largo). At the far right is the 80,000 year-old reef.

large glaciers slid into polar oceans. About 6,000 years ago, the sea spilled over the shelf margin and the south Florida shelf began to flood. Back then, the State of Florida was about twice its present width. The western shoreline was almost 100 miles farther west and there were no Florida Keys. The old 125,000-year-old reef was at that time just an inland ridge of limestone standing in bold relief on flat land with numerous sinkholes.

(top)

As the sea continued to rise, the 80,000-year-old reef ridge five miles offshore became completely surrounded by water, forming a string of islands much like the present Florida Keys. A trench behind the reef was the first to be flooded. It began to fill with lime mud like the mud presently in Florida Bay. By 3,000 years ago while the water was still rising, these offshore islands disappeared beneath the surface. At the same time, an Everglades-like swamp west of the present Keys was being flooded to become what is now Florida Bay. The only remaining land was the 125,000-year-old string of reefs. The Florida Keys had been born.

How do we know this sequence of events? Ongoing USGS research consisting of core drilling and soundwave probing (called seismic profiling) has clearly demonstrated the sequence of geological events described above. However, this research also raises many new and as yet unanswered questions. A combination of radiocarbon dating of cores and a USGS mapping project presently underway shows that all of the reefs one swims over today formed after the shelf

flooded 6,000 years ago.

What is surprising, however, is that there are so few areas of reef accumulation and that many large areas support no reef growth at all. Sediment is also thin over surprisingly large areas. In some places, seismic profiles show that sediment that formed during the past 6,000 years is only inches thick.

The same cross-section showing the reefs (pink) and lime sands (yellow) that accumulated after flooding that began about 6,000 years ago. Blue is lime mud, the first sediment to be deposited as the area was flooded. The author's hand is at present sea level (note that sea-level is higher on the Florida Bay side of Key Largo). Humans have arrived, symbolized by coconut palms (not native).

Seismic profiling uses a device, like a conventional fathometer or fish finder, that bounces signals off the bottom to create a drawing or profile of the bottom. Unlike the standard fish finder, the seismic device creates a signal so strong that it also penetrates the sediment and bounces from any underlying hard surface. In the keys, that hard surface is the old reef and sediment blanket that developed before sea level plummeted 400 ft.

The surface is hard because lowered sea level exposed the reefs and sediments to fresh water. Rainwater is slightly acid and partially dissolves corals and other lime particles. The dissolved lime then reprecipitates in a more stable form as tiny crystals. The crystals cement the sediment grains together, transforming sediment to hard limestone.

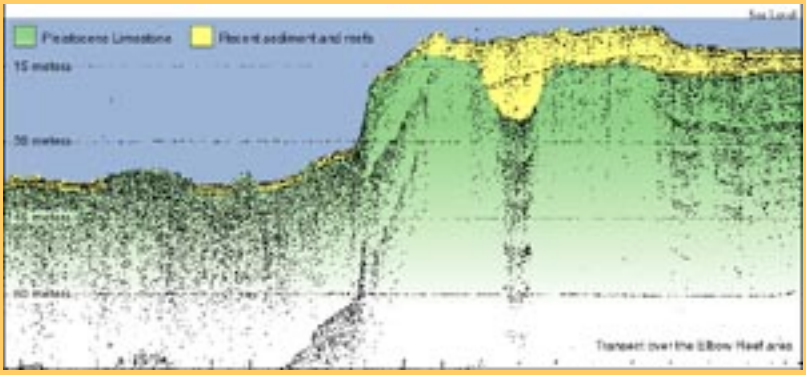
Exposure also causes the formation of red to brown crusts up to 2 inches thick. Radiocarbon tests show that the brown crust represents about 5,000 years of deposition. The crust contains clays, iron, and aluminum, all of which are alien to South Florida. These minerals have recently been shown to originate in Africa. They traveled about 5,000 miles with the trade winds. The limestones and crusts extend to Key West and beyond, all the way out to Dry Tortugas.

(top)

So what else has seismic profiling revealed, and what can be done with the data? Using these data, one can construct maps and cross sections that show unsuspected relation. Cross sections, like cutting a slice through the Earth, show that at the edge of the Gulf Stream there is bounded by a generally pronounced ridge, the old reef that formed 80,000 years ago.

Landward there is a deep sediment-filled trough. The underlying

rock surface then slowly rises upward as it approaches the modern Keys. Several small terraces control the distribution of today's living reefs.

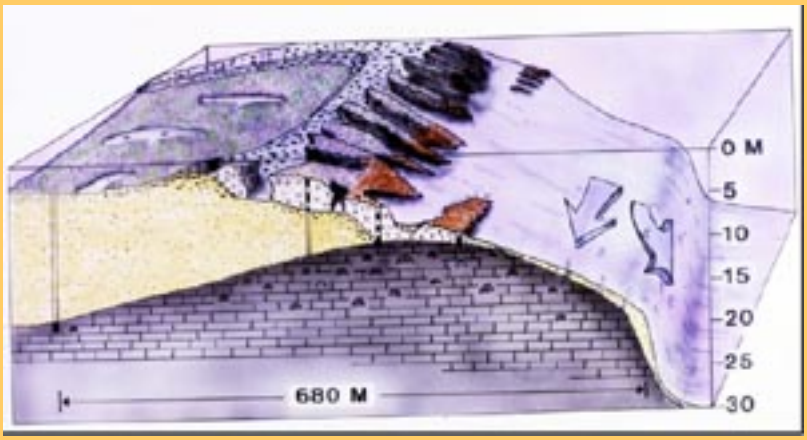


A portion of a seismic profile across Elbow Reef showing Pleistocene limestone (green) overlain by sediment and coral reefs (yellow). The Gulf Stream is to the left of the 80,000 year-old reef ridge. The sediment-filled trough is clearly visible.

When the sea first encroached landward over this irregular rock surface, fine-grained lime mud settled in the low places.

As the sea rose even higher, coral reefs began growing on rock highs, such as the ridge near the Gulf Stream, and along linear terraces. Grecian and Key Largo Dry Rocks are part of a reef trend that formed along one such terrace. The terraces were probably shorelines when the rate of sea-level rise slowed. An old shoreline terrace can be seen in 10 to 12 ft of water less than a half mile off the entire keys chain.

Looe Key Reef, on the other hand, began growing on the outer 80,000-year-old ridge, then backstepped landward over the sediment-filled trough as the sea continued to rise.



With all the seismic data one can construct maps with contour lines showing submarine elevations and depressions as well as old shorelines. These data help explain the distribution of today's reefs, sand banks and

seagrass beds. Barbara Lidz of the USGS is currently making such maps

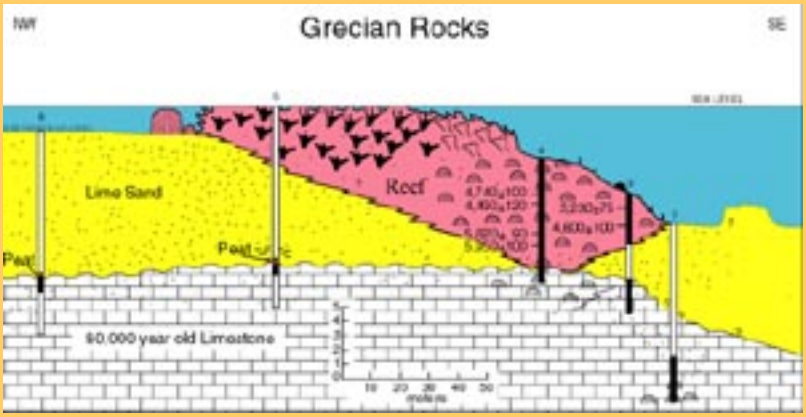
A block diagram and cross-section, based on core borings, of Looe Key. Reef lime sand is moving along reef front as shown by large arrows. The reef began growth on the top of an old reef (limestone) ridge and backstepped as sea-level rose.

But what additional new information do the maps provide, and what new problems have been unearthed? The first surprise was that many modern reefs are thin, or even absent along the Gulf Stream side of the submerged 80,000-year-old reef ridge 5 miles offshore. The major reefs one sees on the charts rest on top of that old ridge, but on the ocean side in water deeper than 30 ft the old limestone is basically uncovered.

(top)

Scattered head corals, sponges, seawhips, and other encrusters give the impression of a thriving reef in depths between 30 and 70 ft. Biologists would not hesitate to call these areas reefs. To the geologist, however, it is just 80,000-year-old limestone, a dead surface with a superficial scab of living reef organisms. This area of the reef tract has been under water for 6,000 years or longer, yet we have no clue why a thick reef has not formed there. There are "true" geological reefs farther landward of the old rock ridge.

A similar situation exists in the Great Barrier Reef of Australia where it has been discovered that the actual barrier reef is a relict feature. In the Keys, reefs inshore of the outer barrier, like Grecian Rocks, Key Largo Dry Rocks, and others, are as much as 45 ft thick!.



Corals that formed these reefs began growing on a rock terrace 45 ft below present sea level and grew right up to the surface during the past 6,000 years.

For unknown reasons, even the thick reefs

Cross-section of Grecian Rocks, based on core borings. Reef (pink) began growing at edge of limestone terrace (blue) and backstepped over lime sand (yellow). Traces of mangrove peat were encountered by core bit on top of the brown crust that coats the limestone. Radiocarbon dates from core no. 4 show that corals began growing on the old limestone about 6,000 years ago.

that have grown upward keeping pace with the rising sea are few and far between. The reefs off the upper Keys that have reached or kept pace with sea-level rise during the past 6,000 years represent less than 0.03 % of the area. Sediment thickness maps for the reef tract reveal that mud and sand are only 3 ft thick over 20% of the area and about 9 ft thick in 30% of the area. Sediments 20 to 30 ft thick represent less than 2% of the reef tract. These observations make us wonder exactly what happened during the past 6,000 years, especially among the corals.

The growth rates of reef-building corals are fairly well known, and they show that even the slowest growing corals should have kept pace with rising water during the past 6,000 years.

(top)

The main reef builders grow may times faster. Staghorn and elkhorn coral, for example, grow about 4 inches each year, fast enough to grow more than 1,800 ft straight up in 6,000 years. Of course, the corals could not grow that tall because the water is less than 60 ft deep over much of the area, and in most places less than 30 ft. The potential for lateral growth, however, should be unrestricted, so one must wonder then why, during this short period of geological time, sediment and corals did not accumulate right up to the surface everywhere.

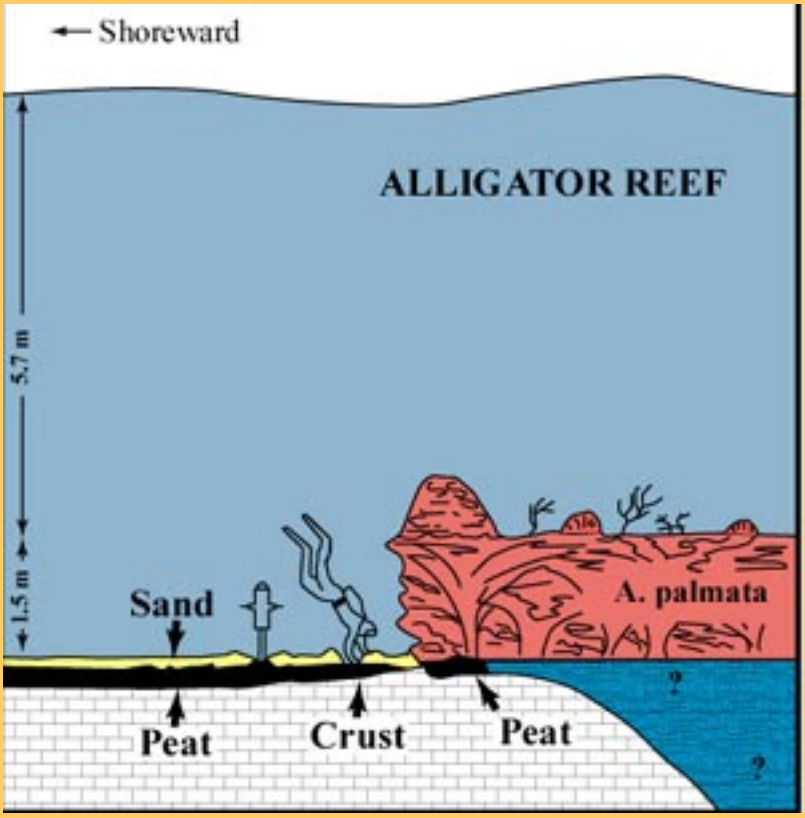
Do recent plagues and hurricanes provide any clues about the past? We know that in recent years the rapidly growing corals throughout the Caribbean have suffered from various diseases, and hurricane damage can be extensive. We know that widespread staghorn and elkhorn coral death began in Florida in the late 1970s and that throughout the Caribbean these species almost died out in single year, 1983.

Did similar diseases happen periodically in the geological past in Florida? Could past disease outbreaks explain why reefs have not reached their full potential during the past 6,000 years? Were there long periods of severe hurricanes that periodically destroyed the reefs? We understand some areas well and other areas not so well.

For example, there is a well-known cause of coral decline off the middle and lower Keys. There, coral growth has been retarded by runoff from Florida Bay and cold Gulf of Mexico waters. Opposite the major tidal passes, notably the 7-mile bridge area, the reefs here are not actively accreting.

Radiocarbon dating of core samples shows these reefs have been senile for at least 2,000 years.

The reason? As sea level rose, creating Florida Bay and the tidal passes, mud-laden bay water began to flow outward and over the offshore reefs. During severe cold fronts, shallow bay water is chilled enough to kill the fast-growing corals. The bay water is also turbid with sediment, an observation noted around the turn of the century by T. Wayland Vaughn.



Schematic cross-section of a drowned "senile" reef at Alligator Reef. The flat surface of this 2,000 year-old elkhorn (A. palmata) reef is thought to represent position of sea-level when the reef was growing. A few inches of lime sand overlie peat and crust, which overlie limestone (brick pattern). The peat is 8,000 years old. This reef is affected by runoff of Florida Bay water through passes. When sea-level was lower, Florida Bay did not exist and there was less runoff.

(top)

Because of tidal passes and Florida Bay water, the more thriving reefs are restricted to areas off Key Largo and the lower Keys where islands offer protection by shielding corals from bay-water runoff. Recent work is showing that the bay level is actually a few inches higher than the ocean. Therefore, even though the tides pass back and forth through the

passes, as well as through the porous limestone beneath the Keys, net flow is "downhill," away from the Gulf of Mexico and into the Atlantic. The reefs opposite the passes have suffered because of rising sea level.

Corals have also been dying in areas far from tidal passes in recent years. Possibly, water flowing from Florida Bay through the limestone could be having an effect. Our measurements show that the net flow through the limestone is about six feet per day.

We should also consider natural causes. For example, bamboo mysteriously dies worldwide about every 120 years. Because the death of bamboo affects panda populations, the Chinese have been observing the phenomenon for more than a thousand years. Unfortunately, we have no long-term observations for corals other that what we can glean from cores and excavations.

Reef workers and divers have for years been puzzled by the presence of dead staghorn "sticks" in the sands along the outer reefs. This species thrives only on hard bottom in clear water but dead staghorn can often be observed a mile or more from hardbottom areas. Did staghorn once grow everywhere like a weed but die back a few hundred years ago, or did storms periodically transport the "sticks" from outer-reef growing areas during the past 6,000 years?

To attempt an answer, staghorn sticks were collected at many places between Key West and Key Largo. More than 20 sites were sampled. The age of the staghorn sticks was then determined using the radiocarbon method. If a plague killed the staghorn, then the dates would show that all the staghorn died at about the same time. If, on the other hand the ages were all different, then the sticks must be have been transported by storms from different sources at different times.

(top)

Surprisingly, the sticks ranged from 100 to almost 5,000 years in age even though they were collected miles apart and just inches below the surface! Only very intense storms and tremendous sediment mixing could bring 5,000-year-old corals to the sea floor. Corals 3,000 to 5,000 years old should be buried more than 10 ft below the surface. For example, at Grecian Rocks, corals more than 3,000 years old form part of the reef framework 30 ft and more below the growing reef surface. Apparently, a lot of unsuspected events took place before man's arrival in the Florida Keys.

Another question. Why do corals, other than some hardy non-reef

building species, not grow near shore? The rocky surface appears suitable for coral growth. In comparison, along the Belize reef tract where there is little tide, sensitive species, even staghorn, grow in sediment (or did so in the 1970s) just a few feet from the mangroves. In the Florida Keys the nearshore bottom is rocky and corals should live there.

What is different in Florida is tidal pumping. The 3-4 ft tides cause the ground water to flush in and out of the limestone twice daily, so it is possible that the twice-daily pumping of anoxic hydrogen sulfide-rich ground water prevents coral larvae recruitment. On the other hand, periodic chilling during cold fronts may kill the more sensitive coral species. We do not know all the answers. The puzzle is further complicated by effects of human activity. In recent years, these nearshore waters have become increasingly polluted by both human pathogens and excess sewage nutrients, and the human population continues to climb.

Of course the big question, still unanswered after millions of dollars in research is, why are the corals dying? Ironically, we seem no closer to a solution to coral death than 10 years ago. Nothing that has been done has prevented coral decline on the scale so familiar to everyone. If the problems were limited only to Florida, the cause or causes might be easier to prove but similar events are happening simultaneously throughout the Caribbean.

Is it El Niño, global warming, or both? Is it something related to global warming? For example, are the billion tons of African soil that settle in the Caribbean and southeastern U.S. each year causing coral death? Research into this possibility is in progress at the USGS, University of South Carolina, Duke University, and the University of Miami.

So far, it has been shown that a soil fungus called Aspergillus is the cause of a Caribbean-wide seafan disease and the same fungal species is present in dust collected from the atmosphere over St. John in the U.S. Virgin Islands. The worst years for dust just happened to be 1983 and 1987. Whether corals are affected by nutrient minerals and/or microbes in African dust remains unanswered. So for now, many geological and biological mysteries remain and await detection on the Florida reef tract. It is all part of a very dynamic Earth system with many challenging processes to decipher.

(top) **RETURN**

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NATURAL SETTING

MAPS

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SEN. BOB GRAHAM

Water Quality in the Florida Keys: The Time to Act is Now

Dr. Bill Kruczynski, Florida Keys Program Scientist
U.S. Environmental Protection Agency

The Florida Keys are a chain of tropical islands composed of several interdependent community types, including tropical hardwood forests, fringing mangrove wetlands, seagrass meadows, hard and soft substrates, and coral reefs. The tropical setting and ecological diversity have made the Florida Keys a popular place to live and vacation.

A snorkeler glides over a coral reef in the Western Sambos Ecological Reserve located within the Florida Keys National Marine Sanctuary. (photo credit: FKNMS)

The economy of the Florida Keys is based largely on tourism and fishing. Approximately 3 million visitor trips annually are made to the Keys generating over $1.3 billion. Tourists come to the Keys primarily to snorkel or scuba dive, fish, observe wildlife, relax on the beach, and sightsee. The annual dockside value of commercial fishes landed in Monroe County is approximately $50 million. Both tourism and fishing are directly dependent on a healthy marine ecosystem.

The community types that make up the Florida Keys ecosystem exist in a dynamic equilibrium, which means that changes that result in a direct impact to one community type can have profound effects on adjacent communities. The continued existence of the

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Keys marine ecosystem is dependent upon maintenance of clear waters with relatively low nutrients.

The recent public health advisory notices posted on swimming beaches in Key West due to fecal contamination of near shore waters highlights the importance of clean water to the economy of the Florida Keys. Other studies have detected human viruses and fecal bacteria in many residential canal systems of the Keys which are indicative of contamination of those water bodies by human feces. Cancellations of reservations by tourists due to health risks from contact with surface waters and the concerns about the safety of swimming in residential canals has helped focus the interest of governmental agencies, the business community, and concerned residents on water quality.

(top)

Detached seagrass chokes a canal in the Florida Keys. (photo credit: FKNMS)

While not nearly as newsworthy as the recent public health advisories, enrichment of nearshore waters by excess nutrients is a significant factor in the maintenance of a healthy Florida Keys ecosystem. Poorly treated wastewater and stormwater are the sources of nutrient enrichment of surface waters. Nutrient enrichment of waters can result in profound ecosystem changes, such as changes in water chemistry (e.g., low dissolved oxygen), productivity, and plant and animal distribution and abundance. Many canal systems in the Keys lack abundant and diverse biota because of nutrient enrichment. These effects can be detected in some other adjacent near shore waters, and it is feared that if nutrient enrichment continues unabated it could result in the further decline of ecosystem structure and function.

Sources of wastewater fecal contamination and nutrient enrichment of surface waters include leaky sewer pipes, poor onsite treatment methodologies, and overboard discharge by live-aboard vessels. In addition, many small treatment plants dispose of disinfected, but nutrient-rich wastewater, by injection into the groundwater via shallow wells. The geology of the Keys results in rapid exchange of groundwater and surface water through porous limestone. There

are only very few areas of the Keys where stormwater is treated before it enters surface waters with its sediment and nutrient load.

Society has known about these problems for some time, but they were largely ignored until the establishment of the Water Quality Protection Program of the Florida Keys National Marine Sanctuary and the adoption of the Monroe County Comprehensive Plan. Those planning efforts have outlined corrective actions required to remedy water quality problems. A countywide wastewater master plan is in preparation and the development of a stormwater master plan will soon be initiated.

However, all planning will be nonproductive unless adequate money is available to implement corrective actions and build required wastewater and stormwater infrastructure. It has been estimated that over $550 million is required to reduce wastewater and stormwater loadings to acceptable levels. The approximately 85,000 permanent residents of the Florida Keys should not be expected to pay the entire bill for these improvements. Help in the form of grants and low cost loans is needed from state and federal governments.

The time to act is now. Cooperation and coordination of the entire Keys community, local, state, and federal legislators, and regulatory agencies is required to implement the complex and costly solutions to solve water quality problems in the Florida Keys.

Leading the efforts in garnering federal financial assistance is Congressman Peter Deutsche's proposed bill H.R. 673, "The Florida Keys Water Quality Protection Project of 1999." Passage of H.R. 673 would result in providing federal grant funds for projects to replace inadequate wastewater treatment systems and inadequate stormwater management systems. Your support of federal, state, and local efforts to solve our water-quality problems is essential to restoring and maintaining our much beloved and economically valuable ecosystem.

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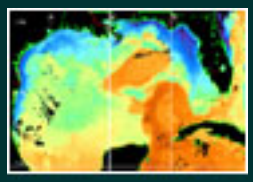

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Overview of the West Florida Shelf Expedition

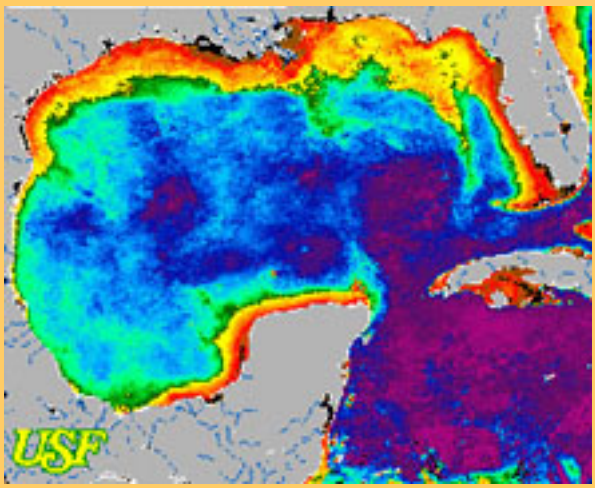
John C. Ogden, Ph.D., Director
Florida Institute of Oceanography

John Ogden

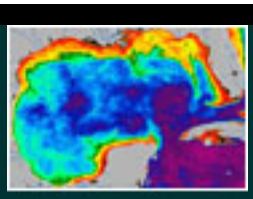
In 1884, Thomas Henry Huxley, in a paper presented at The Great International Fishery Exhibition in London, wrote:

> "The cod fishery, the herring fishery, the pilchard fishery, the mackerel fishery, and probably all the great sea-fisheries, are inexhaustible; that is to say that nothing we do seriously affects the number of fish. And any attempt to regulate these fisheries seems consequently...to be useless."

The unintended irony of this statement made over a century ago is a clarion cry for the future of the oceans. In 1884, the population of the world was just over one billion, and the oceans were perceived as limitless and mysterious. The *H.M.S. Challenger* was two years into its epic four-year voyage of discovery, which laid the foundation of modern oceanography and marine science and brought back the first outlines of the ocean's vastness and sketches of its endlessly fascinating animals and plants.



Now, more than a century later, it is said that we know more about the surface of the moon than we do about the oceans. But our knowledge is sufficient to understand that the present global human population of 6 billion is exerting a tremendous influence on the ocean, fundamentally changing its biological diversity, and threatening



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Phytoplankton populations are more dense on continental shelves and areas of deep-water upwelling. On the image, the areas of red and orange indicate higher concentrations of these organisms; the blue and green indicate areas of lower concentration.

resources and services that are critical parts of our life-support system.

Protection of the U.S. marine environment

Given our current understanding of the decline of the coastal ocean, most people are astonished to learn that the total area of fully protected marine habitat in the U.S. is approximately only 50 square miles. While we have 12 National Marine Sanctuaries, only two of them, the Florida Keys and Monterey, are of sufficient size to encompass a region and only the Florida Keys contains fully protected areas, so-called "no-take marine reserves," that are permanently closed to commercial and recreational fishing. Most of the area of our marine sanctuaries is open to fishing and other human uses. The Dry Tortugas "No-take" Marine Reserve, to be designated as part of the Florida Keys sanctuary in late 2000 after extensive public comment, will quadruple the size of fully protected marine areas in the U.S.! This tiny and as yet insignificant level of marine protection stands in stark contrast to our land areas, where we have designated over 700 national parks and 93 million acres (about 145,000 square miles) of wildlife refuges protecting, in combination with other areas, approximately 5% of the U.S. land mass.

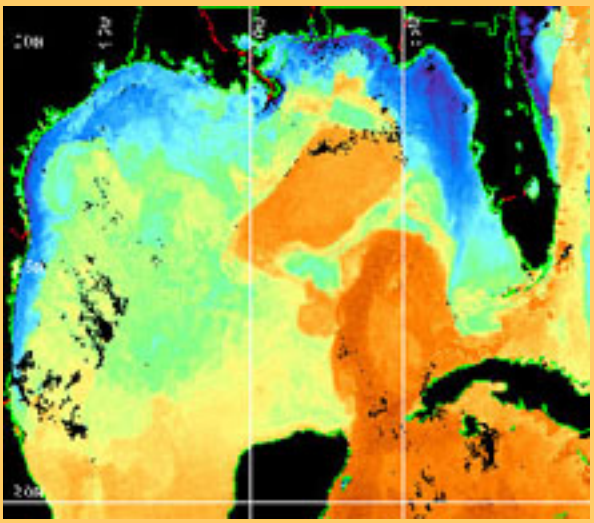
If the goal of the SSE is to explore the marine sanctuaries, why look at the West Florida Shelf (WFS)?

As important as our national marine sanctuaries are to our stewardship of marine resources, they are only a start on the future comprehensive marine protection that is needed. This goal got a major boost from President Clinton's May 26 Executive Order to create a system of national marine protected areas that would eventually encompass 20% of the nation's coastal waters. A follow-up to the Executive Order specifically mentions the West Florida Shelf as a rich region for exploration. Our expedition will be followed by dives of the deep-diving submersible Alvin on the Florida Escarpment in October 2000.

Given this national goal, the SSE has dedicated a portion of its 52-day schedule in Florida to the West Florida Shelf. Our goal is to explore the Shelf, particularly its biological diversity and important fishing areas, its geological history, and potential archaeological sites, to provide critical background information for future expanded marine protection in Florida.

Exploration of the West Florida Shelf

The Gulf of Mexico is bounded by Cuba, Mexico, and the U.S., and has a total area of 564,000 km2 (about 218,000 square miles). Over 24% of this is deep basin, over 3,000 meters deep (almost 2 miles), with a maximum depth of 3,850 meters (over 2 miles) in the Sigsbee Deep. Continental shelves occupy approximately 35% of the total Gulf area and the West Florida Shelf, at 150,000 km2 (about 58,000 square miles), is the second largest continental shelf in the U.S. after Alaska.



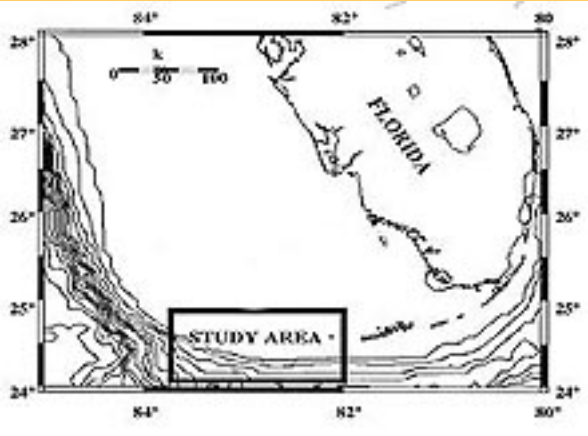
The warm water entering the Gulf of Mexico through the Yucatan Straits is shown in orange and red. The cooler water of the gulf is shown in blue and green.

Much of this vast area of shallow water was dry land only 10,000 years ago. As sea level slowly rose over time to its present level, a series of ancient shorelines was created and then successively drowned by the rising sea, leaving behind deposits typical of the near shore. Also likely to be left behind were relics of ancient human societies, which can be found in shallow waters along the present shoreline, but which have never been discovered in the deeper waters of the Shelf.

As a vast area of clear, shallow water, the Shelf has a rich biological diversity and is connected to the Keys Sanctuary by the Loop Current. It may be a source of larvae for many of the animals and plants within the Sanctuary. The West Florida Shelf is famous for red tides, caused by blooms of tiny, single-celled plants, which produce a potent toxin that causes massive fish kills and human respiratory problems. Red tides have been known since the time of the early Spanish explorers, but they may be increasing in frequency, geographic extent, and virulence, fertilized by sewage and runoff from populated coastal regions. The Loop Current has been known to carry red tide organisms around the Florida Keys to the East Coast. It may also carry pollutants originating in the rapidly growing cities of West Florida into the sanctuary.

The Shelf supports a major commercial and recreational grouper fishery centered in the Florida Middle Grounds and deeper waters to the west. On June 19, 2000 the Gulf Fisheries Management Council declared two marine protected areas to prevent overfishing of gag,

red, and black groupers. These two sites, the Madison and Swanson Site southwest of Cape San Blas, and the Steamboat Lumps Site west of Tampa, will initially be closed to grouper fishing only seasonally, but the Council has recommended year-round closure. Inshore of these protected sites, the Florida Middle Grounds have long been noted for a concentration of biological diversity and as a key fishing area.



Pulley Ridge is located in the boxed study area.

Further south, the Pulley Ridge area north of the Dry Tortugas is an incredibly rich biological community located in deep, clear water on a long topographic feature that may have been an ancient reef system when sea level stood lower along the Shelf. Investigations in this area with a Remotely Operated Vehicle (ROV) have shown nearly 100% cover of algae and bottom-dwelling invertebrates. Shallow depressions in the ridge shelter large fishes. Inshore of the Ridge are several famous spawning sites for jewfish, which, at a maximum of over 500 pounds, is the largest grouper in the world. These spawning sites were heavily fished until regulations protecting them were implemented in the early 1990s.

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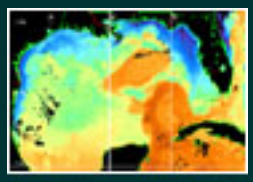

REEF HABITATS

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Reef Habitats of the West Florida Shelf

Felicia Coleman, Ph.D., Marine Ecologist
Institute for Fishery Resource Ecology, Department of Biological Science, Florida State University

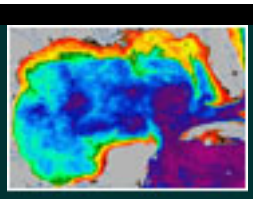
Felicia Coleman

The development of marine habitat maps is a fundamental requirement for marine habitat management and conservation. Because habitat is at the foundation of fishery production and biodiversity, it is essential that scientists and managers have available, spatially and temporally, specific inventories of marine habitats in a classification framework that is nationally (and internationally) consistent and objective.

The shelf-edge (50-120 m deep) coral habitat of Florida is important economically to the commercial and recreational fishing industries, and ecologically as areas of high biodiversity and as source areas supporting the spawning aggregations of some of the most important reef fishery species of the southeastern United States. Yet virtually nothing is known of these ecosystems, and no inventory of benthic-associated species exists. Given the potential for human-induced threats to shelf-edge habitat -- including oil and gas exploration and exploitation, pipeline transits, and inappropriate fishing practices -- the need is acute to identify and classify the area into spatially and temporally specific regions.

Little is Known about Shelf-edge Habitats

The reason these shelf-edge habitats have received so little attention is because they are remote (especially on the West Florida shelf), difficult to sample (they occur below scuba depths, 50-120 m deep), and their study requires the use of large ships and remote acoustic and visual imaging. Only in the last decade have the undersea techniques and electronics developed that allow such studies to be conducted.



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Dr. Christopher Koenig (left), from Florida State University, has conducted much research on the West Florida shelf.

Because the shelf-edge reef habitats of Florida (especially West Florida) have been fished for over 100 years, it is possible that direct as well as indirect fishing impacts have affected the benthic communities and habitat features of these deep reefs. Direct effects include anchor, long-line, and trawl impacts. Indirect effects may include trophic cascade effects resulting from the removal of key species from the system. Certain types of fishing clearly have been the causative agents for the extensive loss of coral habitat in some regions. Less clear are the changes resulting from the loss of apex predators (e.g., groupers and snappers), species now scarce in certain regions of the shelf edge where they once had been abundant.

Much of the information on West Florida Shelf-edge reefs is derived from research conducted by the Institute for Fishery Resource Ecology, a partnership between the Florida State University and the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center, particularly involving scientists from the NMFS Panama City Laboratory. Collaborators for describing shelf-edge habitat communities include Dr. Christopher Koenig from Florida State University, Kathryn Scanlon, a geologist with the U.S. Geological Survey in Woods Hole, MA, and Dr. Margaret Miller, a benthic ecologist from the Miami Laboratory of the National Marine Fisheries Service (NMFS). It is clear that shelf-edge reefs are important spawning habitat for several economically important reef fish, including gag *(Mycteroperca microlepis)* and scamp *(M. phenax)* groupers, which spawn exclusively on shelf-edge reefs. Aside from the function of spawning aggregation sites for gag and other reef fish species, the benthic community structure, composition, processes, and habitat functions of these reefs are essentially unknown.

Research Opportunities in the New Marine Reserves

During recent (February 2000) field studies directed by Kathryn

Scanlon, the team used side-scan sonar to acoustically map over 200 square nautical miles of shelf-edge habitat in the northeastern Gulf of Mexico in two newly established marine reserves, Madison-Swanson (MS) and Steamboat Lumps (SL). In June 2000, the NMFS closed these areas to all fishing for a period of four years, to evaluate the effects of fishing on grouper spawning aggregations. Closing such large areas to fishing provides the opportunity to observe the effects of fishing on habitat outside of the reserves, and, conversely, the possible reversion of habitat back to some historical condition within the reserves in the absence of fishing.

Two newly established marine reserves in the Gulf of Mexico are Madison-Swanson and Steamboat Lumps. Also pictured are the Florida Middle Grounds. The SSE team will attempt to visit all three areas. (Sizes are approximate)

The team's next step is to identify the characteristic biological components while using its side-scan mosaic and surficial geology database as the first tier of a hierarchical classification. During one leg of the Sustainable Seas Expeditions, manned submersible dives will be made in the reserve sites for a preliminary visual evaluation of key habitat features, using both video and visual transects in high- and low-relief sites. Acoustic methods are insufficient for doing this alone and must be combined with optical imagery, available from the submersible, in classifying the deepwater coral reefs of the shelf-edge. Submersible dives will aid in evaluating habitat cover and benthic species composition. Later this year, the team will select reference habitat sites and indicators of biological condition within each of the two marine protected areas, based in part on these dives.

Designating Habitat Classes

The overall approach will be to use the information from complete-coverage side-scan sonar mosaics and surficial geology, including

sub-seafloor characteristics (the sonar system can detect rock meters below the seafloor sediment), to select sites for habitat class designation. Shelf-edge habitats can be high relief (up to 20 m above the seafloor) or low relief (less than 1 m above the seafloor). It is likely that high-relief structures require a different approach than do low-relief structures.

The classification of geomorphological features is relatively straightforward because remote acoustic imagery is unequivocal, produces relatively sharp boundaries, and can be classed into convenient categories. By contrast, assemblages of benthic organisms and associated substrata are more difficult to classify, because they often exhibit considerable variation, tend to grade gradually from one assemblage to another, and require direct visualization for the identification and estimation of cover.

The benefits from this work will accrue to ecologists and environmental and fishery scientists, as well as to natural resource managers. The Sustainable Fisheries Act of 1996 mandated the regional fisheries management councils to prepare management plans for essential fish habitat. The classification scheme that the team develops, and the information gained from its investigations of shelf-edge habitats, should provide new insights into this little-studied ecosystem.

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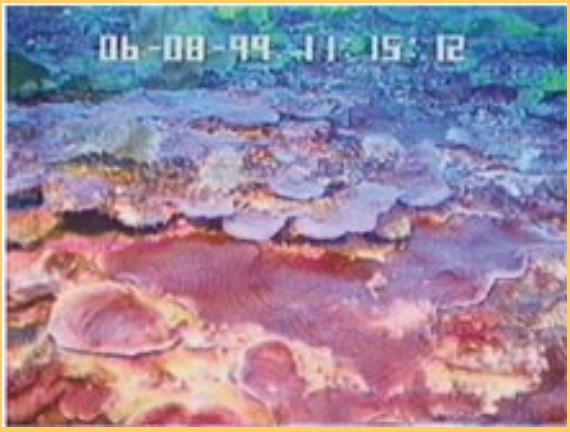
Deep Coral Reefs at Pulley Ridge

Bret D. Jarrett, Ph.D. Candidate
University of South Florida, St. Petersburg Campus

Bret Jarrett

Recent scientific discoveries by geological oceanographers at the University of South Florida (College of Marine Science) reveal extensive, modern, coral reef development at substantial water depths (60-80 meters) on the western south Florida continental margin.



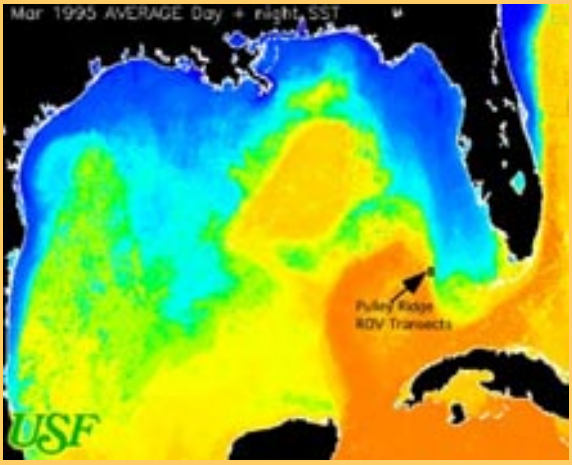
Footage from a remotely operated vehicle (ROV) reveals excellent water clarity and a high abundance of healthy coral growth at Pulley Ridge. This may be explained by the pervasive impingement of clear, low-nutrient Loop Current waters to the west.

The area is known as Pulley Ridge and consists of a series of elevated, linear, north-south-trending ridge bodies.

Imaging of the southern portion of Pulley Ridge using seismic reflection and multibeam sonar technologies, combined with ROV video observations and geologic sampling (dredging), has allowed for detailed mapping and geologic interpretations of past and present depositional environments.

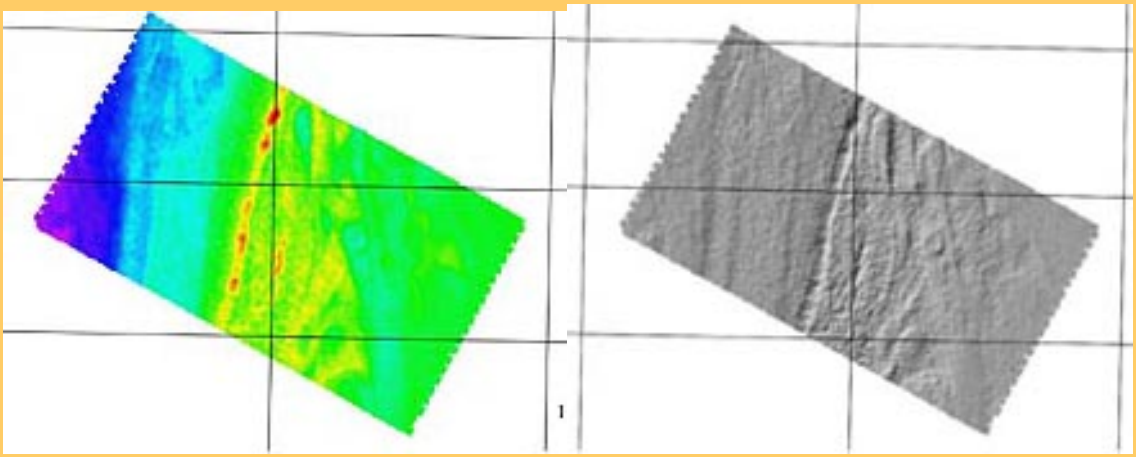
Presently, benthic communities at Pulley Ridge are dominated by living *Agaricia sp*. coral and large, leafy clusters of green algae *(Anadyomene menziesii)*. Less common stony corals include *Montastrea cavernosa* and *Porites sp.*, and most are found in platy form (to most efficiently utilize the available light). Encrusting and branching coralline red algae and sponges are also common. Water clarity is pristine at Pulley Ridge, and reef development is not solely restricted to the elevated ridge crests.

Oceanic circulation patterns, interpreted from satellite data, may help explain the enigmatic proliferation of deep coral reefs at Pulley Ridge. Cold, nutrient-rich, Mississippi River-derived waters bathe the majority of the south Florida shelf and are not conducive to reef growth. However, warm, nutrient-poor, Loop Current-derived waters consistently impinge on the western portion of the platform, where Pulley Ridge is located. Therefore, the oceanographic environment supports coral reef development at Pulley Ridge.



Satellite imagery reveals pervasive intrusion of warm, low-nutrient, Loop Current water on the southwestern portion of the platform, which fosters the development of deep, healthy reefs at Pulley Ridge (indicated by arrow). (AVHRR satellite image downloaded from the Univ. of FL Marine Science Dept. Remote Sensing Laboratory. - Muller-Karger)

Of additional scientific interest at Pulley Ridge is the underlying rock, which contains the history of past sea-level positions and past climatic conditions in South Florida. Many lines of geological evidence suggest that Pulley Ridge represents a paleoshoreline complex that developed during a sea-level standstill within the last deglaciation. First, seismic data from Pulley Ridge displays a layered seismic reflection character (similar to a modern beach or dune environment).



Top: Color bathymetric mosaic (using multi-beam sonar technology) across the Pulley Ridge deep reef system shows the linearity of the underlying ridge that presently supports reef communities, and numerous circular features (sinkholes) that indicate freshwater dissolution of a nearshore geologic deposit (beach or dune?). Red = 60 meter depth, Purple = 80 meter depth. **Bottom:** Shaded mean depth mosaic of Pulley Ridge using artificially illuminated sun angle from the southeast.

Secondly, multibeam sonar and ROV video often reveal circular depressions (sinkholes) within ridge deposits, which are most likely the result of freshwater dissolution (cave formation) when Pulley Ridge was exposed to rain waters. Thirdly, ROV observations clearly show a tabular, bedded nature to the ridge edifice (comparable to bedding in a modern beach environment). Finally, through dredge sampling, rock fragments have been retrieved that clearly represent beach/dune rock.

Continued scientific exploration by the Sustainable Seas Expeditions, to Pulley Ridge in August 2000 will be valuable for many reasons. First, through reconaissance ROV surveys, the extent of living coral reef growth and benthic variability may be assessed over large portions of the ridge. Next, through up-close, manned submersible transects and physical sampling of the ridge body, the geologic history (including past sealevels and past climates) may be determined. It is clearly in the scientific community's best interest to explore more of the potentially huge reef resource at Pulley Ridge.

Read Bret Jarrett's log summarizing his research on Pulley Ridge.

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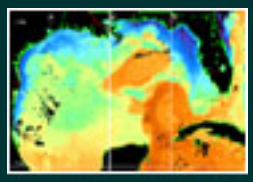


Underwater Archaeology on the West Florida Shelf

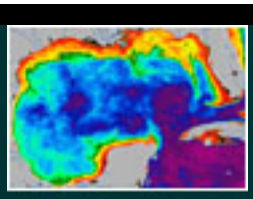
Text and images for this essay were selected from the **Florida State University Underwater Archaeology Web Site**.

Underwater Archaeology is the systematic recovery and study of human artifacts that is performed below the surface of the water. The material evidence consists of buildings, tools, pottery, graves, and other remains from past human life and culture.

Divers excavating at a J&J Hunt Site

Since the late 1950s, Florida State University's Program in Underwater Archaeology has actively conducted and supported hundreds of underwater archaeology projects. Using a variety of methods, from the more detached remote sensing to hands-on excavations, FSU faculty, staff and students investigate the spectrum of prehistoric and historic times. From prehistoric settlements on the West Florida Shelf to Civil War era blockades closer to modern shorelines, scientists use these methods to preserve important artifacts and improve our understanding of settlement patterns of prior cultures.

The Sustainable Seas Expedition hopes to aid researchers in their quest by providing extended observation and sampling using *DeepWorker 2000* submersible. During previous projects, researchers were limited to diving, which imposes bottom-time and depth limits. The towed-diver surveying method requires a scuba diver to hold a sled tied to a moving boat while making



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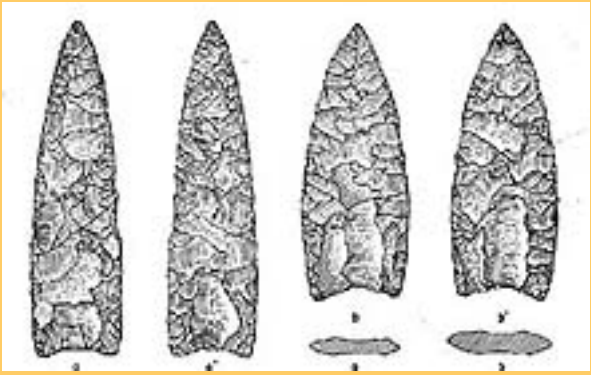
observations. In contrast, the *DeepWorker* allows researchers to make observations and take samples at depths not reachable by or accessible by SCUBA for only short periods of time.

Why look underwater?

Besides holding captive a variety of artifacts from modern colonial times, such as shipwrecks, the sea is a "library" of archived evidence of prehistoric times. At one time, the western shoreline of Florida extended far beyond the current shoreline out into the Gulf of Mexico and onto what is widely known as the West Florida Shelf. During that period, the climate and topography provided an environment that nourished prehistoric animals, such as mastodons, and allowed early Paleoindians to settle along the shores of this larger land mass. In time, the sea level rose high enough to hide the evidence of these cultures, flora and fauna, thus researches must now plunge beneath the sea to learn all they can about the history of the West Florida Shelf. Working beneath the sea requires more equipment, time and personnel than land-based archaeology, and poses greater risks to researchers. While dry-land archaeology is exciting, diving into the unknown is well worth the risk for researchers hoping to find even a small piece of the prehistoric Florida puzzle buried beneath the blue sea.



Clovis Points from Sellards -- These are diagnostic of the earliest fluted point making people in the New World, dating to 11,000 radiocarbon years before present (13,000 calendar years old). Discovery of points like these offshore would help scientists determine the arrival and migration patterns of Paleoindians.

Continental Shelf Prehistory

Information on submerged archaeological sites on the West Florida Shelf is needed to determine when, where and how Paleoindians first set foot in the New World and began making use of coastal resources. The FSU Clovis Underwater Offshore Archaeology Project addresses the issues of prehistoric offshore sites and attempts to answer questions about the paleoenvironment and its inhabitants.

Utilizing diagnostic Clovis-fluted points and artifacts is common practice in today's peninsular Florida, especially within the "karst" rivers of Northwest Florida -- irregular limestone regions characterized by sinks, underground

streams, and caverns -- where most of the discoveries have been made. Researchers have mapped the distribution of fluted-point projectiles in the United States, showing their distribution in predictable areas. Researchers continue to investigate why these fluted points exist in the far Southeast, when they should be found more to the north, in the Plains and far Northwest.

Evidence suggests that thousands of years ago, the West Florida Shelf extending out beyond the current shoreline, providing an arid climate and habitat for such animals as mastodons, mammoths, horses and sloths. Stratigraphic evidence also suggests that Paleoindians could have occupied these areas. The "Oasis Hypothesis" purports that this region was comprised of freshwater sinkholes found in the canyons of the karst topography, which, over time became inundated by the encroaching sea. Before disappearing beneath the waves, these sinkholes and surrounding environments may have provided Paleoindians with adequate resources for survival, which suggests that evidence of these populations might be found within these now submerged cultural "caches."

An artists rendition of prehistoric animals in Paleozoic Florida.

If this holds true, then Paleoindian sites are currently underwater off the coast of today's west Florida shoreline and remain undisturbed from human and natural processes. Information from these sites will help researchers determine the arrival, migration and colonization patterns of these early inhabitants. Using radiocarbon dating at these sites, scientists will be able to deduce the locations and rates of Paleoindian colonization adding to the existing information about their cultural history, settlement patterns and adaptations to the changing environment. Such research is important not only to improving our understanding of the environment, but also ensuring that the knowledge and relics of these past cultures are preserved and shared with the public.

To gather information and artifacts, researchers use a variety of field methods, including aerial and diver surveys, sidescan sonar, remote sensing, vibra-coring, induction dredge excavations and transect collections. Blending computer-assisted products with on-site observation and excavation provides scientists with the base information that allows them to determine where more in-depth

investigations and excavations should be conducted.

FSU student diver discovers an ancient projectile point - about 6,000 years old.

PaleoAucilla Prehistory Project

In 1999, the PaleoAucilla Prehistory Project (PAPP) was initiated to search for early Paleoindian sites on the continental shelf of Northwestern Florida. The project builds on the principles, technology, and experience developed over 13 years of offshore research, which has resulted in the discovery and sampling of Late Paleoindian, Early Archaic, and Middle Archaic archaeological sites. In addition, a number of relic river-channel segments and other geological features have been inventoried in this region of Florida, known as the Big Bend.

We work with a two-pronged, long-term research philosophy that proceeds from the known to the unknown. One operation conducts research at known site locations, while the other seeks out new sites farther offshore. With State Special Category Grant funds, FSU College of Arts and Sciences support, and local community support and resources, the 1999 PAPP worked at two locations: the J&J Hunt Site 3.5 miles offshore, and surveying for new sites at "Locus T," approximately nine miles offshore, within state jurisdiction boundaries. Research at J&J Hunt was conducted in 1989, 1991, 1992, and 1998. J&J Hunt is a multi-component archaeological site located within a broad expanse of the drowned Woodville Karst Plain around the margins of a relic segment of the PaleoAucilla drainage system. Locust T is a name given to another, larger expanse of past land mass, where there is a confluence of three relic river channels in what might be the PaleoOcklockonee River system.

This research will determine the range of time periods and culture groups represented on the State's western submerged lands. In addition, the project will familiarize students, participants, and the public with site discovery and data recovery techniques for submerged prehistoric sites. The project offers a possibility of significant scientific discoveries, just as the Aucilla River Prehistory Project did between 1983 and 1999.

Aucilla River Prehistory Project

A SCUBA diver excavates an intact mastodon tusk.

Over 12,000 years ago, Paleoindian explorers entered Florida and were the state's first natives. Hunting big game such as mammoths and mastodons, these early settlers survived the Pleistocene era and left evidence of their culture behind. Their artifacts, which are often found on the bottom of the Aucilla River preserved by layers of silty sediment, depict the history of the region from pre-human habitation to historic times. A mastodon kill site discovered in the area revealed a variety of tools used by these ancient peoples. Evidence of the paleoenvironment and the earliest populations of Florida also include a nearly complete skeleton of a juvenile mastodon, a wooden log that may be the world's oldest dugout canoe, and a variety of stone, bone and wooden tools. The wealth of sites make the river one of the most well preserved records of the prehistoric Pleistocene era in the New World.

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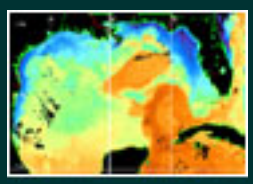


Gag Grouper in the West Florida Shelf

Felicia Coleman, Marine Ecologist
Institute for Fishery Resource Ecology, Department of Biological Science, Florida State University

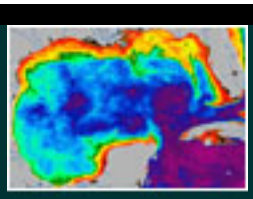
Gag grouper *(Mycteroperca microlepis)* are currently overfished. The problem is compounded by evidence that male fish in some populations are declining. No males, no sex, no babies, no fish. No one wants that. And yet, resistance to protecting male groupers, and grouper populations in general, is profound, because protecting males means protecting specific habitats where males reside, and because protecting populations involves protecting spawning sites. It turns out that these sites often form the heart of the fishery.

This video still of a male gag grouper was taken from a small submersible at Jeefs Reef, an area in the Oculina reserve in the Atlantic Ocean, at a depth of ~300 ft. The fish is approximately 1 meter in length and weighs over 50 pounds.

Groupers, the dominant predatory fish on many coral reefs, are particularly vulnerable to rapid overfishing because of their reproductive behaviors. First, they have complex social systems that lead them to change sex, and second, they form large groups called "aggregations" to spawn for relatively short periods of time.

Sex Change and the Loss of Males

Sex change in groupers is a one-way street, from female to male. It occurs in a social context when fish form spawning groups offshore. For gag, this only occurs for a relatively brief period of time during



BIOGRAPHIES

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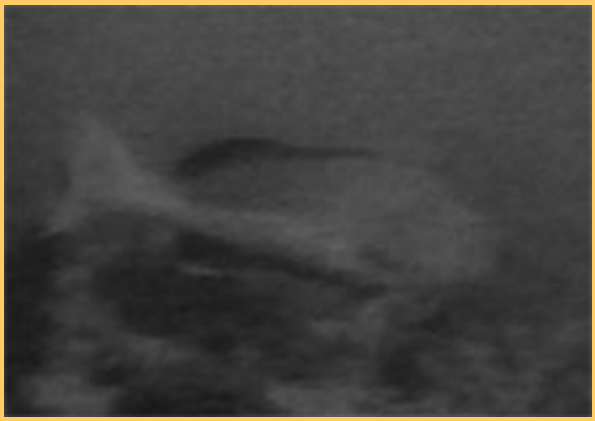
the late winter or early spring. At other times of the year, males and females occur in separate locations, with males staying offshore while females move to shallower water. Virtually all of the reproduction in the population takes place in the brief time the sexes are together, as do all of the cues for sex change. Social interactions among individuals in the group allow some sort of assessment to occur of the relative numbers of males and females. If there are too few males, then dominant females will change sex so that by the following spawning season, more males are available.



This still is from ROV footage taken while on a Gulf of Mexico reef-fish cruise aboard the NOAA vessel *Oregon II*, in the Twin Ridges area, at a depth of ~230 ft. It is a male, approximately 1 meter in length, and weighing over 50 pounds.

These species characteristics and fishing collide during the gag's spawning season, when fishers target locations where the fish reproduce. The fisher's advantage of getting larger catches over a shorter period of time -- like fishing in a barrel -- results in the fish's rapid decline. Not only are the largest fish removed from the population, but the social cues that trigger sex change are interrupted. Thus, fishing that concentrates on aggregations results in smaller fish with fewer eggs, and ultimately, leads to the loss of males. This is compounded by the loss of fish that are changing sex, because they act more like males than like females, and, thus, are more vulnerable to capture. Gag in the Gulf of Mexico and throughout the South Atlantic, for instance, have 90% fewer males now than they did 30 years ago.

Many Grouper Species Are at Risk

How widespread is this phenomenon? A quick review of the status of economically important groupers in the southeastern United States reveals that 11 of the 19 most important reef fish species are on the verge of, or are being, overfished. Most of them are grouper, and all of them change sex from female to male. At least two of those suffer from low proportions of males in the population, and all of them aggregate to spawn. Two of them (Nassau grouper and Jewish) are already protected from fishing. Two are on the verge of being protected (Warsaw grouper and speckled hind). Finally, 26 grouper species worldwide are being considered for the

IUCN list of species vulnerable to extinction.

New Management Approaches

This gag was captured on a 1999 long-line cruise aboard the NOAA research vessel *Ferrel*, in the Gulf of Mexico somewhere off Alabama, at a depth of ~240 ft. It is also a male, 1,270 mm in length, and weighing about 50 pounds.

There are currently no management plans in effect to preserve either the social structure or the natural proportion of males in these fishes. Most management approaches, in fact, fail to address these overwhelmingly important aspects of their reproduction. The most logical tool for protecting these fish is marine reserves, areas of the ocean closed to fishing. This is not a radical or unprecedented idea. All anglers understand, and accept, the need to protect juveniles. They throw fingerlings back in streams, just as hunters do not shoot young deer. The advantage of a marine reserve, or closed area, is that it protects spawning fish. It would also specifically offer protection for male gag, which tend to stay on these reproductive sites year-round. Perhaps the strongest two arguments for closing areas essential to protecting these species are that it allows investigation into the natural range of complex behaviors that are otherwise not within our control, and it provides insurance to protect us from our ignorance about natural marine systems.

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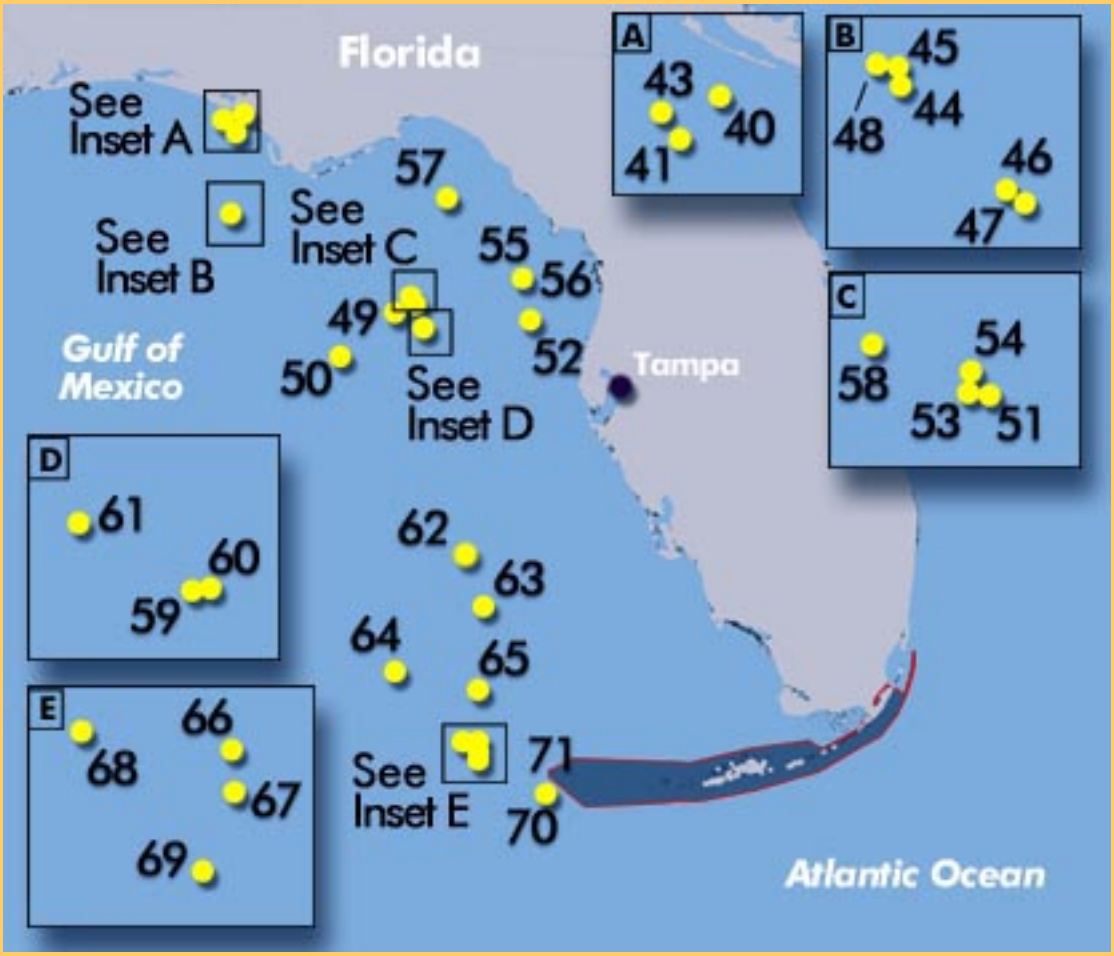
PULLEY RIDGE
ARCHEOLOGY AT SEA
GROUPER
MAPS

Maps

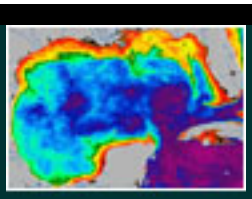
These maps represent a collection of spacial products produced by the partners in the Sustainable Seas Expeditions' mission to the West Florida Shelf.

Dive Maps



View a series of dive maps produced during this expedition. Click on the reference map above to **link to the Dive Maps page**.

Gulf of Mexico Loop Current based on Phytoplankton



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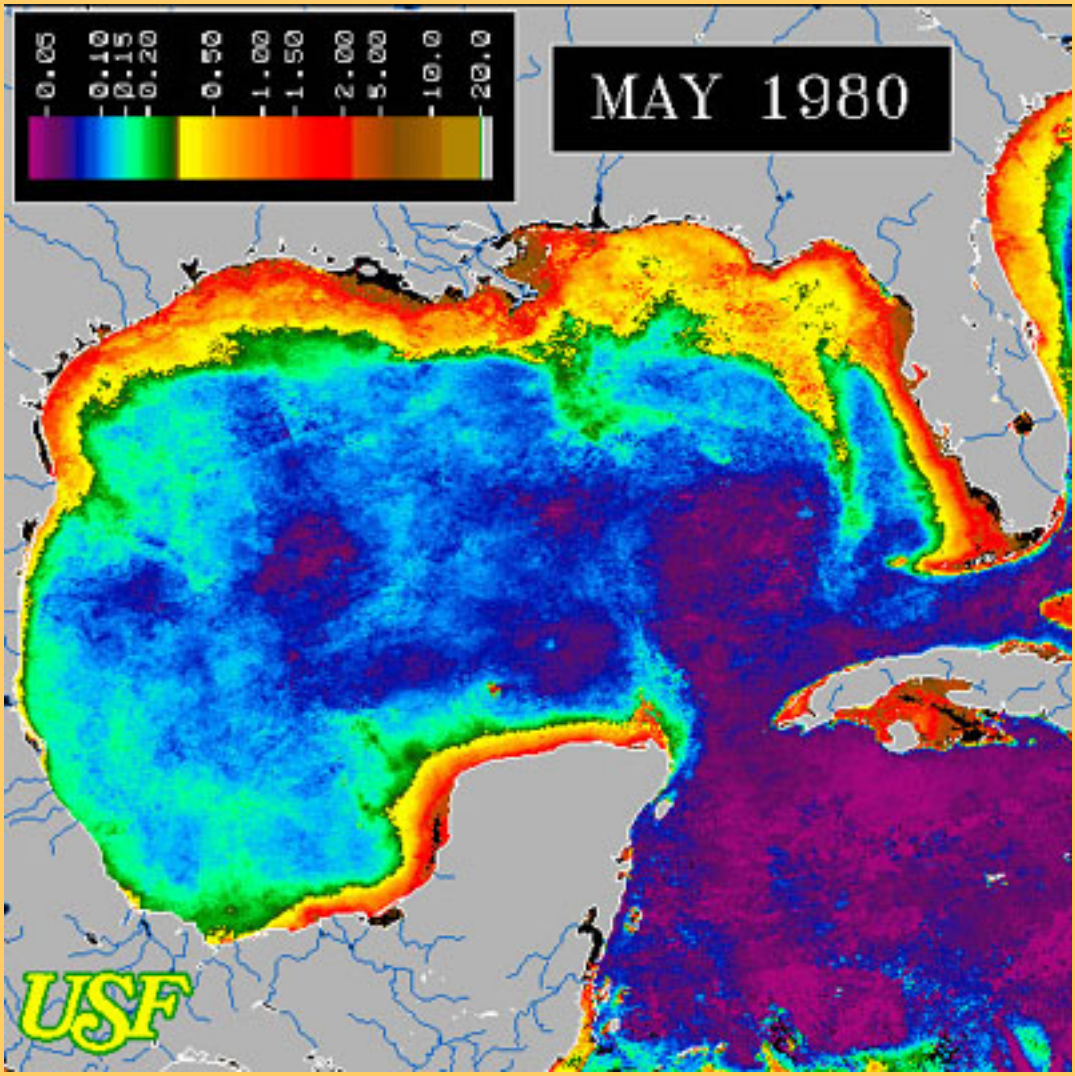
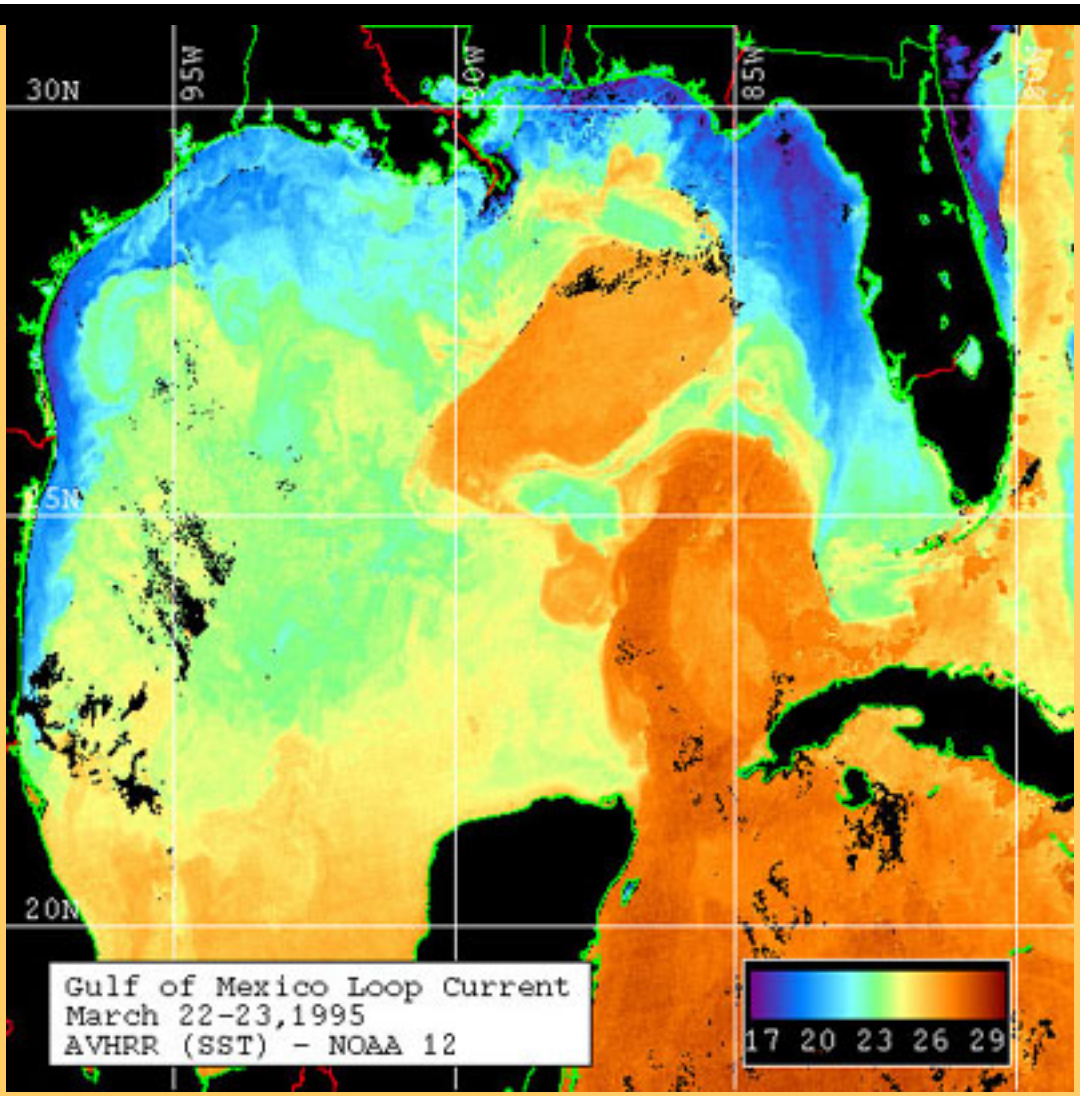


This image of the Loop Current is from the Coastal Zone Color Scanner (CZCS). The CZCS is a satellite-based sensor launched aboard the Nimbus-7 satellite in 1978 that measures ocean color using the light absorption and reflection properties of phytoplankton (microscopic plants found in all ocean waters). Phytoplankton populations are more dense on continental shelves and areas of deep water upwelling. On the image, the areas of red and orange indicate higher concentrations of these organisms and the blue and green indicate areas of lower concentration.

Gulf of Mexico Loop Current based on Sea Surface Temperature



This view of the Gulf of Mexico Loop Current is based on sea surface temperature. The warm water entering the Gulf of Mexico through the Yucatan Straits is shown in orange and red. The cooler water of the gulf is shown in blue and green. Northwest of the Loop Current there is another area of warmer water that has broken away from the main current.

Madison Swanson and Steamboat Lumps Marine Reserves

The West Florida Shelf supports a major commercial and recreational grouper fishery centered in the Florida Middle Grounds and deeper waters to the west. On June 19, 2000 the Gulf Fisheries Management Council declared these marine protected areas to prevent overfishing of gag, red, and black groupers. These sites, the Madison Swanson and Steamboat Lumps areas, will initially only be seasonally closed to grouper fishing, but the Council has recommended year-round closure. These areas will be closed to all fishing for a period of four years in order to evaluate the effects of fishing on grouper spawning aggregations. Closing such large areas to fishing provides the opportunity to observe the effects of fishing on habitat outside of the reserves, and conversely, the possible reversion of habitat back to some historical condition within the reserves in the absence of fishing. Inshore of these protected sites, the Florida Middle Grounds have long been noted for a concentration of biological diversity and as a key fishing area.

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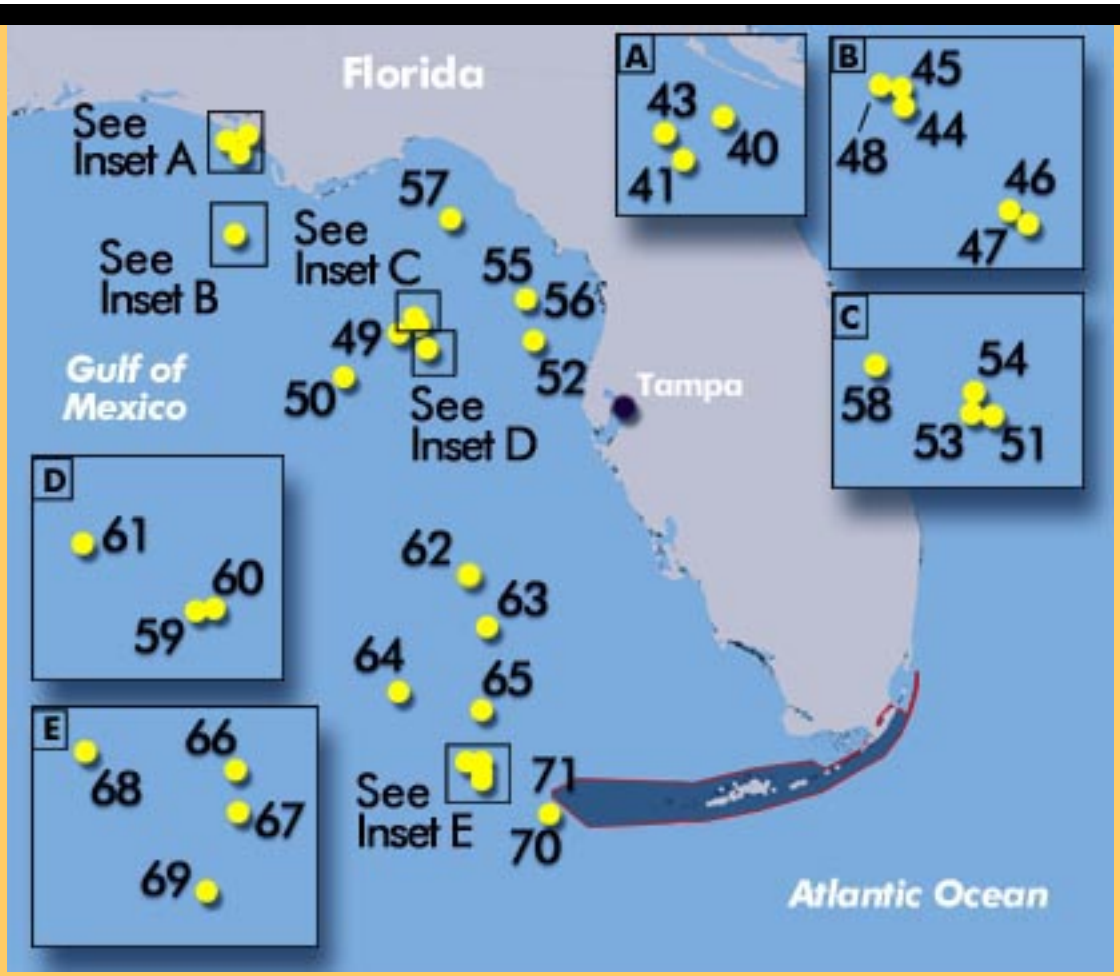
August 5-31, 2000 Dive Maps

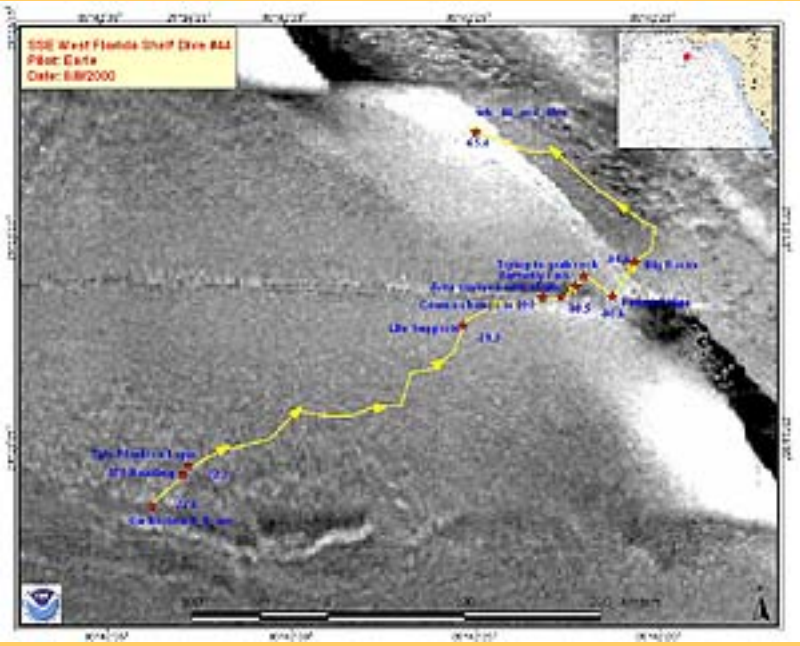
Dave Lott and Craig Russell, GIS specialists from NOAA's National Ocean Service, Special Projects Office, tracked and mapped the *DeepWorker* submersible during the SSE mission to the West Florida Shelf. Using a combination of GIS and sonar technologies, they produced this series of dive maps. The maps depict the underwater track of each *DeepWorker* dive, and include depth readings, life-support readings and pilots' comments. Together, they represent a critical component of the underwater log of the expedition.

During the West Florida Shelf mission, from August 5 to 31, 2000, pilots completed Dives 40 to 73. The yellow dots on the reference map below approximate where these dives were made. **Click on any dive number or individual map to view a large-scale version of that specific dive.**

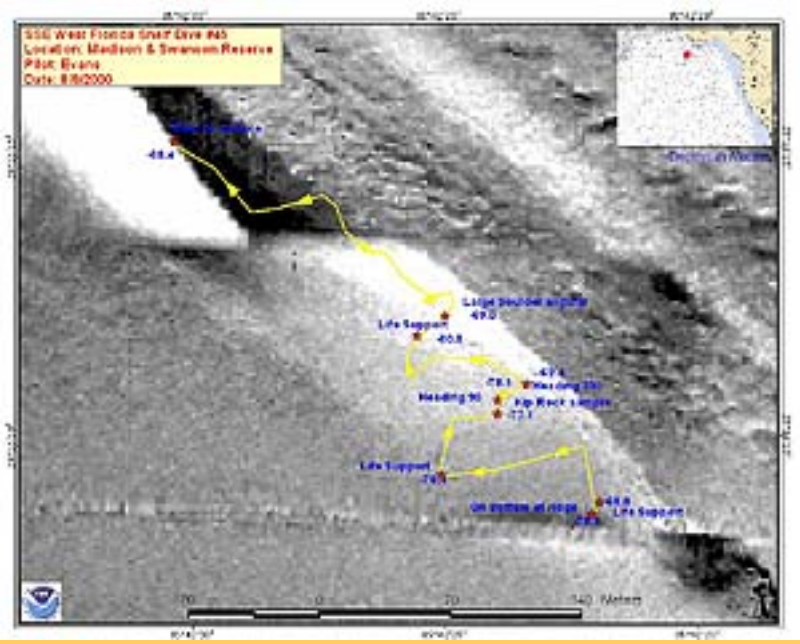


Dives 40-43
Aug. 5-6, 2000, Panama City Beach

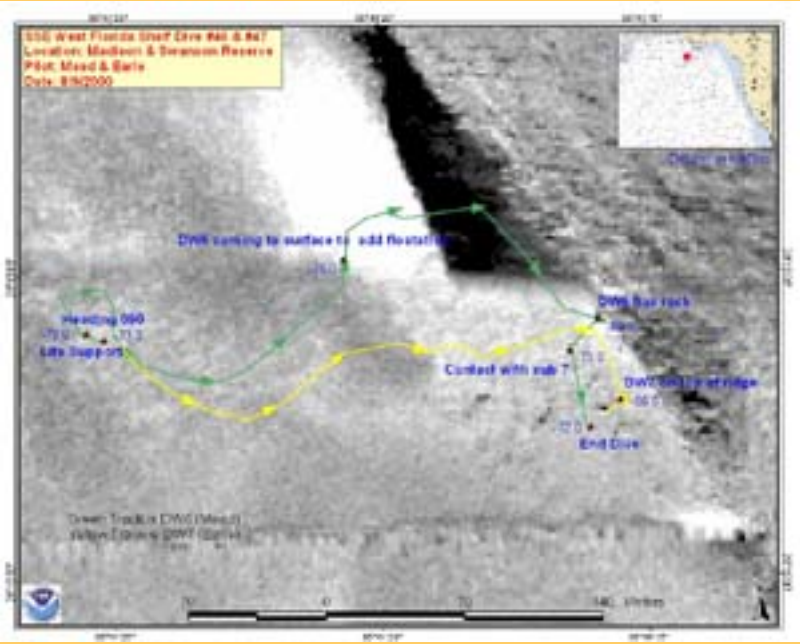
Dive 44
Aug. 8, 2000,
Madison and
Swanson



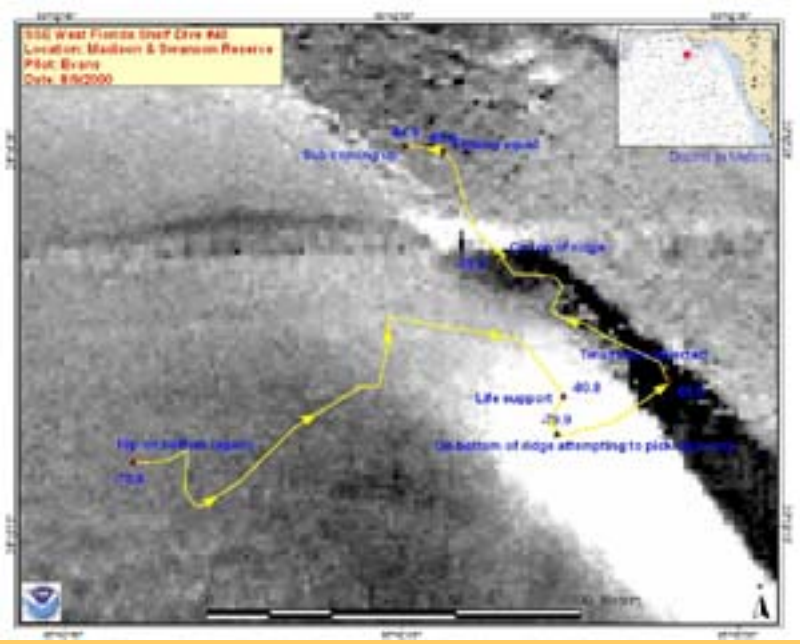
Dive 45
Aug. 8, 2000,
Madison and
Swanson



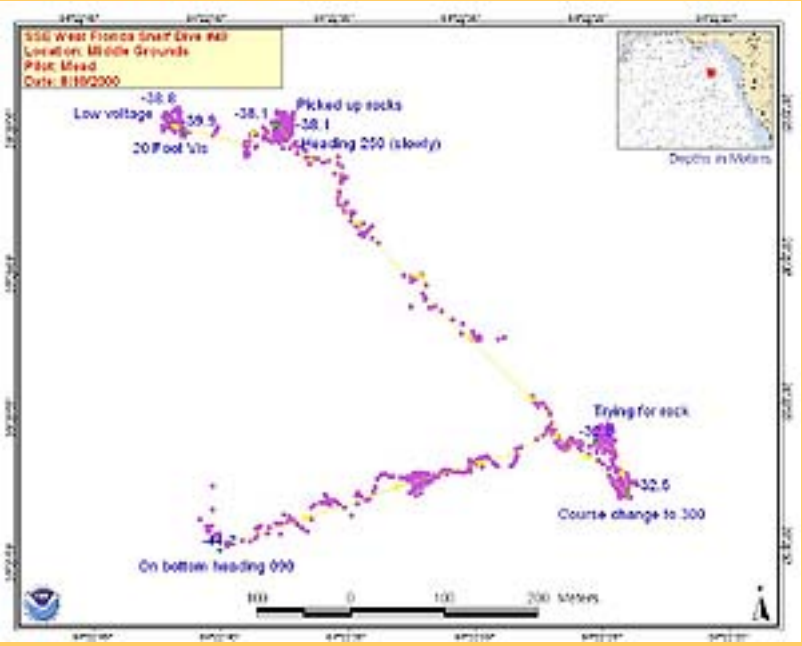
Dives 46-47
Aug. 9, 2000,
Madison and
Swanson



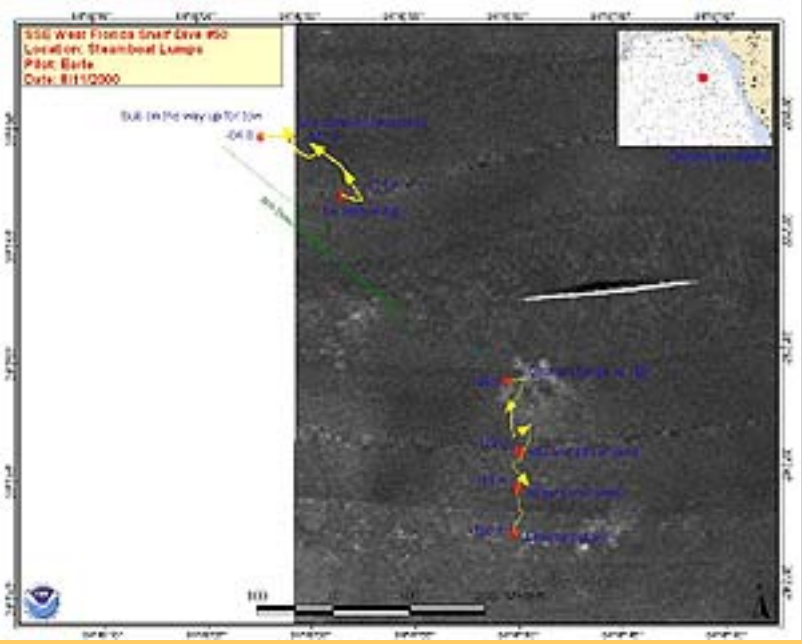
Dive 48
Aug. 9, 2000,
Madison and
Swanson



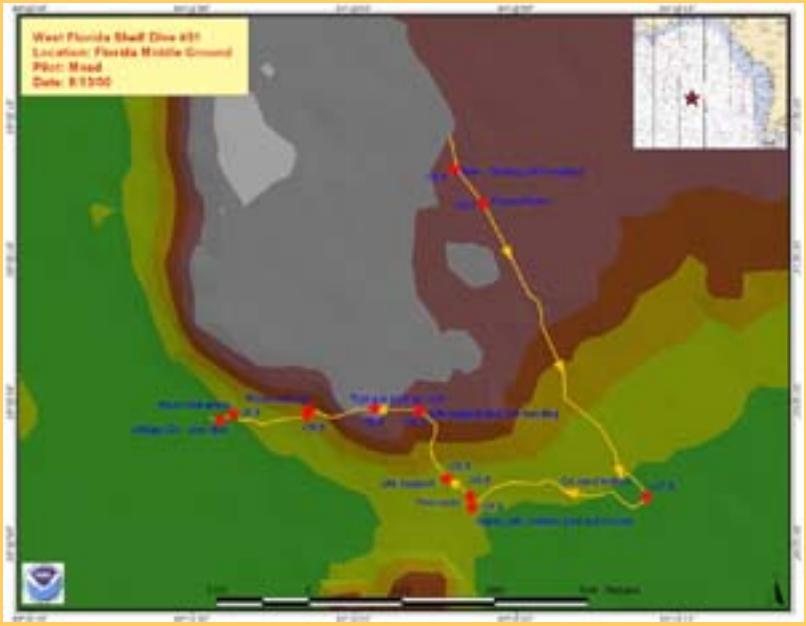
Dive 49
Aug. 10, 2000, Florida Middle Grounds



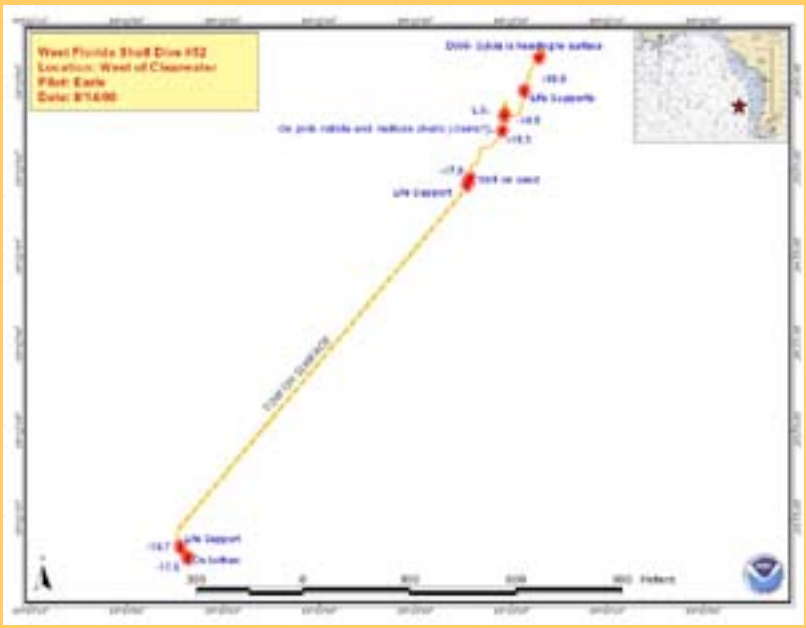
Dive 50
Aug. 11, 2000, Steamboat



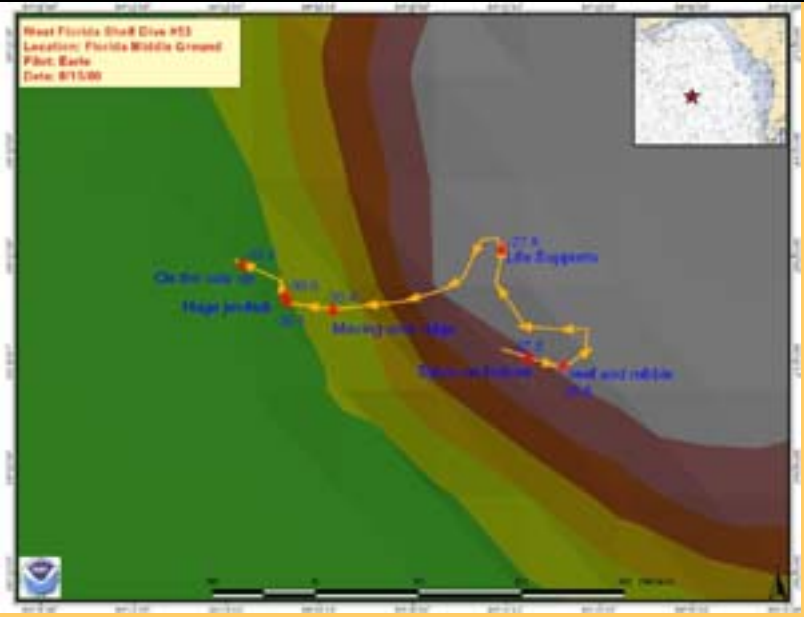
Dive 51
Aug. 13, 2000, Florida Middle Grounds



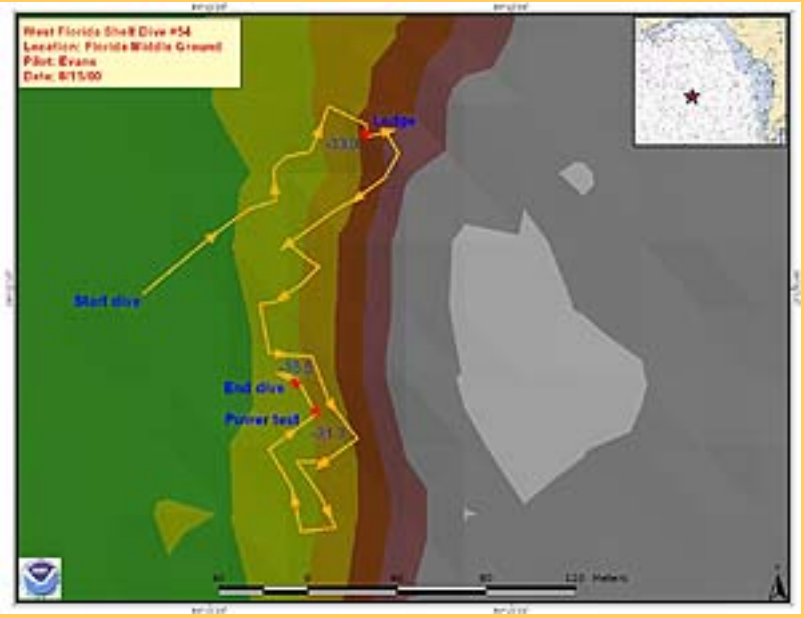
Dive 52
Aug. 14, 2000, Outside Clearwater



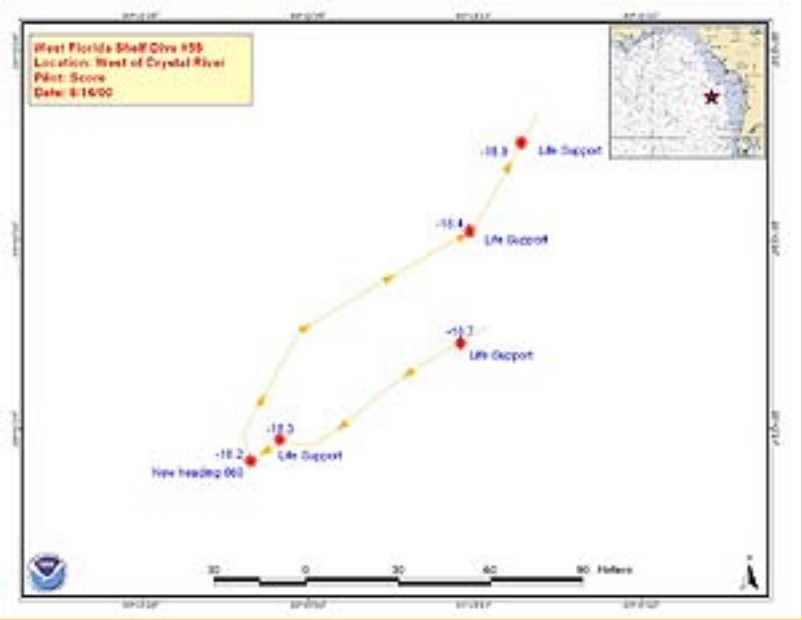
Dive 53
Aug. 15, 2000, Florida Middle Grounds



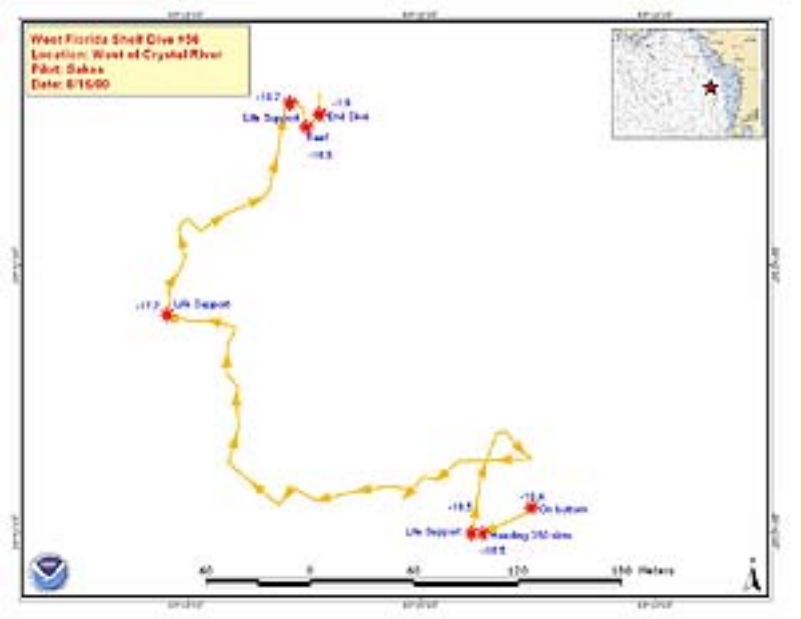
Dive 54
Aug. 15, 2000,
Florida Middle Grounds



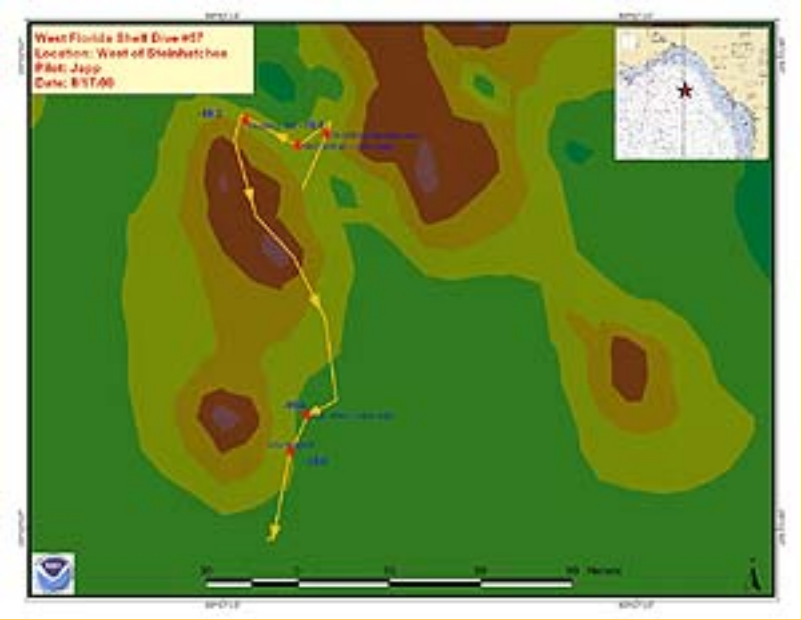
Dive 55
Aug. 16, 2000
West of
Crystal River



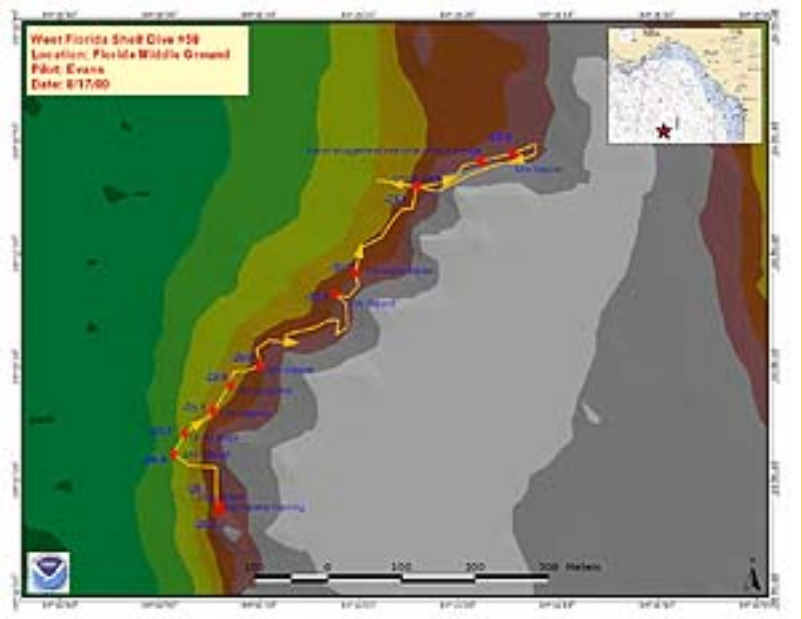
Dive 56
Aug. 16, 2000
West of
Crystal River



Dive 57
Aug. 17,
2000,
West of
Steinhatchee
(Big Bend
Area)

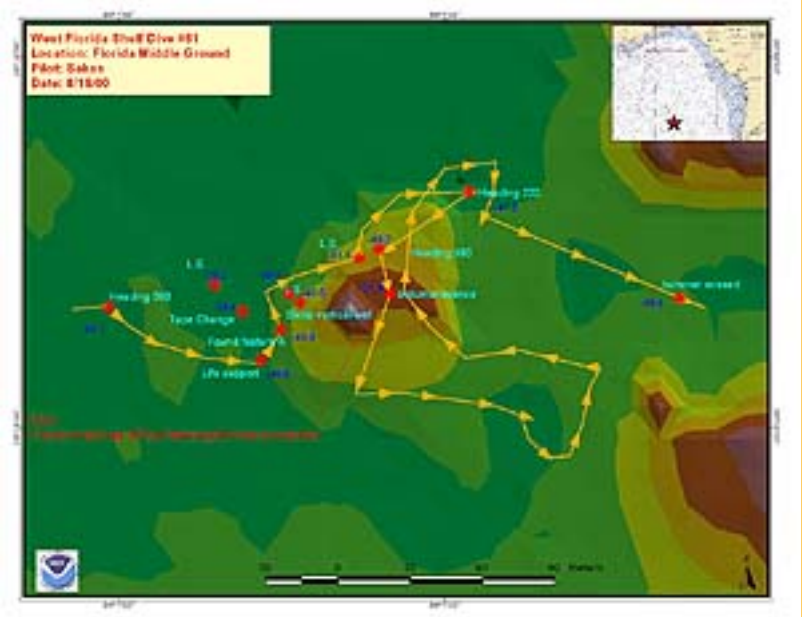


Dive 58
Aug. 17, 2000, Middle Grounds West

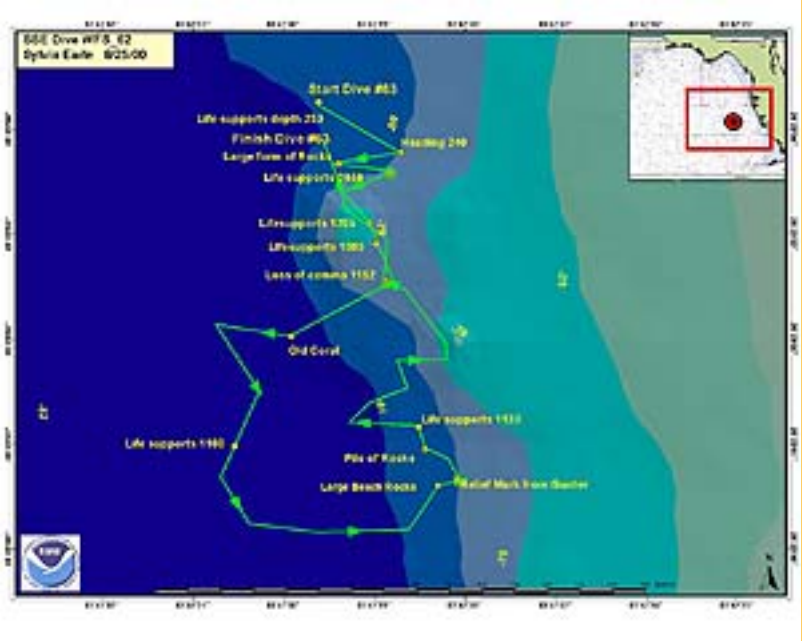


Dives 59-60
Aug. 18, 2000, Middle Grounds South

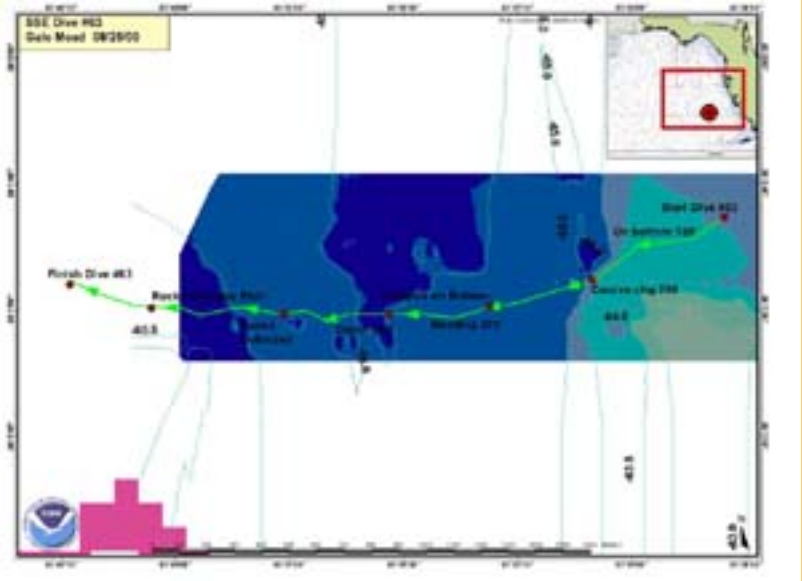
Dive 61
Aug. 18, 2000, Middle Grounds South



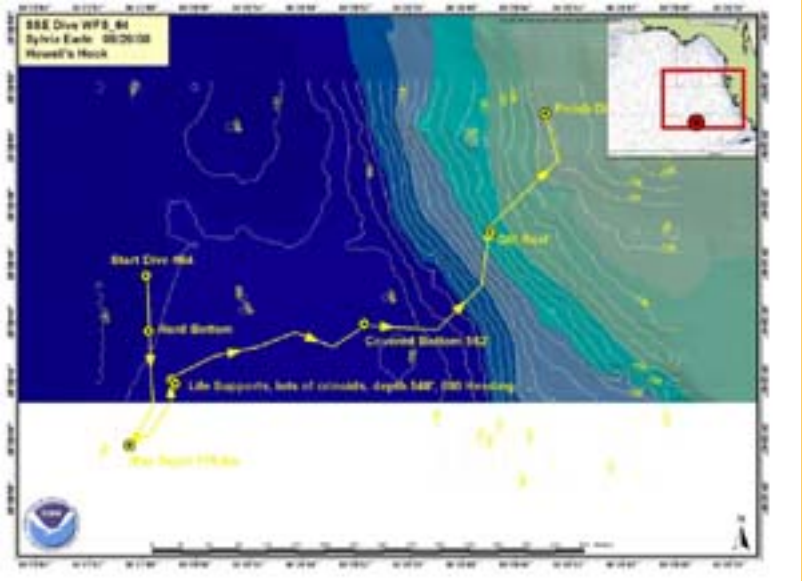
Dive 62
Aug. 25, 2000, Pulley Ridge



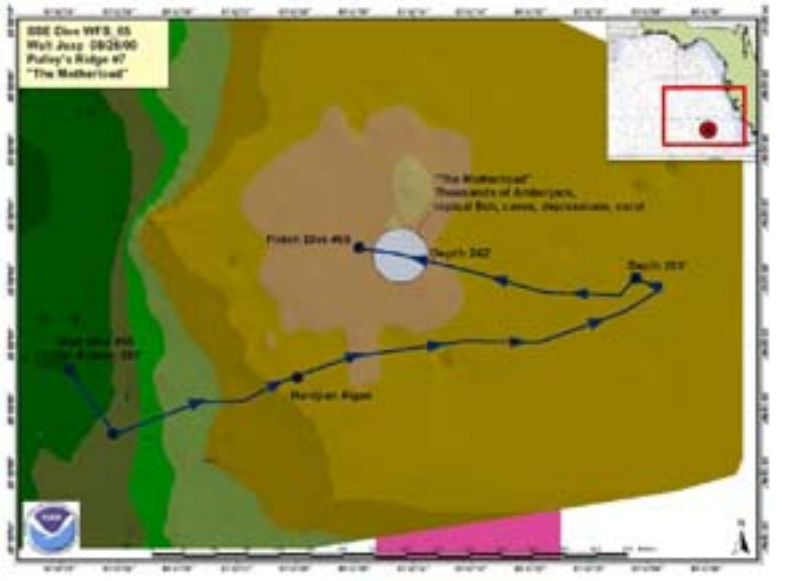
Dive 63
Aug. 25, 2000,
Pulley Ridge



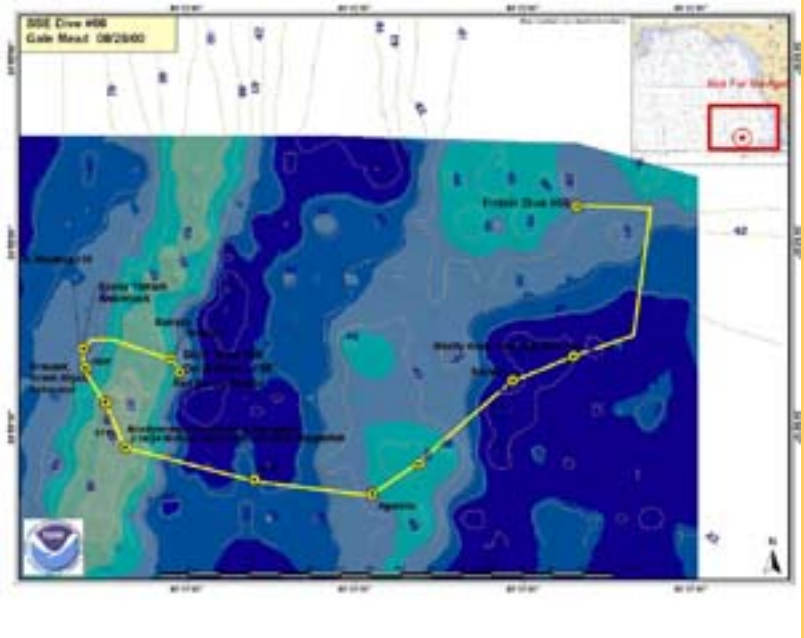
Dive 64
Aug. 26, 2000,
Howell's Hook



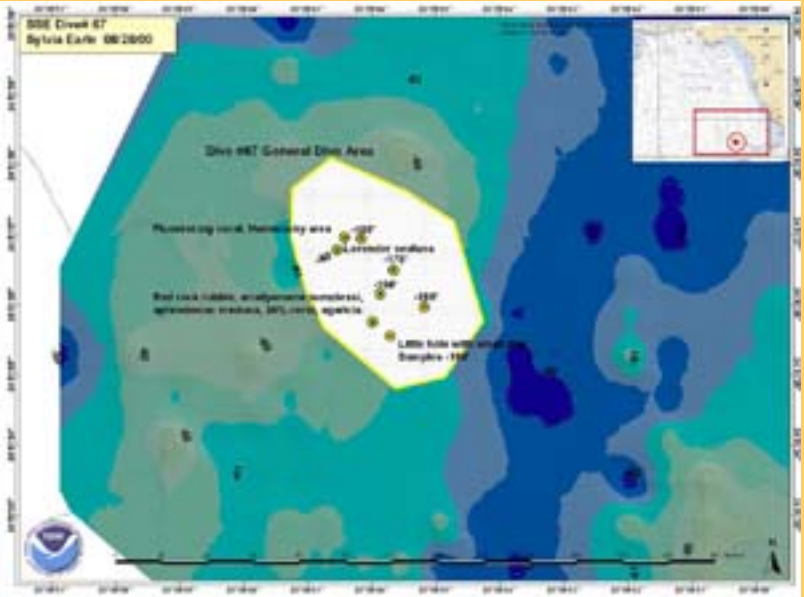
Dive 65
Aug. 26, 2000, Pulley Ridge #7



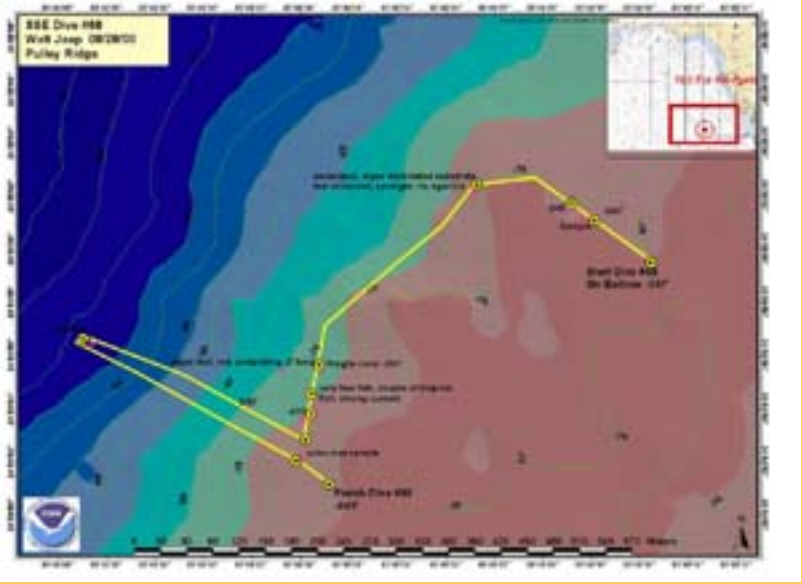
Dive 66
Aug. 28, 2000, Pulley Ridge



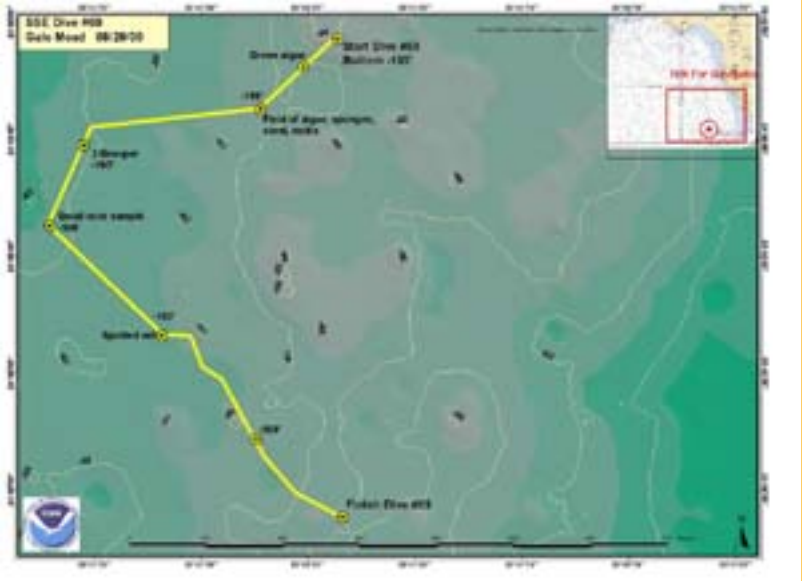
Dive 67
Aug. 28, 2000,
Pulley Ridge



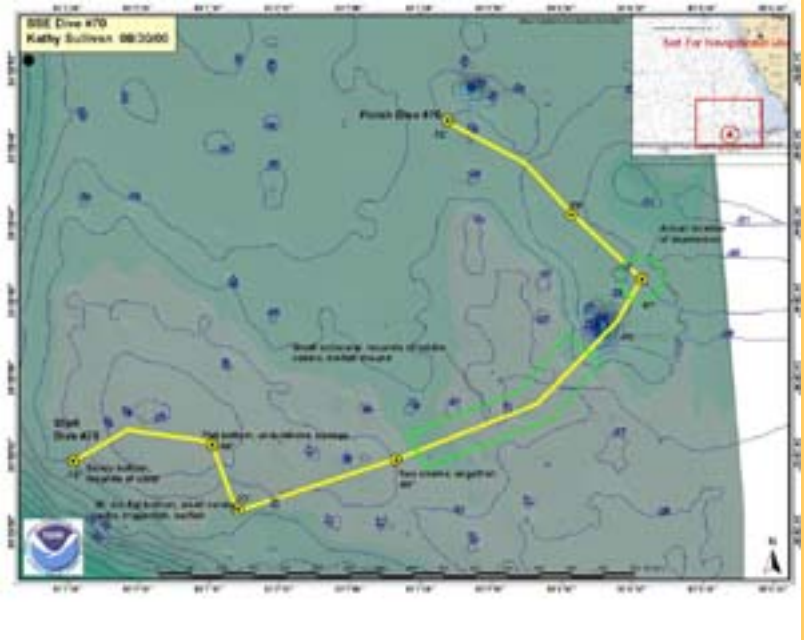
Dive 68
Aug. 29, 2000,
Pulley Ridge #10



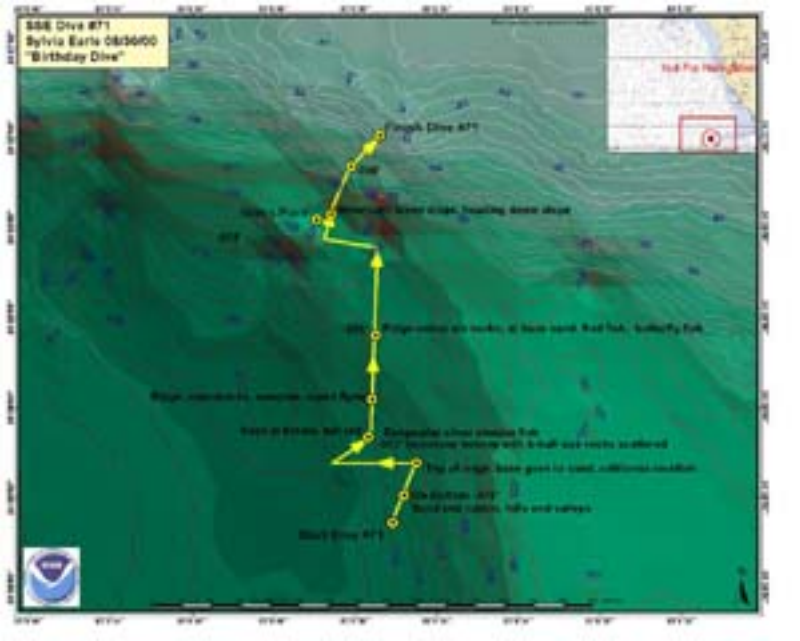
Dive 69
Aug. 29, 2000,
Pulley Ridge South



Dive 70
Aug. 30, 2000,
Riley's Hump



Dive 71
Aug. 30, 2000,
Miller's Place



Dive 72
Aug. 31, 2000, South of Woman Key

No Map, Dive Aborted

Dive 73
Aug. 31, 2000, South of Woman Key

No Map, Dive Aborted

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SUSTAINABLE SEAS EXPEDITIONS

SANCTUARY LOG

EXPLORING WEST FLORIDA SHELF

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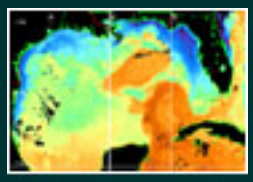

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EXPEDITION UPDATE

August 7-31, 2000

The SSE mission to the West Florida Shelf is the first to occur outside of a national marine sanctuary. By exploring and observing critical habitats, searching for signs of prehistoric habitation in drowned river valleys, and documenting the biodiversity of deep-water paleoshorelines, this expedition is designed to collect information that will enhance marine protection strategies -- one of the fundamental precepts of the National Marine Sanctuary Program.

On this page, you can follow the West Florida Shelf expedition. To learn about planned activities and other interesting facts, select a background essay of your choice, or track the mission through expedition logs and updates.

NOAA Ship *Gordon Gunter*

Paul McClelland

Aug 7 Paul McClelland (12 yrs. old) got his wish -- to sit at the helm of the *DeepWorker*. The NOAA Ship *Gordon Gunter* left port in the evening carrying the SSE crew to the West Florida Shelf. To discover what is planned for this mission, **read researcher John Ogden's expedition overview.**

LOG

August 7-10 Personal Log: Ogden

August 12 Macroalgal Diversity

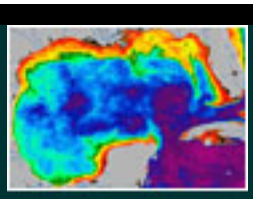
August 8-13 Underwater Archaeology

August 25-29 Pulley Ridge

August 30 Explorer's Journal

August 14-31 Summary Log

August 5-31 Dive Maps



BIOGRAPHIES

WEATHER

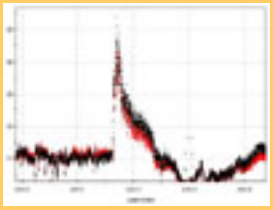
Aug 8 The SSE team arrived at an area called Madison and Swanson, a new fisheries reserve approx. 35 miles offshore of Cape St. George. John Ogden and Michael Faught are onboard to conduct research. Two dives, to about 265 ft., were completed. High-resolution sidescan imagery, provided by the U.S. Geological Survey (USGS), is being used to help locate dive sites. The main feature being studied is a long ridge that appears to be a paleoshoreline (an ancient shoreline from a time when the sea level was lower). A videotape of the ridge shows large boulders that seem to be the remains of a high-energy shoreline.

Extracting a rock sample from a submerged ridge (approx. 250 feet down) in the Madison and Swanson reserve.

Michael Faught (left) and John Ogden study a rock sample.

The team collected a rock sample with the *DeepWorker*. It is believed to be beach stone, which supports the hypothesis that this area was an ancient shoreline during a period of glaciation. Michael is especially interested in this area because human settlements, from more than 10,000 yrs ago, may have existed along this presumably ancient coast. He has found evidence of other now drowned settlements in shallow water along prehistoric coastlines. Everyone is very excited. **Read about the Florida State University Underwater Archaeology program.**

Aug 9 A dual sub dive was completed this afternoon. Two pilots dove to about 260 ft. for 3 hrs. each on the southeast portion of the drowned shoreline in the Madison and Swanson reserve. Kip Evans completed an evening dive northwest of that position on



an area with even greater relief. He retrieved two rock samples that will be sent to geologists for further study. Evening wind gusts gave the team an interesting ride. The *Gunter's* SCS (scientific computing system) records several dozen weather and oceanographic parameters that scientists can refer to during and after a cruise. **Read about the reef habitats of the West Florida Shelf.**

A wind speed graph captured by the *Gunter's* wind sensors. The sudden spike indicates the beginning of a storm. (Click for larger image)

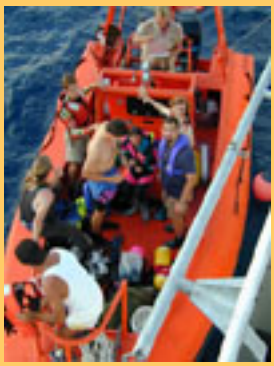
Dive sites are plotted over sidescan imagery. (Click for larger image)

Aug 10 The SSE team is using USGS sidescan imagery to select dive sites and for real-time navigation. The large ridge feature is believe to be a drowned shoreline from a period of glaciation. This hypothesis has been strengthened by the *DeepWorker's* recovery of several rock samples. The samples from the ridge appear to be beach rock and not from a drowned coral reef.

After the mission, geologists will study the rocks and perhaps confirm this hypothesis. Brigitte Gavio and Brian Wysor, researchers from the University of Louisiana at Lafayette, examined a sample of sea grape *(Botryocladia occidentalis)* that they retrieved while scuba diving to 80 ft. in the Florida Middle Grounds this morning. **Read John Ogden's log entry summarizing the first few days of the expedition.**

Brigitte and Brian examine a sea grape.

Aug 12 Due to marginal conditions, no submersible operations were completed today, but the squally, mixed seas (3-5') and variable winds did not prevent three scuba parties from entering the Gulf water. The teams reached depths of 80 to 100 ft., and collected algae samples from the bottom. During downtime, the SSE team made advances in mapping the Gulf



Divers prepare to descend.

floor, and developed two quick-release attachments for the tag line used to launch the *DeepWorker*. **Read about progress in the macroalgal research project.**

Aug 13 Today, Sylvia dove to 350 ft. on the western portion of Steamboat Lumps. She observed some very sandy bottom features. The SSE tracking team experimented with transferring the communications equipment from the *Gunter* to the chase boat. One night dive was completed in the Florida Middle Grounds. At the end of the day, the ship returned to Clearwater, Florida to exchange personnel. **Read Michael Faught's summary log about the underwater archaeology project.**

Star seen near Clearwater

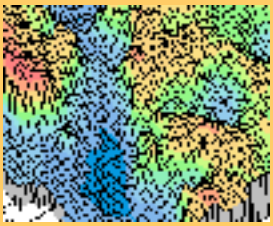
Aug 14 Today signaled the end of the mission for John Ogden, Michael Faught, and the researchers from Louisiana. They boarded the ship's support vehicle, *Relentless II*, and were ferried back to shore in Clearwater. In their place, Kathy Sakas and Alex Score from Gray's Reef National Marine Sanctuary boarded the *Gunter* to continue the West Florida Shelf research efforts. Both participated in the **1999 SSE mission in the Gray's Reef sanctuary**. Walt Japp, a researcher from the Florida Marine Research Institute (FMRI), also joined the team. In the afternoon, Sylvia completed a long, but very shallow dive (60 ft.) on a shell mound offshore of Tarpon Springs. She observed dolphins, sea stars and eels.

Marine worms

Aug 15 This morning, Sylvia dove to 120 ft. and observed several very large fish, including grouper. **Read about the current state of the grouper fishery.** Kip dove a relatively short night dive

slightly west of the Florida Middle Grounds. Unexpected low battery power forced him up a little earlier than planned. There is talk of picking up new batteries in Tampa during the planned stopover. Several colorful marine worms were captured on videotape.

Aug 16 The *Gunter* returned to Clearwater this morning to drop off a few team members, then sailed for about 4 hrs. before initiating afternoon dives. The team completed two dives about 30 miles west of Crystal River on a relatively shallow patch reef. Alex (3 p.m.) and Kathy (7 p.m.) each dove to 60 ft. Other team members completed scuba reconnaissance dives, or processed sediment and algae samples. The launch process is much improved now that the tag line releases quickly. Overnight surveying (3D mapping) for the dives on the Florida Middle Grounds was completed while the crew was resting. Maps are created by using the ship's echo sounders and GPS system. The images are being used to pinpoint dive locations.



3D Map of the Florida Middle Grounds (Click for larger map)

Aug 17 After steaming most of the night to the Big Bend area, the tracking team mapped a few areas that the science team had identified as having some interesting features. In the morning, the tracking team led Walt Japp to some of those areas.

Kip Evans in the *DeepWorker*

He dove to 60 feet for a few hours and observed low octocoral coverage and patchy rocks. Two small fishing boats approached later in the morning to inquire if the subs had sighted any grouper (seems the *Gunter* was located on their fishing spot). After the *DeepWorker* surfaced, scuba divers immediately hit the water and returned with some additional algae and sediment samples. The *Gunter* then steamed 5 hrs. back to the Florida Middle Grounds, where the team dove on a large "mound" west of where they had previously been. Kip Evans completed a

long night dive on the mound and observed it to have very nice relief, a good ledge, and a relatively strong bottom current that helped push him along, saving battery power. There were few boats in the area, and seas were flat and calm. Several turtles and dolphins have been spotted.

Aug 18 As of early this morning, the team was headed to the southern section of the Middle Grounds to survey possible dive targets. If nothing looks promising, they will probably resume operations where Kip left off last night. The crew is focusing on morning and evening dive operations, avoiding the midday Florida sun, as it can be very draining.

Aug 19 The NOAA ship *Gunter* left the Middle Grounds and returned to Tampa Bay in the afternoon. A professional "pilot" boarded the vessel to help guide her up the narrow shipping channel into the Tampa Bay port.

Aug 20 A day of rest for most of the ship's crew. Others cleaned and prepared for the upcoming Open House.

Aug 21 The *Gunter* made a short hop down a narrow canal to a prime parking spot next to the Tampa Aquarium, where it would host this mission's Open House. As many curious onlookers tour the ship, the commanding officer is keeping a close eye on Hurricane Debby, which is moving rapidly across the Caribbean and heading directly for southern Florida.

Aug 22 The West Florida Shelf Open House welcomed over 400 visitors board the *Gunter*. They toured the ship, examined the submersibles, and spoke with the SSE team. Employees of NOAA's aircraft operation center, including some of the crew from the Hurricane Hunter P-3 aircraft from nearby McDill Air Force Base, are spotted in the crowd. Concern over the hurricane increases, as Debby appears to be headed toward the next operation area. Plans are postponed for 24 hours to allow for better forecasting of the storm track.

Aug 24 The SSE team resumed the expedition and departed from Tampa.

Aug 25 The *Gunter* steamed overnight and arrived at Pulley's Ridge by 6:30 a.m. Sylvia completed a 3.5-hour dive to a maximum depth of 250 ft., where she observed possible beach rocks, old (dead) coral, and other angular rocks. She reported that these seemed to be affected by human impacts. The dive objective was to explore an area well north of the sites previously investigated by University of South Florida researchers via remotely operated vehicle (ROV) and scuba. Bret Jarrett, a Ph.D. candidate at the university, describes the **deep coral reefs of Pulley Ridge.**

Aug 26 Team member Gale Mead completed a dive last night to a depth of about 210 ft. for 3 hours. She reported a mostly flat, sandy bottom with a gradual slope. She collected several rock samples to ground-truth some unexplored areas on Pulley Ridge. A supposed ledge feature was never found. After Gale's dive, the *Gunter* steamed to the Howell Hook site. There, the navigation team completed some survey work and Sylvia dove on a possible paleoshoreline. The survey work indicated a reef and crests at about 500 ft. that dropped down about 250 ft. After completion, the ship steamed back to Pulley Ridge, where Walt Jaap conducted an evening dive to a depth of 250 ft. The dive began up a 30 ft. ledge onto a sand flat, and ended on a ledge where he observed numerous amberjack, coral, depressions, crevasses and tropical fish.

Walt Jaap and Sylvia Earle examine a sample.

Aug 27 No dives were completed today. The ship attempted to outrun an encroaching squall but got caught in it for most of the day. VIPs Mike Collins, Kathy Sullivan, and David Guggenheim, and a press entourage from ABC News, arrived by transport boat and boarded for a tour of the *Gunter* and to observe operations.

Aug 28 Walt Japp successfully dove on Pulley Ridge and obtained quite a few rock, coral, and

The science team examines samples taken during a dive on Pulley Ridge.

exotic algae samples. Several different species of algae were collected for classification.

Aug 29 Gale Mead extended the investigation of Pulley Ridge in an attempt to aid scientists in determining the extent of the reef structure there. Her dives revealed coral and a variety of algae. Overnight, the ship fatho-surveyed Riley's Hump for tomorrow's sub and scuba dives. **Bret Jarrett's log entry summarizes the research on Pulley Ridge.**

Aug 30 In the morning, Kathy Sullivan completed a successful checkout/exploration dive on Riley's Hump. She reported mostly hard bottom with some octocoral and algae. Towards the end of her dive, Kathy was instructed to rest the *DeepWorker* on the bottom with its lights off for 30 minutes to wait for the high winds and seas at the surface to calm down. Winds were gusting to 35 knots, increasing the chop enough to make the ship roll a bit. A half-hour later, the winds died back to 6 knots and the seas calmed, allowing for a smooth recovery. In the afternoon,Sylvia completed an exploration dive to 375 ft. off Riley's Hump, for about 1.5 hrs. However, the dive was cut short due to the unpredictable weather conditions. Wind and swell had picked up again, and the *DeepWorker* was recovered just before a storm. The dive occurred in a high-relief area, which Sylvia described as mountainous. Huge walls, steep slopes, sandy bottom, rockfish, squid, butterfly fish and red fish were also reported. Samples of "baseball-sized rocks" were collected. Bret Jarrett informed the team that

Aquanaut and astronaut Kathy Sullivan completes her pre-dive checks before diving on Riley's Hump. Former astronaut Mike Collins looks on, while the Nuytco crew prepares Kathy for her first sub dive.

these were actually limestone rocks covered in algae and coral. **Kathy Sullivan recounts her participation in this SSE mission.**

A starfish collected on Pulley Ridge.

Aug 31 This morning, Walt Jaap aborted his dive due to an inability to flood the soft tank (this enables to sub to descend). After several attempts, Walt succeeded in flooding the tank and began to descend, but then quickly resurfaced. The Nuytco team is troubleshooting the submersible to pinpoint the problem. **Read Walt Jaap's summary of the final two weeks of this mission.**

Sept 1 The *Gunter* is steaming to Key West to begin the transfer of personnel and equipment for the next SSE mission, which will take place in the Florida Keys National Marine Sanctuary. **Follow along!**

View expedition Dive Maps

View the Dive Maps from the West Florida Shelf Expedition.

When Dave isn't mapping, he's writing. No rest for the weary...

Updates submitted by Dave Lott, GIS and Tracking Specialist, and NOAA SSE Log Editor for the West Florida Shelf mission

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August 7-10, 2000

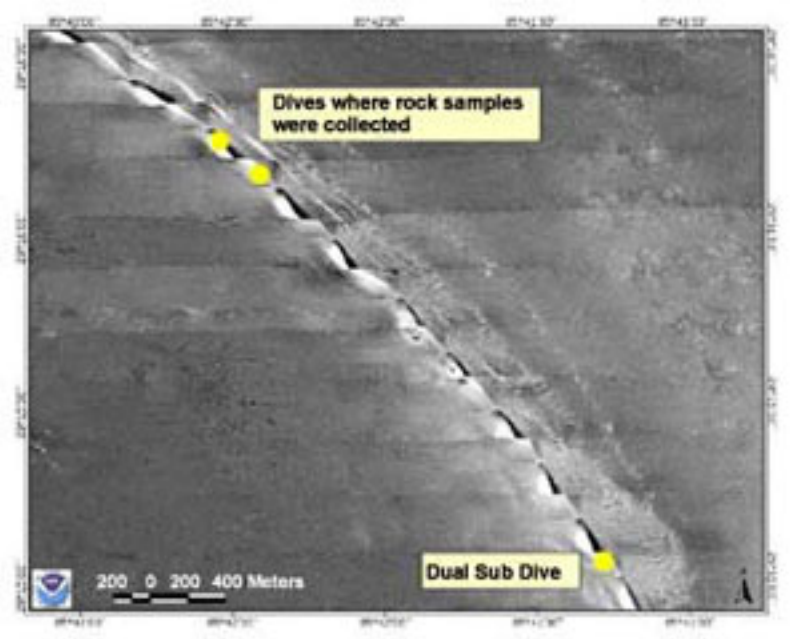
John C. Ogden, Ph.D.
Director, Florida Institute of Oceanography

Dr. John Ogden aboard the NOAA ship *Gunter*.

Dive operations since our departure from Panama City on August 7 have proceeded very smoothly. Our first target site was the Madison-Swanson Ridge, which is a grouper fishing exclusion zone. The U.S. Geological Survey (USGS) provided sidescan sonar imagery that showed a striking arc-shaped ledge on the bottom. Preliminary USGS analysis of the images by the USGS led to the hypothesis that the ledge was an ancient shoreline that formed 15,000 years ago when sea level was as much as 300 ft. lower than it is today.

A series of dives by DeepWorker pilots Sylvia Earle, Kip Evans and Gale Mead on August 8-9 confirmed this hypothesis. The dives revealed a steep ledge about 60 ft. high.

Set into the ledge were outcrops of "beach rock" about the thickness of paving slabs and composed of egg-shaped sand grains called "oolites." Beach rock forms at the edge of the sea, so the two ledges may



The U.S. Geological Survey provided sidescan sonar imagery that showed a striking arc-shaped ledge on the bottom. Dive sites were plotted over this imagery.

represent two former "still stands" where the sea level stopped rising long enough to allow the rock to form.

All along the ledge was evidence of erosion by breaking seas at the shoreline, which undercut the beach rock and caused large slabs to fall in a jumble. This complex rubble pile was excellent shelter for groupers of various species which were seen in abundance in video from the submersibles. It is hoped that the fishing exclusion zone will afford further protection to the groupers in this complex habitat and help their populations recover from overfishing.

On August 10, the mission moved to the Florida Middle Grounds, a very different type of habitat in shallower water averaging about 120 ft. deep. Information provided by marine geologists Dave Mallinson, Al Hine and David Naar, of the University of South Florida, showed a series of rocky outcrops. This region has the most complicated underwater topography on the West Florida Shelf and is among the best habitat for fishes. Unlike the Madison and Swanson area, the outcrops in the Middle Grounds have most likely been built up over thousands of years by corals whose stony calcium carbonate skeletons were deposited and cemented into the complex of outcrops. We did several scuba dives in the area and noted that, while corals are still present on the tops of the outcrops, they are no longer growing. At some point in the past, the sea level rose too fast to allow the corals, which require shallow water and sunlight, to keep pace with the rising sea.

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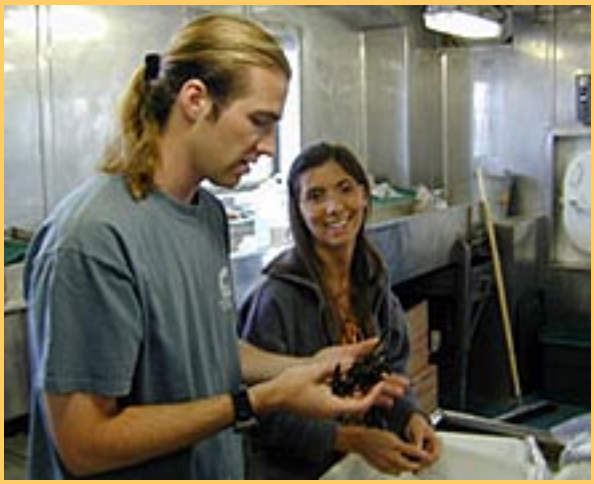
August 12, 2000
The Importance of Seaweeds in the Gulf of Mexico

Brian Wysor and Brigitte Gavio
Doctoral Candidates, University of Louisiana at Lafayette

Background



Brian Wysor (left) and Brigitte Gavio examine a species of green seaweed called *Codium*. Some species of this seaweed form spongy mats on the sea floor, while others form a network of branches that creep over hard substrate. Still others form elegantly branched, upright plants. All species have a soft, velvety or spongy feel.

The Gulf of Mexico is a relatively old ocean basin (~100 million years), with an interesting andcomplicated geological history that has resulted in one of the world's most biologically unique and productive water bodies. The Gulf basin is characterized by a relatively shallow but well developed continental shelf with an extensive system of hard banks, which support rich and biologically diverse assemblages of marine plants and animals. The significance of these biologically diverse "marine oases" has been recognized recently by the inclusion of hard bank communities in the NOAA National Marine Sanctuary Program. Gulf of Mexico marine sanctuaries include the East and West Banks of the Texas Flower Gardens, Stetson Bank off the coast of Louisiana, and the Dry Tortugas located west of the Florida Keys.

Many of the banks have been subjected to biodiversity surveys resulting from efforts to monitor the impact of the oil industry in the Gulf of Mexico as well as the success of the marine reserves to

Scuba divers prepare to dive in the Florida Middle Grounds. While seaweeds are known to grow at depths in excess of 750 feet, divers can only effectively collect them in waters around 100-150 feet. Manned submersibles or remotely operated vehicles (ROVs) are necessary to investigate the flora of deeper waters. Dredging can also be used, but the scientific community views this destructive process with increasing disapproval.

conserve biodiversity. Scientists believe, however, that these areas' actual biodiversity is vastly underestimated. Currently, research is underway in the Seaweeds Lab of Dr. Suzanne Fredericq, at the University of Louisiana at Lafayette, to characterize the marine algal flora of these reserves. Seaweeds, which are technically known as macroalgae, re important in marine ecosystems because they form part of the base of the food chain (in addition to phytoplankton, which are also known as microalgae). As such, they oxygenate the water through photosynthesis and provide a source of food for marine animals. Because seaweed is entirely submerged, the entire organism is capable of taking up nutrients from the surrounding waters, thus making them a highly nutritive food source for a variety of organisms, including people! Seaweeds and phytoplankton) are essentially the "grasses" of the marine realm.

In addition to these functions, seaweeds also provide habitat that supports all sorts of marine plants and animals. Thus, conservation efforts that respect seaweeds will also protect a wide range of other organisms.

Studies focusing on the algal communities of the Flower Garden Banks off Texas and Stetson Bank off Louisiana have recently revealed that these communities are much more diverse than scientists had thought. Because such hard-bank communities have received little attention in terms of their diversity, continued studies are expected to reveal that both the Florida Middle Ground and the Dry Tortugas are more diverse, too.

Recently, we had the opportunity to participate in the Sustainable Seas Expeditions' mission to the Florida Middle Grounds. Intent on

uncovering the seaweed diversity there, we dove to depths of 100 ft. on scuba, and reached greater depths via the DeepWorker manned submersible, to collect seaweed samples. The environment is dominated by diverse assemblages of gorgonia -- colonial animals that resemble stick-like underwater ferns -- as well as multicolored sponges, intermittent corals, and coral rubble and sand. Seaweeds are commonly found growing on all of these surfaces, but because many are small in size and others are hidden by corals and sponges, seaweed diversity can easily be underestimated. Some species, such as the velvety green alga *Codium*, form spongy turfs that blanket the sea floor sporadically and can be mistaken for invertebrate animals such as sponges. Other encrusting algae include calcified red algae, which tightly adhere to dead coral or other hard substrate and often overgrowing each other, giving much of the benthic habitat a dull red, pinkish or purplish color.

Samples of marine algae are kept in small jars of formalin, a preservative that keeps the samples "fresh" enough to later be identified. When sufficient material is available, the algae are also preserved in Ethanol or silica gel -- drying agents known as desiccants -- from which DNA can be extracted in the laboratory. Studies of algal DNA can reveal new species that have previously gone undetected. Such studies are useful for estimating the similarities between different locales.

Overall, we found an estimated 75 species of seaweed, at least one of which may represent a species new to science. This number is particularly striking given that only five dives were completed, for an estimated bottom time of about 1 hr. Continued surveillance of the Florida Middle Grounds will undoubtedly result in the discovery of even more species of algae. Dr. Sylvia Earle, Director of the Sustainable Seas Expeditions, and other submersible pilots

Brian Wysor examines the epiphytes (small seaweeds that grow on top of other seaweeds) on a red seaweed called *Botryocladia*. This seaweed, because it is organized as a stem with lots of small bladders coming off of it, is often referred to as the "sea grape."

will conduct additional sampling in Florida waters, including the Dry Tortugas. Ultimately, we plan to compare the marine algal floras of all of the marine sanctuaries in the Gulf of Mexico to gain more understandign of the similarities between these habitats. We will also continue to monitor the impacts from the oil industry and the success of marine protected areas in preserving the diversity of seaweeds in the Gulf of Mexico.

Read more about the Seaweeds Lab at the University of Louisiana at Lafayette.

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August 8-13, 2000
Using Tools of the Future to Reveal the Past

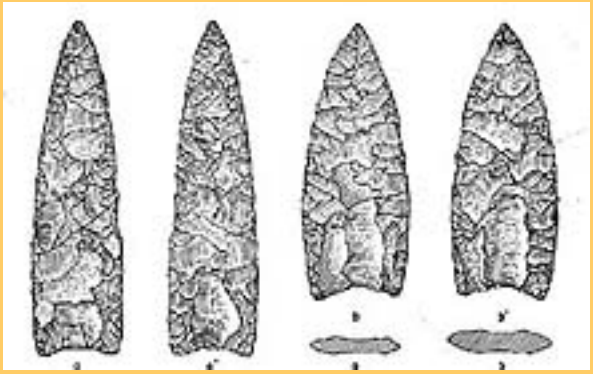
Michael Faught, Ph.D.
Director, Underwater Archaeology Field School
Florida State University

Michael Faught

One might ask, "What in the world is an archaeologist doing on board a ship working in the ocean, so far out to sea, in such deep water?" Well, things have not always been the way they are today, and that is particularly true about sea levels and the exposure of the continental shelves around the world. At the end of the last Ice Age, more than 12,000 years ago, the continental shelves were exposed because great amounts of water were frozen into glaciers. The implication is that prehistoric archaeological sites should exist out on the continental shelves, where they were submerged when the ice melted and sea levels rose.

I am fortunate to accompany this mission of the Sustainable Seas Expeditions to consult with Dr. Sylvia Earle and the other scientists on board about where to look for archaeological sites, and what they might look like. I direct a research program at Florida State University (**Read about the Program**) that focuses on such sites right here in the Big Bend of Florida, but in much shallower waters that are closer to the modern coastline. The project is known as the PaleoAucilla Prehistory Project because it studies submerged sites located near drowned portions of the ancient Aucilla River system. We have found sites as far out as nine miles offshore, but it is likely that more sites exist even farther out, and perhaps even as far offshore as we are this week.

Looking for evidence of prehistoric sites is not the most common thing for underwater researchers to do. I am aboard this vessel with people who are very knowledgeable about underwater plants,



Clovis Points (from Sellards). These are the earliest fluted points known to be made by people in the New World. They are dated at 11,000 radiocarbon years (13,000 calendar years old). The discovery of points like these offshore of modern-day Florida would be very significant. The distribution of these points is weighted to the eastern portions of North America.

fishes, algae and corals, and who know details about water salinity and other factors of the ocean environment. I am here, however, seeking evidence of human presence on a sea-floor bottom that once was dry land. Not many of us have experience with this way of doing archaeology, so it is both exciting and challenging.

Precisely where the sea floor may give up its mysteries is still unknown. We have a growing list of tools and principles to find underwater sites, and a growing understanding of what submerged sites and artifacts look like. One reason this is a good place to look is because many sites in Florida date back more than 5,000 years, which is approximately when the sea rose to today's levels.

Predicting where such prehistoric sites might exist on this particular continental shelf of northwestern Florida is somewhat complicated and conjectural, not only because it is difficult to date the rise in sea level through radiocarbon or other radiometric means, but also because we don't really know when people first came to inhabit the region we call Florida. Surely, they must have been here at the end of the last Ice Age, some 13,000 calendar years ago, when mammoths, mastodons and other large, now-extinct animals roamed the land and served as an excellent source of food.

From a global perspective, the sea level should have been about 100 meters (300 ft) lower during the full glacial period, some 14,000 to 18,000 years ago. By 13,000 calendar years ago it had risen about 50m, at a time known as the Younger-Dryas Period. Of course, nothing could be so simple. According to a 1970 study by Ballard and Upicho, sea-level

The SSE crew studies a rock specimen retrieved by the DeepWorker's manipulator arm during dives at the Madison-Swanson Ridge, also known as "Stu's Ridge."

indications on the West Florida Shelf can be found at 200 m, 160 m, 60 m, 40 m and 20 m. Some of these markers, however, might have come from previous glaciations, and the shelf itself moves up and down to some degree. In my Ph.D. dissertation and other publications, I have proposed that the 40-mcontour is the 13,000-calendar-yr-old shoreline that may have been familiar to the Paleoindians.

The Madison-Swanson Ridge: August 8-9, 2000

So far this week we have visited at least one place that clearly looks like it was once on (or very near) dry land, a location known as the Madison-Swanson Ridge. Too deep to reach on scuba at about 80 m (240 ft) depth, the feature is a wave-cut terrace with associated beach rock that is now home to groupers and other fishes and marine life. Sometime in the past, however, it was right at the beach line, and the waves eroded a long notch as they crashed against the beach over untold millenia. It may even be that people once stood here, looking out to sea, watching the sun go down, and never even dreaming that their beach would someday lie far under the sea.

Dr. John Ogden of the Florida Institute of Oceanography studies a rock specimen on board the *Gunter*.

The way that this area was determined to be a potential drowned shoreline reflects the state of the art of underwater geology today. A team of USGS geologists noted that this large area has interesting topographical features, one of which looks like a barrier spit. There is also a 40-to-50-ft ledge and wave-cut marks that demonstrate the lower sea level at some unknown time in the past. Dr. Earle, Gail Mead and Kip Evans made dives on this location, getting video, taking rock samples, and looking for oyster shells and other artifacts up on the ridge line. While no artifacts were found, it is still interesting and stimulating research.

Watching the streaming video footage that came up from more than 100 ft below and seeing the rocky ledge loom into view, I

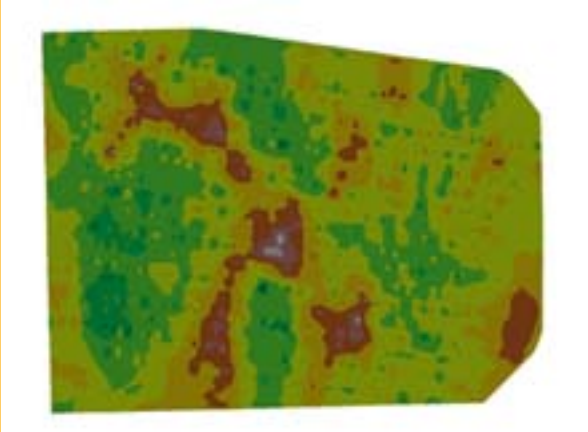
became excited observing the morphology on the bottom that clearly represented a shoreline when sea levels were lower.

The Florida Middle Grounds: August 10-13, 2000

The 40-m contour is the inside contour on the Florida Middle Grounds. For the past two days we have been working on the outside portions of this contour, as it is surely a relic reef feature of some sort. I'm hoping that tomorrow we will start looking for rocks. It would be nice to find even one artifact out here.

The weather has not cooperated for these three days, and we waited for waves and wind to settle down. We can't get the sub in the water, and it's too rough for scuba. One of the crew members had to be taken back to shore, and on the way back I studied the fathometer returns. Fathometers not only inform one about the depth of the water, but can also be used to determine hard from soft substrate on the bottom. During this "transect" we crossed over several probable relic channels and rocky outcrops within the Florida Middle Grounds.

This morning I went scuba diving on the Florida Middle Grounds (84 ft) on top of a reef feature. There was no potential for artifacts, but it was beautiful. Today we will venture into deeper waters to observe the shelf margin. Perhaps I'll be able to identify features of the 14,000-yr-old drowned shoreline.



This topographic map represents an area of particular interest inside the Florida Middle Grounds where prehistoric human artifacts may be found. Dr. Faught and SSE GIS Guru David Lott created this map while on board the *Gunter*.

If you asked me two years ago when we would begin to look for Paleohuman occupation sites out on the edge of the continental shelf, I would have answered, "A long time from now." Sometimes, however, opportunities come to you that you just can't turn down. Such is my involvement with the Sustainable Seas Expeditions.

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August 25-29, 2000 Summary of Pulley Ridge Research

Bret D. Jarrett, Ph.D. Candidate
University of South Florida, St. Petersburg Campus

The SSE mission in late August gave scientists an outstanding opportunity to explore the entire extent (over 85 nautical miles) of a geological feature, known as Pulley Ridge, which is believed to represent a drowned shoreline that formed during the last major sea-level rise.

North Pulley Ridge

Video observations and sampling began at the northern part of the ridge complex, west of Charlotte Harbor, at a depth of 260 to 300 feet (80 to 90 meters). There, it was discovered that benthic communities differ greatly from those previously studied at the southern portion of Pulley Ridge. No stony corals were present, and scattered soft corals, sponges, crinoids and red/brown algae characterized the benthic biota. Water clarity was fair, and sediments were composed primarily of quartz. Notably, with a decrease in biological cover, the nature of the underlying Pulley Ridge rock edifice was better revealed. Large blocks of bedded and rectilinearly jointed rock (most likely beach rock) were abundant, supporting the "paleoshoreline" interpretation of Pulley Ridge.

USF oceanographic geologists Brett Jarrett and Lisa Merman examine a rock sample taken from 170' on Pulley's Ridge. Scientists believe the area is a paleoshoreline.

Middle Pulley Ridge

LOG

August 7-10 Personal Log: Ogden

August 12 Macroalgal Diversity

August 8-13 Underwater Archaeology

August 25-29 Pulley Ridge

August 30 Explorer's Journal

August 14-31 Summary Log

August 5-31 Dive Maps

Next, submersible transects were conducted across the middle portions of Pulley Ridge in water depths ranging from 200 to over 330 feet (60 to over 100 meters). The sediments, rock, and biological communities there were similar to those described above.

South Pulley Ridge

Finally, at the southern portion of Pulley Ridge, thriving coral reefs were discovered (consisting mostly of Agaricia spp.),

Brett Jarrett, Sylvia Earle, Walt Jaap, and Lisa Merman (left to right) examine samples taken by Walt Jaap during his dive on Pulley's Ridge. Several different species of algae were collected for classification.

along with meadows of green leafy algae, coralline red algae, encrusting sponges, crinoids and deep-water soft corals. Water clarity was pristine on the ridges at a 200 to 300 feet (60 to 80 meter) depth. The transition to flourishing reefs at southern Pulley Ridge was sharp rather than gradational, supporting the hypothesis that a distinct oceanographic boundary, separating two physically and chemically distinct water masses, exists on the southern portion of the West Florida Shelf.

Future Research

Future work will utilize satellite imagery, focused on sea-surface temperature and nutrients, to better understand the cause and effects of this distinct boundary between water masses. In addition, continued rock sampling will be useful to accurately document the geological and biological history of Pulley Ridge.

For more information on Pulley Ridge, please **read Bret Jarrett's characterization essay.**

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August 30, 2000 Explorer's Journal

Kathy Sullivan, President, COSI

Editors note: Kathy Sullivan is a former astronaut and currently the president of COSI, one of the nation's leading hands-on science museums. This log is adapted from an article she wrote for Ohio's Columbus Dispatch.

On the deck of the NOAA ship *Gordon Gunter* off the southwest coast of Florida, I notice something that looks like a cross between a chubby VW beetle and some bizarre kind of crab. The clear domed canopy on the top hints that a person is meant to get inside (clearly only one person, and tightly at that!). Peering more closely at its midriff, I spot four rather small, propellers. Surely this awkward thing doesn't fly?

Kathy Sullivan orients herself with the *DeepWorker* submersible prior to her dive on Riley's Hump.

Such are my first impressions of a one-person submersible called the *DeepWorker* that is helping scientists understand the living environments of our country's National Marine Sanctuaries, which can be likened to underwater national parks. I've come aboard the *Gunter*to work for a week with the Sustainable Seas Expeditions (SSE). The brainchild of my good friend, Dr. Sylvia Earle, this five-year initiative is supported by the federal government, private donors and the National Geographic Society. The SSE aims to document marine life in our nearshore waters, with special emphasis on the sanctuaries. So far, the Florida legs of this journey have provided rare glimpses into a truly wonderful realm, which Dr. Earle describes succinctly as "a whole 'nother Florida underwater."

LOG

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August 12 Macroalgal Diversity

August 8-13 Underwater Archaeology

August 25-29 Pulley Ridge

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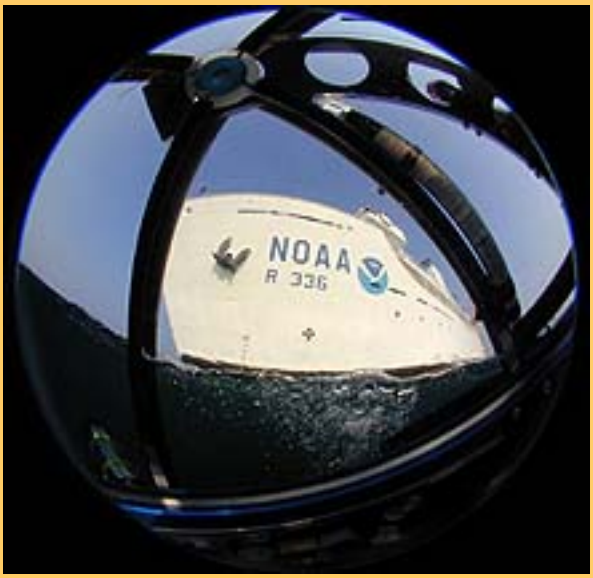
August 14-31 Summary Log

August 5-31 Dive Maps

I serve on the Scientific Advisory Committee of the SSE. This year I'm also one of the "education divers," meaning that I'll be assigned a working scientific dive, but am also expected to help bring the experience and insights of the expedition to the public and policymakers. Just hours after joining the ship some four miles off the coast of Naples, Dive Supervisor Jeff Heaton is putting me through my paces with a dry-run of a full pre-dive checklist. Anyone who disappoints or worries him doesn't get to dive in the sub.



The NOAA Ship *Gunter* as seen through the eyes of a *DeepWorker* pilot. (Photo by Kip Evans)

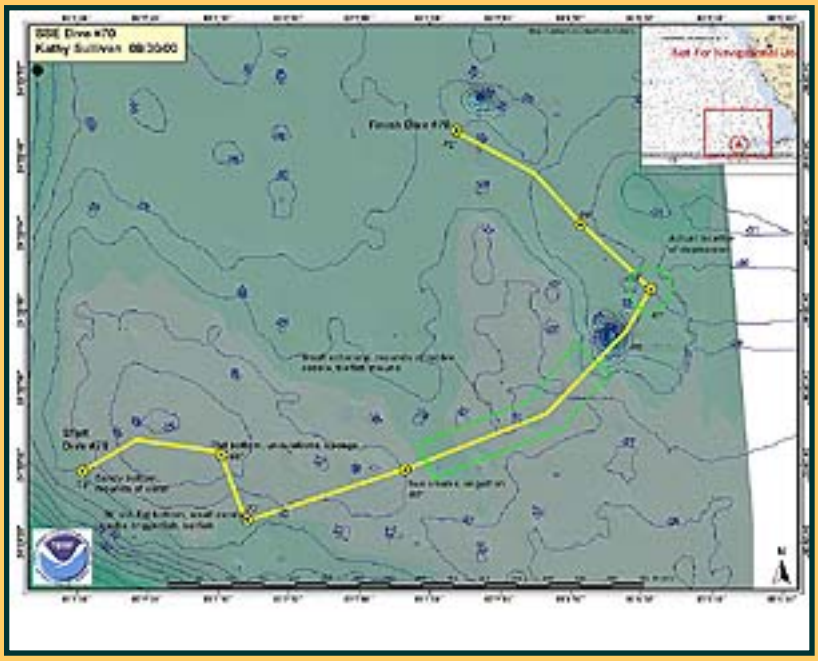
Diving is my entire reason for coming aboard, however, so I have already absorbed the *Pilot's Manual*and am ready to go. Thanks to my dad, my favorite sport is to figure out how some new complex system or operation works. Systems like spacecraft of submarines-- technological marvels that let me explore places that otherwise would be impossible to reach--are my very favorite challenges.

I've been around various airplanes, boats, space shuttles and submersibles since I was 13, so the *DeepWorker* seems pretty straightforward. I ask the dive supervisor more questions than he asks me, each one probing a specific aspect of the sub's design and operations to fill in all the details in my mental picture of how the systems are built.

The capsule I will sit in is basically a sphere that has a can welded onto it. My posture will be almost like sitting in my office chair, with my feet resting on foot pedals that command the sub's thrusters. The air inside is recirculated through tubes called "scrubbers" and supplemented as needed by oxygen, just like on the space shuttle. The sub can dive to 2,000 feet and stay on the bottom for up to 72 hours in an emergency. An oxygen mask rig would allow me to scrub the air even if electricity fails, and I could do an emergency ascent by jettisoning everything that's attached to the capsule. For scientific work, the *DeepWorker* has high-definition video systems, a manipulator arm to grab samples, and a hydrophone to record ocean sounds. I'll stay in contact with the surface throughout the dive using an underwater telephone, and they will track me with a special sonar system.

I pass the checkout, and Dr. Earle places me in the rotation for a dive out in the Tortugas Bank area of the western Florida Keys. Since this will be my first *DeepWorker* dive, we'll follow smart operational safety practices and put me down on a fairly simple bottom feature in fairly shallow water. I'm really eager to see some of the steep walls and amazing deep-water reefs that the SSE has found out here, but I fully support the good safety sense in this plan. There will be lots of dives, as long as we continue to dive safely. Besides, bottom time is what counts in the end, and my little reef, known as Riley's Hump, should be a great place to hang out.

On dive day I discover the untold secret of the *DeepWorker:* It's nicknamed the "Deep Cooker" because of how well broiled you become on the surface in sunny places like Florida. I'm drenched in sweat by the time we complete the predive checks and are ready to close the canopy. Sylvia passes me four ice packs, spare towels and three battery-powered fans. Of course, once the hatch is closed, I lose even the faint whisper of a breeze that existed during the predive checks. My glasses fog over instantly, and I hurry to rig one of the fans so it blows directly in my face. All the while, the deck crew is attaching the lifting lines and preparing to hoist me over the side. It cannot come too soon!



Kathy Sullivan's dive track. Click on the map for a larger view.

As soon as the swimmers have released all the lines and the support boat has backed off, the dive supervisor gives me clearance to dive, and I drive down to the bottom. It's a delightful little reef, with wonderful large sponges and sparse corals. A school of crevally jacks fly along in formation as I set off on my first traverse. At every stop, angelfish come by to take a close look at the strange new creature that's visiting their reef. If fish can laugh, I'm sure these elegant swimmers are splitting their sides at my ungainly craft. No matter, I'm in heaven.

Operating the *DeepWorker* proves to be simple, but pretty amusing. Between the odd shapes that make up the capsule and equipment pods, the manipulators and cameras hanging off it and the way the thrusters are placed, it flies through the water rather like a basketball would "fly" through the water. Both heel and toe taps make the thrusters turn, so I quickly learn the "*DeepWorker* tap dance" that's needed to make the sub fly a fairly straight and level path. Happily, I note that the post-dive plot of my track doesn't have too many embarrassing odd wiggles in it!

Four hours later I'm back on deck, grateful to feel the air moving around me again and eager to see the dive videotapes. Like all of my first flights, this one has made me eager to fly even more. I hope to join the Sustainable Seas Expeditions again next year, but as a working science diver, exploring even more interesting offshore terrain and creatures.

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August 14 - 31, 2000 Summary of Submersible Operations

Walter Jaap
Florida Marine Research Institute

As a researcher from the Florida Marine Research Institute, I joined the SSE mission on the R/V *Gordon Gunter* on August 14 off of Clearwater, Florida and remained until September 1.

During this time, submersible operations focused on two major features in the eastern Gulf of Mexico: rocky ridges that appear to be old shorelines (the deep ridge's names on charts are Pulley Ridge and Howell Hook), and the Florida Middle Grounds an old reef system. On 18 *DeepWorker* dives, scientists made observations, documented the dives on video, and collected biological and geological samples. The pilots were Sylvia Earle, Gale Mead, Kathy Sakas, Alex Score, Kathy Sullivan, and I. We logged a great amount of bottom time in *DeepWorker* submersibles and made two scuba dives to look at shallower sites off Steinhatchee and Chassahowitzka (Homassassa Keys). Our efforts began in the north; we worked our way south to the Straits of Florida, and took a break to attend an open house and National Geographic Society

Walt Jaap and Sylvia Earle examine a sample taken by Gale Mead during one of her dives.

reception in Tampa.

Observations from the hard-bottom sites off Steinhatchee and Chassahowitzka.

The depth was about 65 ft. and the majority of the seabed was sand; however, there were limestone structures colonized with sponges, sea whips, and sea plumes (soft corals).

Figure 1. Sponges, soft corals and algae cover the low-relief, hard-bottom habitat off of Steinhatchee and Chassahowitzka.

On close inspection, we saw arc shells that were attached to the rock and covered with algae, sponges, and small stony corals. We also saw starfish and arrow crabs. These sites are important refuge habitat for the fish; we saw a number of moderately sized snapper, small grouper and numerous smaller fish species. This is the typical hard-bottom habitat that occurs from Tarpon Springs northward. A recent survey for a gas pipeline reports that 20 to 30 percent of the sea floor in the area is a low-relief hard bottom with sponges and soft corals. This habitat is often undervalued because, at first glance, it does not appear important; however, it provides significant refuge for fish and invertebrates. Figure 1 shows is a good example of this low-relief, hard-bottom habitat.

Observations on the Florida Middle Ground.

The Florida Middle Grounds is a very unique area. About 100 miles northwest of Tampa Bay, it is composed of two types of large reef structures: mountain-like pinnacles and flat-top plateaus.

The tops of the structures are in 70 to 90 ft. of water, and they slope down to depths of 120 to 130 ft. They are covered with dense algae, large sponges, sea whips, and several stony coral species: fire coral, ten-ray star coral, and pineapple coral. Fish populations include 170 species. Our operational procedure was to use the sonar depth finder on the *Gordon Gunter* to search the sea floor and find the reef structures. The deck officers on the *Gunter* refer to this process as, "mowing the lawn", because the ship is driven back and forth in parallel course lines that overlap to map the sea floor. The computer was used to generate maps that were very

helpful in selecting where to launch the submersibles. We looked at both the pinnacle and plateau-type reefs. On one of my dives, we explored a plateau tentatively identified as Score's Plateau. Alex Score piloted the #7 *DeepWorker,* and I piloted #6. Our exploration around the bottom revealed a steep slope from 130 to 80 ft. Along this slope we saw schools of fish (see Figure 2). The fish included blue angelfish, damsels, tiny blue chromis, schools of medium-sized amberjack, and scamp grouper. The impression is that populations of invertebrates and fish are relatively abundant and healthy. At night, Cathy Sakas dove on a pinnacle reef structure that we named Mount Sakas. Her comments follow.

Figure 2. A school of scamp grouper swim by a slope on Score's Plateau.

Cathy Sakas' Observations

On August 18, 2000 I closed the hatch of the *DeepWorker 2000* at 17:54 for deployment off the NOAA Ship *Gunter,* and submerged at 18:18.

The sea state was less than one foot, and the surface current was minimal. With the evening sun lowering, the sub approached 100 ft. with visibility of less than 20 ft. The sub settled to the rippled sand bottom and sat for a few moments while the necessary adjustments were made to achieve neutral buoyancy. Once all was adjusted and life support readings given, the chase boat relayed the compass heading for the sub to steer.

After traveling for a few minutes, the sub approached a low-relief formation. Several feet beyond, and just out of

While others were diving, Walt would laboriously log underwater video footage for future reference.

view in the waning light, a sea mount rose up off the ocean floor. The bottom current carried the sub too close to the abruptly rising wall, so I made a hard turn to port to gain a more favorable approach. After repositioning the sub, I again approached the west-facing wall of the sea mount, and managed to maneuver the sub up the craggy face to the top. The sea mount rose from 110 to 65 ft.

The top of the sea mount was approximately 10 ft. in diameter, flattened and covered with a low density of octocorals and sponges. There were some fish--blue angelfish, grunts and a cowfish. The three other sides of the mount were more gently sloped than the west-facing side, which appeared to be eroded from perhaps, the prevailing currents. The sharp exposed rock was colonized by algae and octocorals with damselfish in attendance. The other sides of the sea mount and the top were covered with sand that provided substrate for short green algae (<20cm), octocorals, tunicates and sponges, with small assemblages of various fish, mostly damselfish and gobies.

Because most of the dive took place in low to zero natural-light conditions (that is to say, after the sun had set), the sub's light system was employed most of the time. With a narrow tunnel of light provided by the sub, I steered another course given by the chase boat, but had to deviate to avoid hitting a sea mount which may or may not have been the one I was originally observing. At 20:40 the sub broke the surface and made way for the *Gunter's* stern for retrieval. At approximately 20:55 the hatch was opened, and the sub and I were secure on the back deck of the *Gunter.*

More Observations

In one of Sylvia Earle's dives in the Florida Middle Grounds, she encountered a very large jewfish patrolling along the reef slope (Figure 3).

As Sylvia watched, the fish, which she dubbed "Big Daddy," moved from the top of the slope to the bottom, came close to the *DeepWorker* for a look, and then backed off. This was the largest fish we saw and it was a special experience, since a few years back, jewfish were hunted nearly to extinction, and emergency measures were necessary to protect them. Now, we are seeing more large jewfish, a sign that the protective measures are working. Jewfish are totally protected, so if you happen to catch one you should release it.

Figure 3. Jewfish are a species of grouper that can grow to several hundred pounds. Until they were protected several years ago, they were almost fished to extinction.

The Florida Middle Grounds is located in a temperate climate area; minimum winter seawater temperature (61 ° C) is a barrier to many tropical marine plants and animals. Twenty-three types of stony coral and 13 species of soft coral are known to exist in the FMG area. In the 1970s, oil and gas environmental studies documented 103 species of algae, approximately 40 sponges, 75 snails and clams, 56 shrimp and crabs, 41 marine worms, 23 starfish and urchins, and 170 species of fish. The fish fauna is as diverse as many of the tropical reefs in the Florida Keys. The puzzle yet to be put together is when the Florida Middle Grounds began their upward growth. Are they recent (100,000 years old) or ancient (millions of years old)? Geologists are looking for the answer, and the SSE should help them to gain a better understanding, and the of this the FMG and look for way to conserve and sustain this area.

Pulley Ridge Observations

Pulley Ridge is a feature in depths of 230 to 260 ft beyond nominal research scuba-diving depths.

It appears to extend from about the same latitude as Charlotte Harbor or Boca Grande to west and south of the Dry Tortugas. University of South Florida Geologists have studied the southern portion of Pulley Ridge over the past few years, and their video from remotely operated vehicle investigations reveals a low-relief, rolling topography with occasional sinkhole-like depressions. The plants and animals on the southern portion of Pulley Ridge include a unique alga: Anadyomene menziesii

Figure 4. Large, leafy, and very green, this algal specimin *Anadyomene menziesii*was found at a depth of 250 ft.; far below the shallower depths one would typically find green algae.

(Figure 4). This alga is large and leafy, with very dark green pigmentation. Finding this alga at 250 ft. is remarkable; the available light usually restricts the green algae to shallower depths. Another very interesting observation is the presence of large plates of lettuce coral. Lettuce corals are common on deep reefs in the Caribbean. The area also supports black coral, glass sponges, deep-water octocorals lacking zooxanthellae, and crinoids (sea feathers). The research questions we considered included, "Do the alga and coral continue north on the ridge? Is the deeper ridge to the west a similar feature? Is the ridge an old shoreline?"

Our first dive was off of Charlotte Harbor in 250 ft. We found evidence of a rocky ridge, but the leafy alga and the lettuce coral were not present. The ridge was only 50 ft. wide, and the elevation from the surrounding sea floor was about 5 to 6 ft. Fish, including grouper, were abundant around the ridge. The corals included deep-sea cup corals, hydrocorals and very beautiful red and yellow sea fans (Figure 5). As we continued our quest south to examine Pulley Ridge, we made a number of dives, and returned with rocks and one of the very delicate hydrocorals (Figure 6).

Crinoids, or sea feathers were one of the many delicate and beautiful invertebrates found during the exploration of Pulley Ridge.

The examinations revealed that the alga and lettuce corals are restricted to the southern portion of Pulley Ridge. The lettuce coral does not occur on the outer ridge; however, the dark green alga is present. The deeper depth at the outer ridge (about 65 ft. deeper than Pulley Ridge) is perhaps the reason that lettuce coral is not present. It was very dark, and the principal plants on the deeper ridge were red algae.

Surface water temperature was 86 to 88 ° F and the bottom temperature was 66 ° F at 300 ft. The currents at the outer ridge were relatively strong from the south, witnessed by the *DeepWorker's* inability to follow a course to the south. During some of the dives, a cloud of plankton occupied the water around the sub.

Figure 5. A close up view of a sea fan coral found during a dive off of Charlotte Harbor

There are differences in the northern and southern portions of Pulley Ridge. In the southern portions, the ridge is less of a rocky outcrop and has more low-relief mounds, with the somewhat more tropical characteristics of the lettuce coral and the leafy green alga. In the north, the ridge looked more like layers of rectangular and square rocks. Rocks appear to be in layers with a lot of void space. The north and south portions of the ridge both have red algae, sponges, hydrocorals, octocorals, crinoids and ascidians on the ridge formations.

Straits of Florida Observations

We made three dives on the margin of the Straits of Florida, two south of Riley's Hump and one south of Marquesas Key. These were in 370 to 500 ft. of water. The bottom was sand, and starfish and crabs were abundant. The rocks we recovered had numerous cup corals attached to them.

Figure 6. A delicate hydrocorals found during the exploration off of Charlotte Harbor.

Acknowledgments

The contributions of the submersible pilots would not have been possible without the team effort from the *Gordon Gunter's* officers and crew, the NUYTCO submersible technicians, and the support of the National Geographic Society and NOAA. We sincerely appreciate the effort that everyone pitched in to give 110%. Thank you, one and all.

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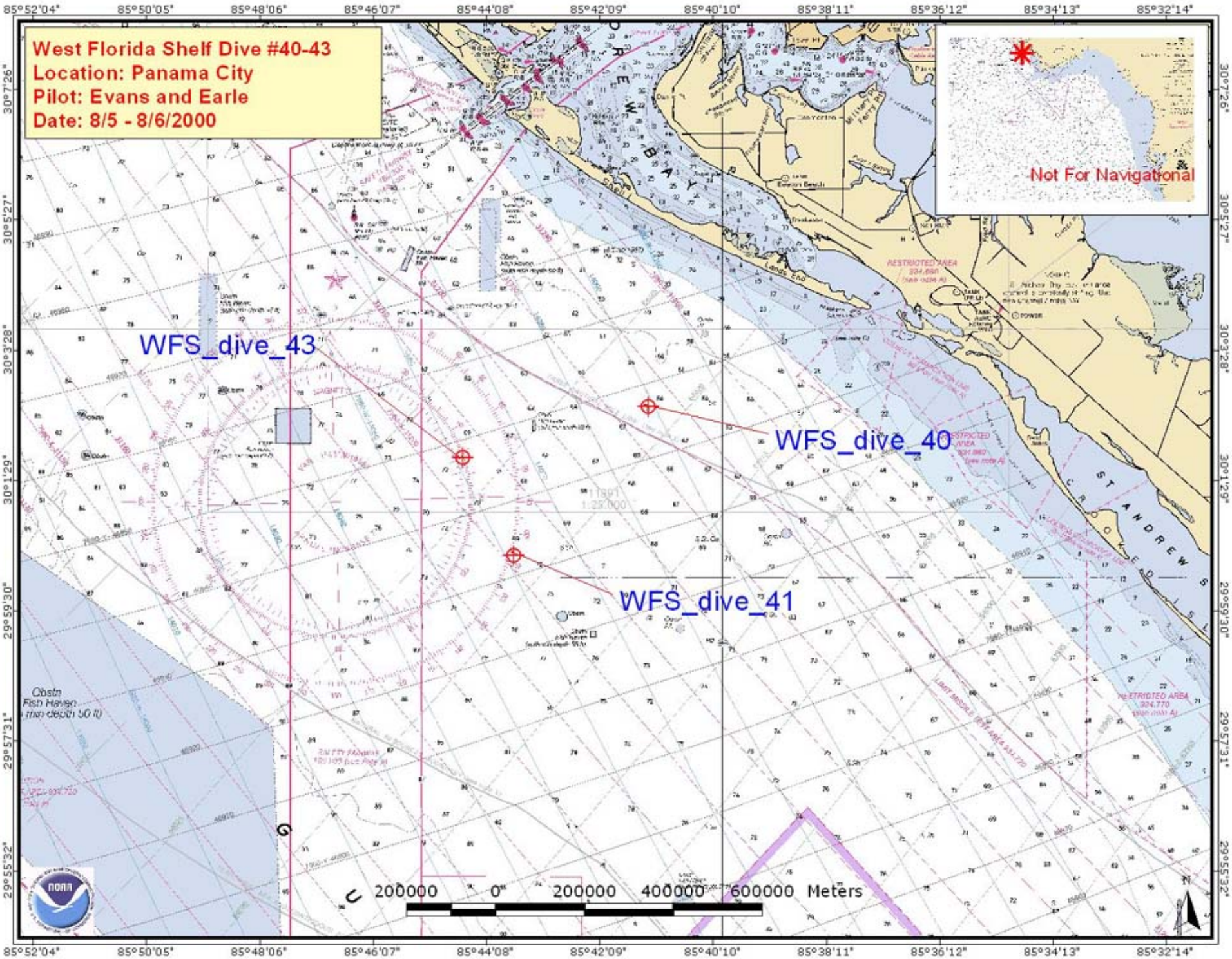
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Location: Panama City
Pilot: Evans and Earle
Date: 8/5 - 8/6/2000
Not For Navigational
WFS_dive_43
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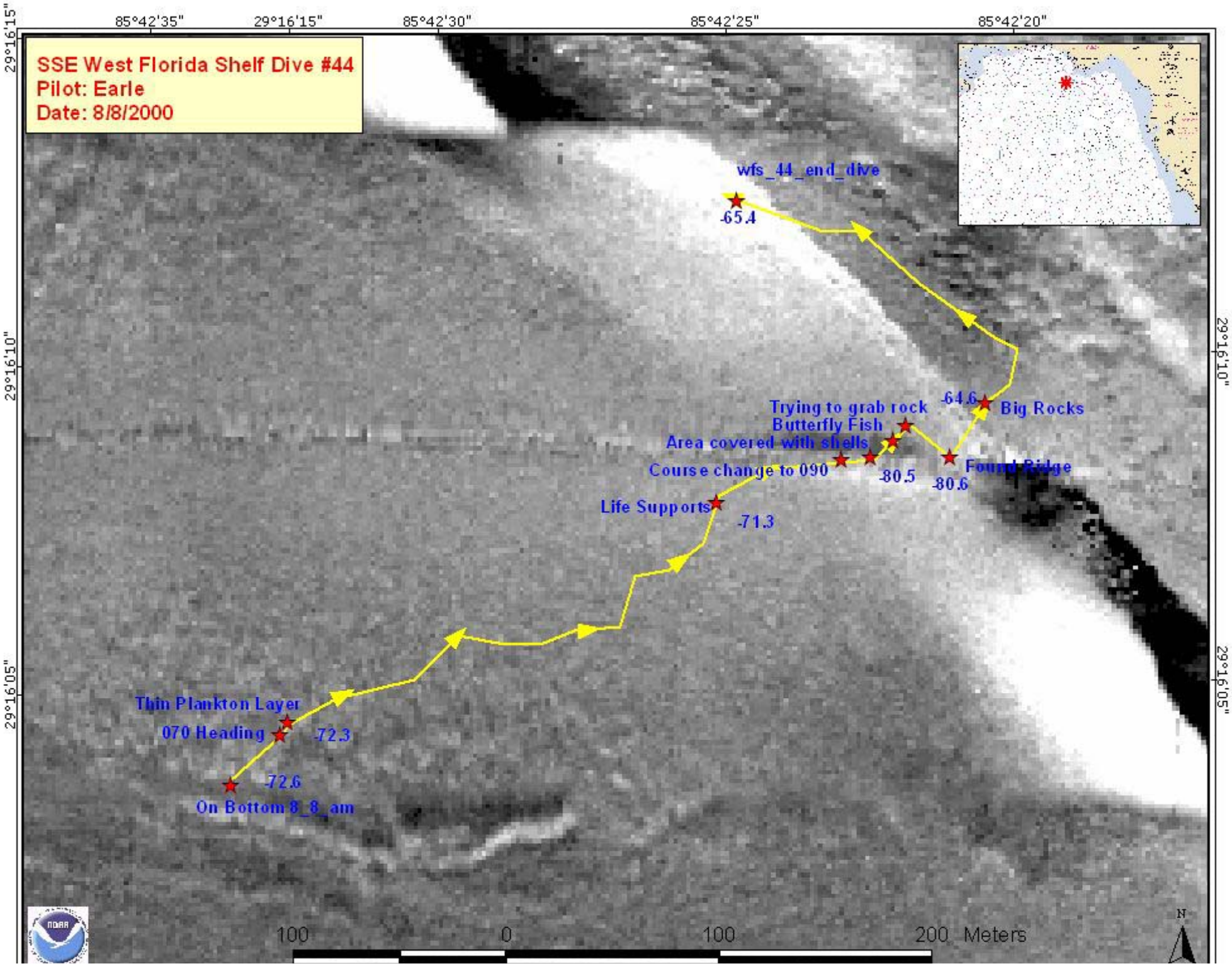
WFS_dive_41
200000 0 200000 400000 600000 Meters
N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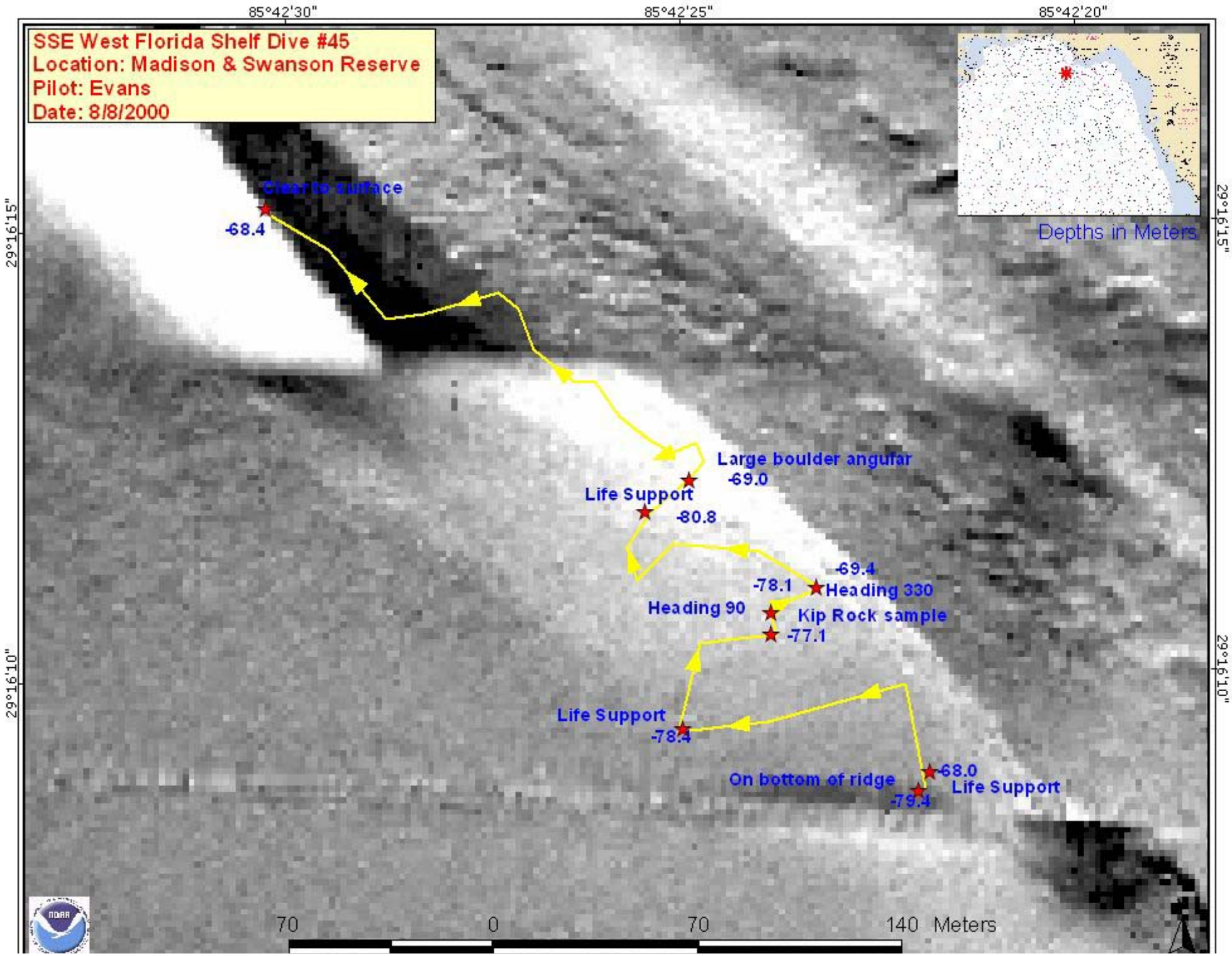
Pilot: Earle
Date: 8/8/2000
85°42'35"
29°16'15"
85°42'30"
85°42'25"
85°42'20"
29°16'15"
29°16'10"
29°16'05"
wfs_44_end_dive
-65.4
-64.6
Big Rocks
Trying to grab rock
Butterfly Fish
Area covered with shells
Course change to 090
-80.5
-80.6
Found Ridge
Life Supports
-71.3
Thin Plankton Layer
070 Heading
-72.3
-72.6
On Bottom 8_8_am
100
0
100
200 Meters
N


85°42'35"
85°42'30"
85°42'25"
85°42'20"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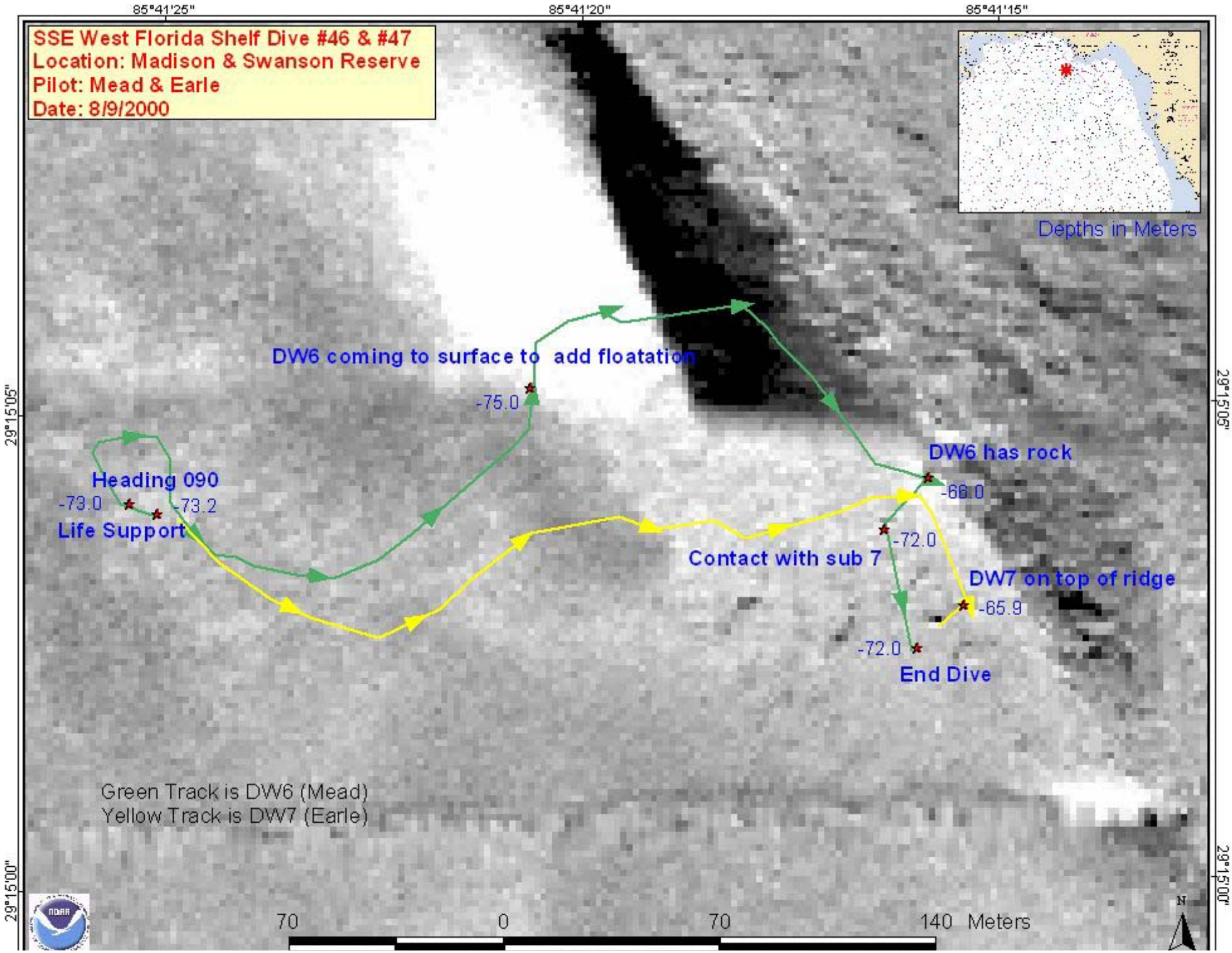
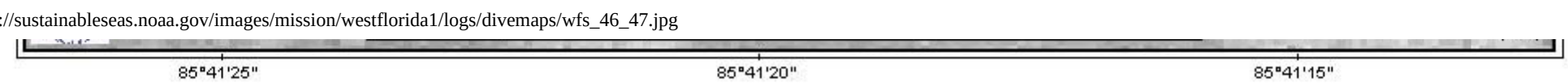
Location: Madison & Swanson Reserve
Pilot: Evans
Date: 8/8/2000
85°42'30"
85°42'25"
85°42'20"
29°16'15"
29°16'10"
Depths in Meters
Clear to surface
-68.4
Large boulder angular
-69.0
Life Support
-80.8
-69.4
-78.1
Heading 330
Heading 90
Kip Rock sample
-77.1
Life Support
-78.4
On bottom of ridge
-68.0
Life Support
-79.4
70
0
70
140 Meters


85°42'30"
85°42'25"
85°42'20"


SSE West Florida Shelf Dive #46 & #47
Location: Madison & Swanson Reserve
Pilot: Mead & Earle
Date: 8/9/2000
85°41'25"
85°41'20"
85°41'15"
29°15'05"
29°15'00"
Depths in Meters
DW6 coming to surface to add floatation
-75.0
Heading 090
-73.0
-73.2
Life Support
DW6 has rock
-66.0
-72.0
Contact with sub 7
DW7 on top of ridge
-65.9
-72.0
End Dive
Green Track is DW6 (Mead)
Yellow Track is DW7 (Earle)
70
0
70
140 Meters
N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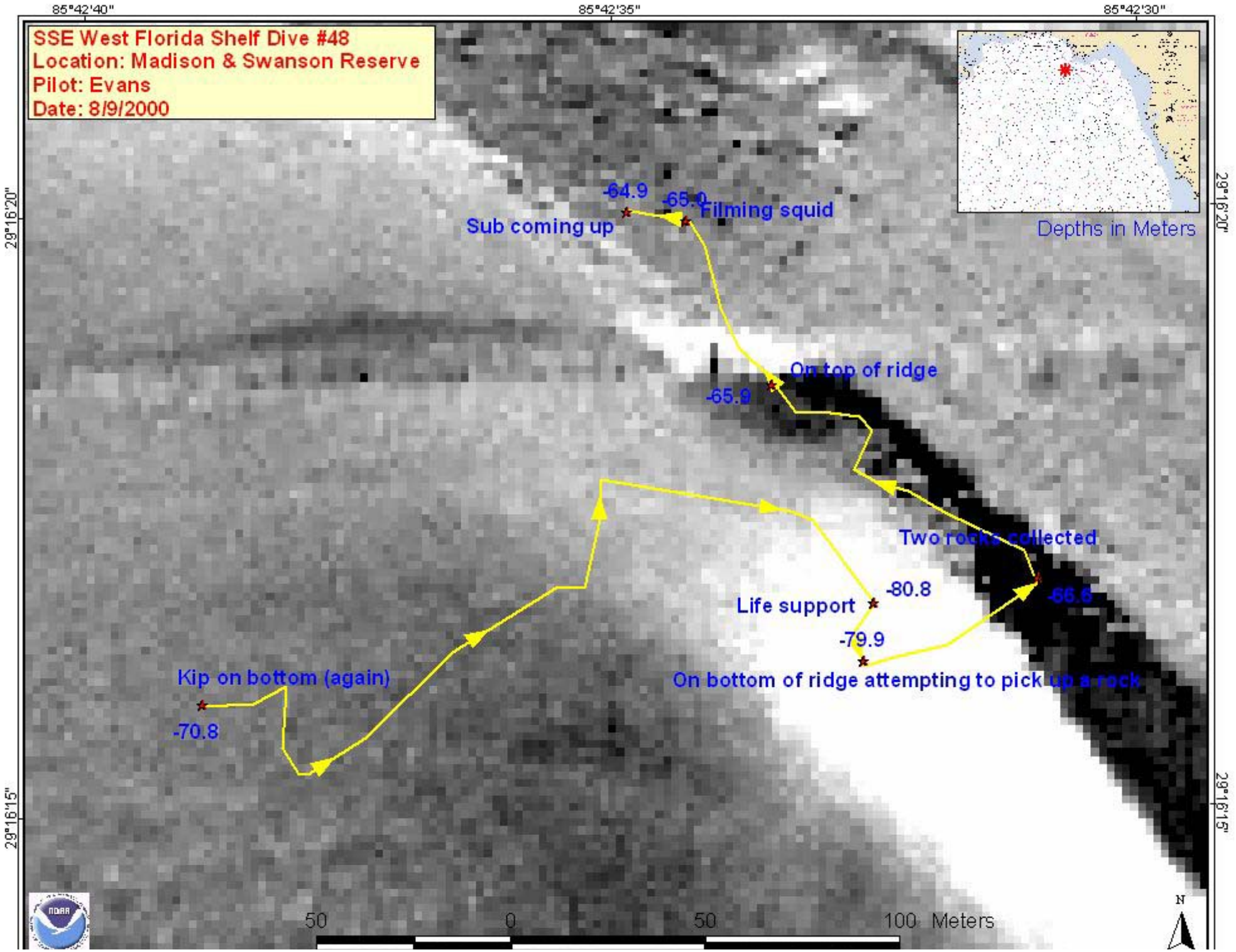
85°41'20"
85°41'15"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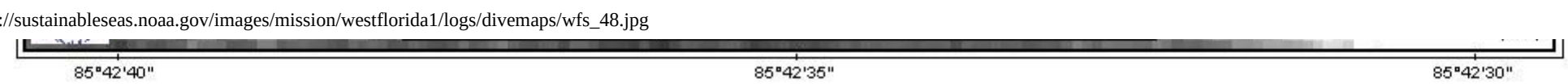
85°42'35"
85°42'30"
29°16'20"
29°16'15"
SSE West Florida Shelf Dive #48
Location: Madison & Swanson Reserve
Pilot: Evans
Date: 8/9/2000
Depths in Meters
-64.9
-65.0
Filming squid
Sub coming up
On top of ridge
-65.9
Two rocks collected
-66.6
-80.8
Life support
-79.9
On bottom of ridge attempting to pick up a rock
Kip on bottom (again)
-70.8
50
0
50
100 Meters
N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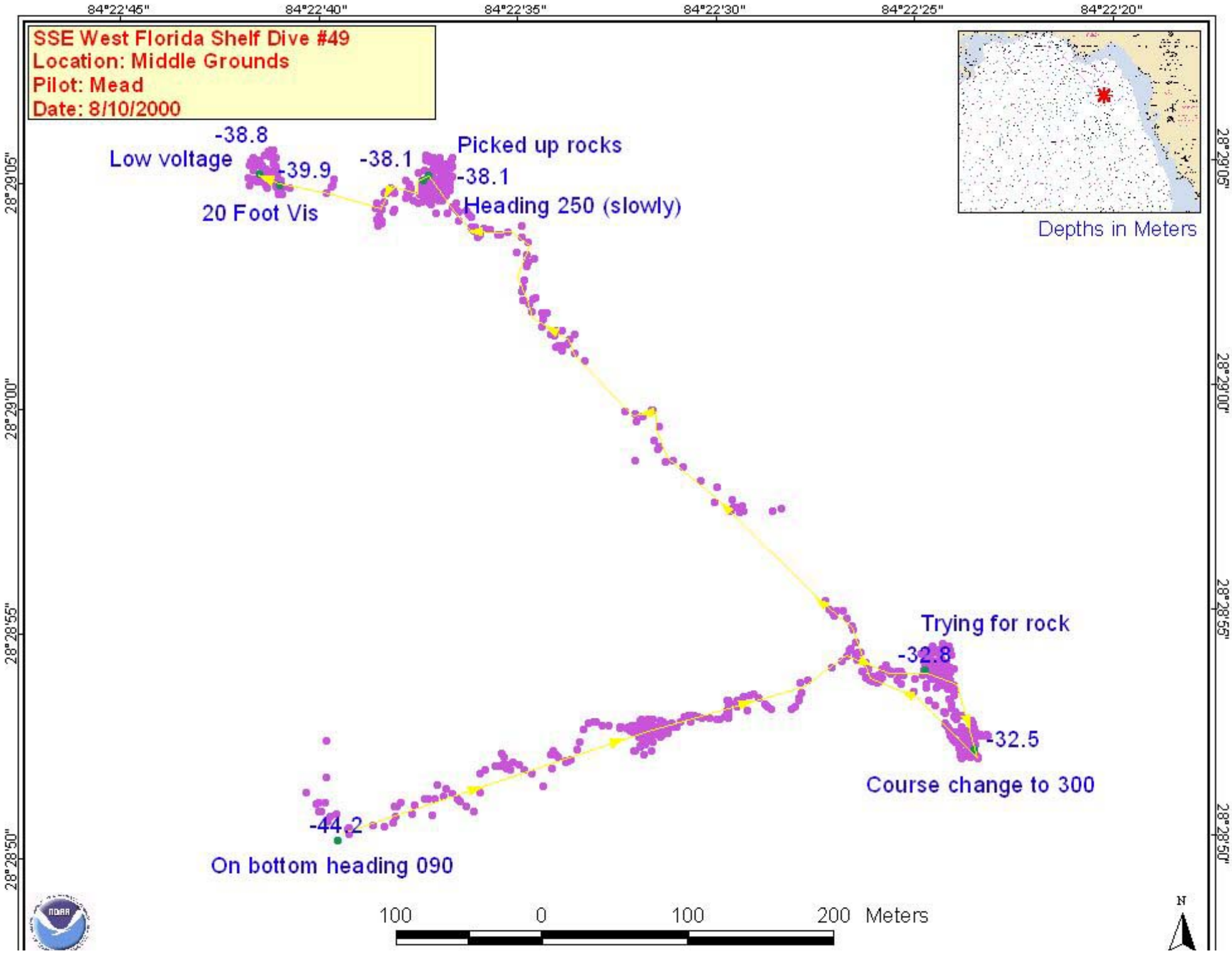
85°42'30"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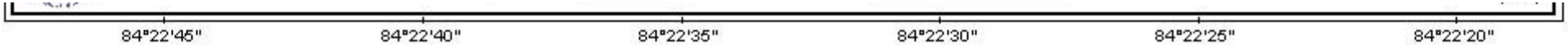
Location: Middle Grounds
Pilot: Mead
Date: 8/10/2000
84°22'45"
84°22'40"
84°22'35"
84°22'30"
84°22'25"
84°22'20"
28°29'05"
28°29'00"
28°28'55"
28°28'50"
-38.8
Low voltage
-39.9
20 Foot Vis
-38.1
Picked up rocks
-38.1
Heading 250 (slowly)
Depths in Meters
Trying for rock
-32.8
-32.5
Course change to 300
-44.2
On bottom heading 090
100
0
100
200 Meters
N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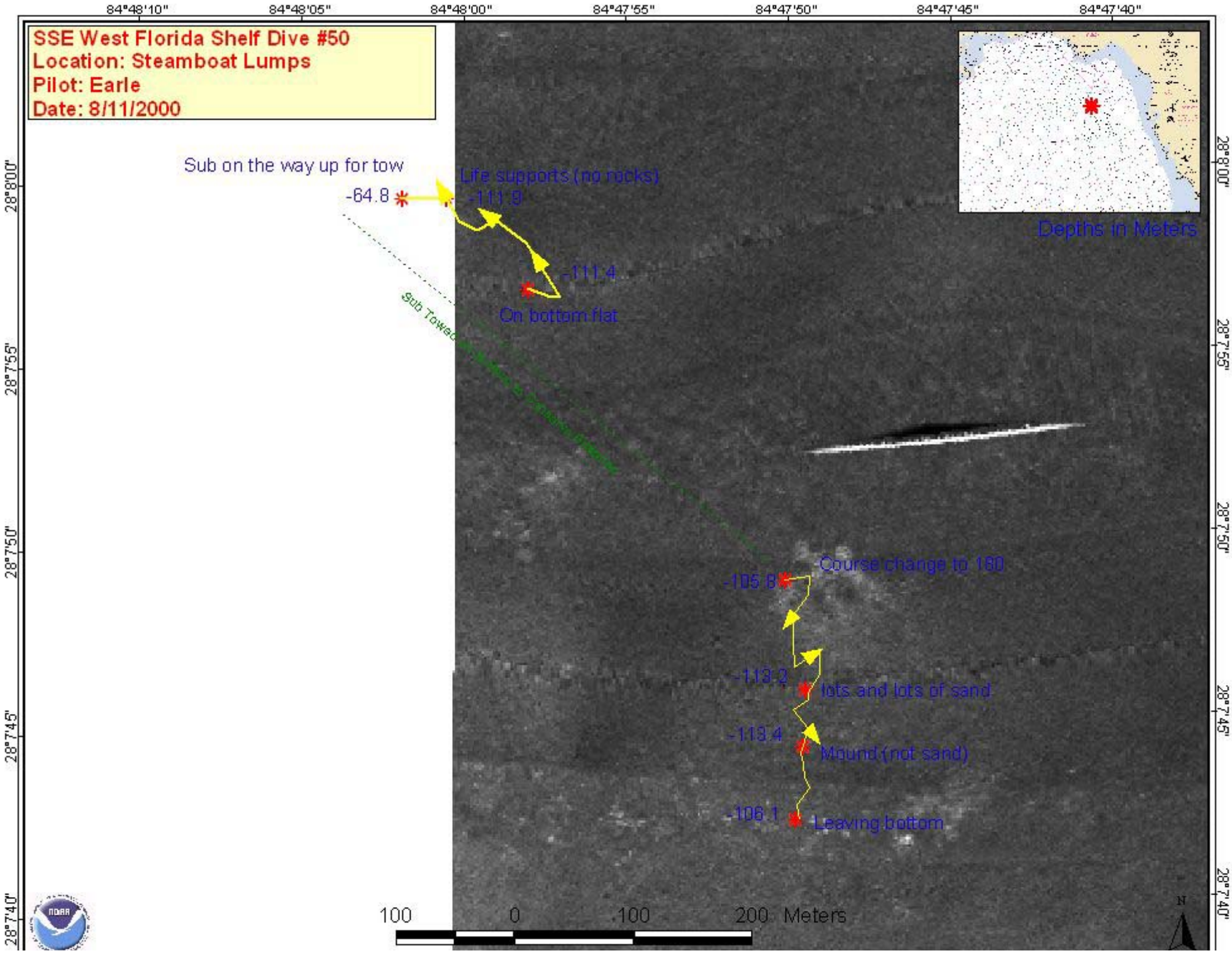
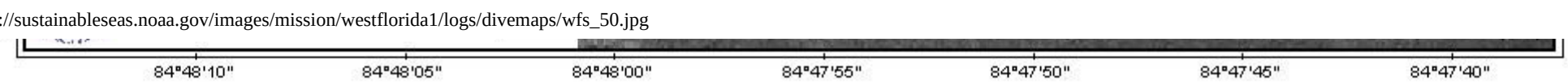
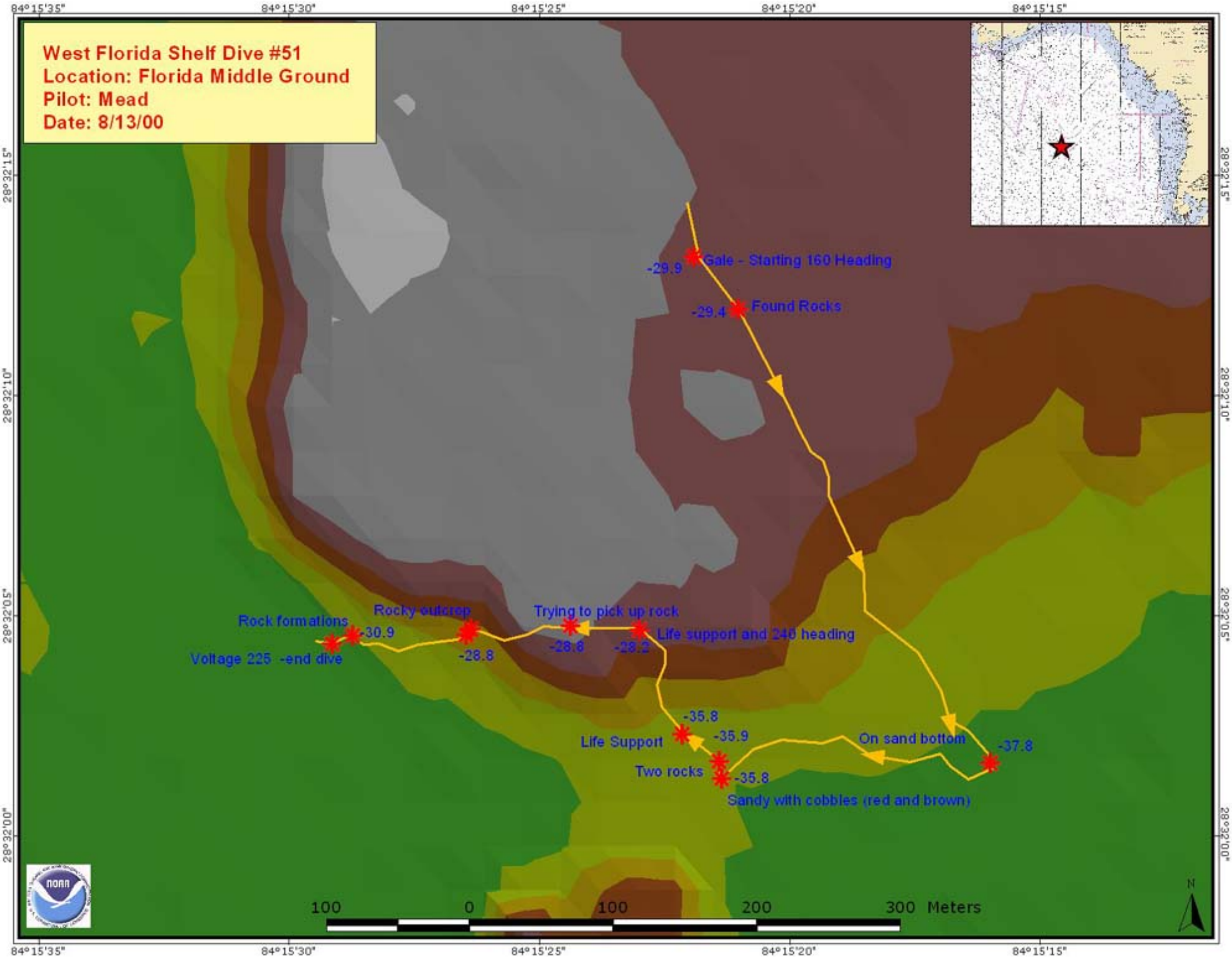
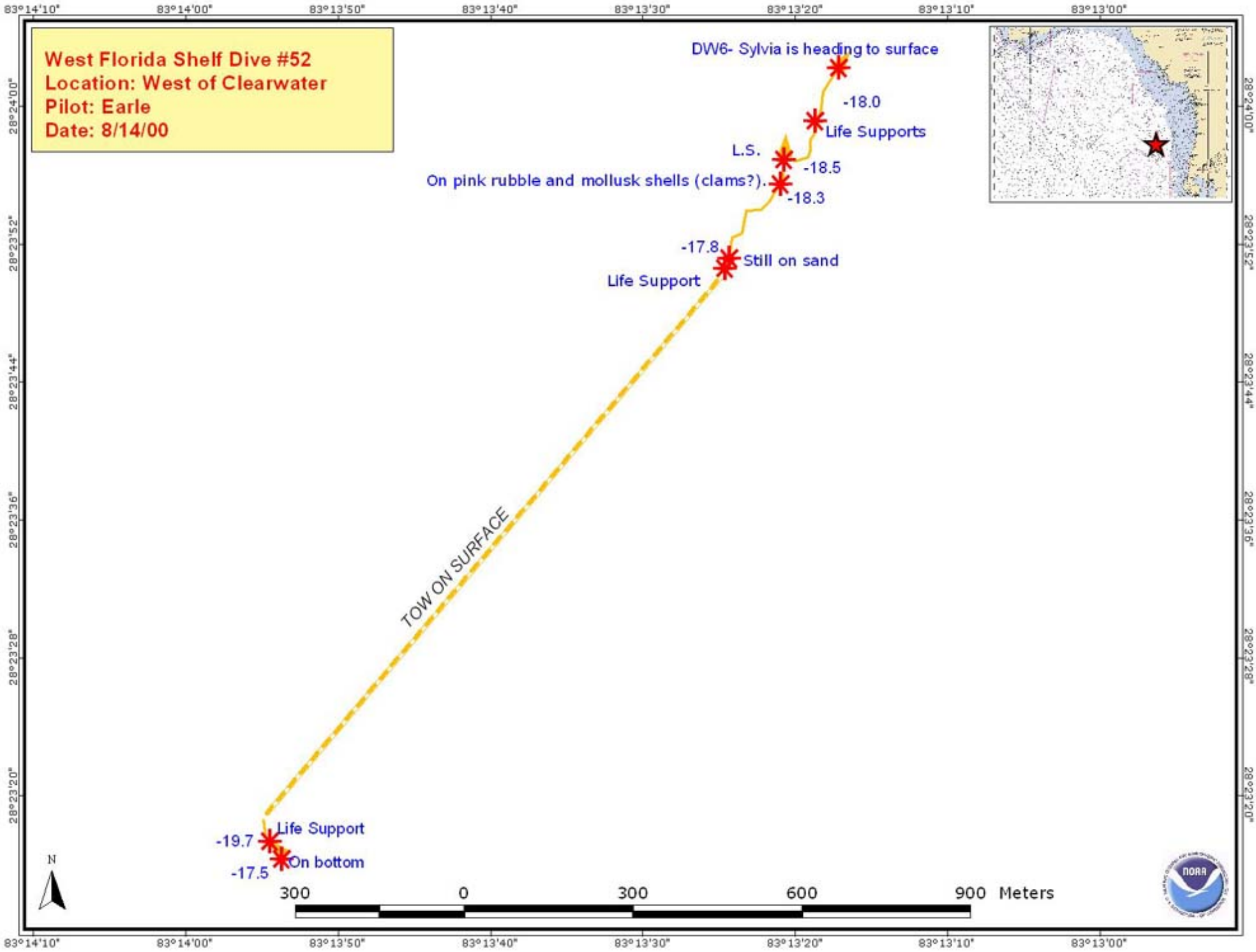
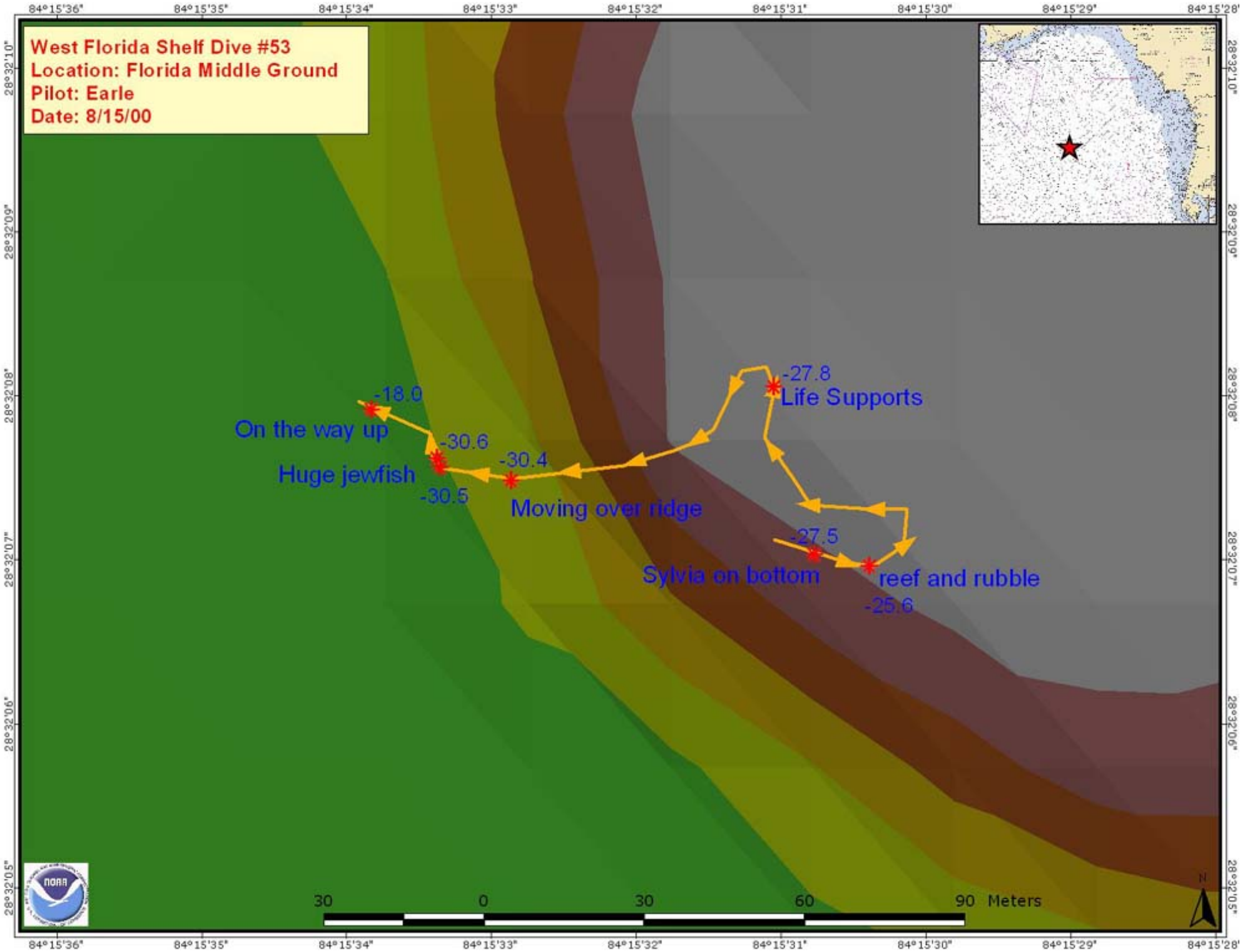
84°22'40"
84°22'35"
84°22'30"
84°22'25"
84°22'20"

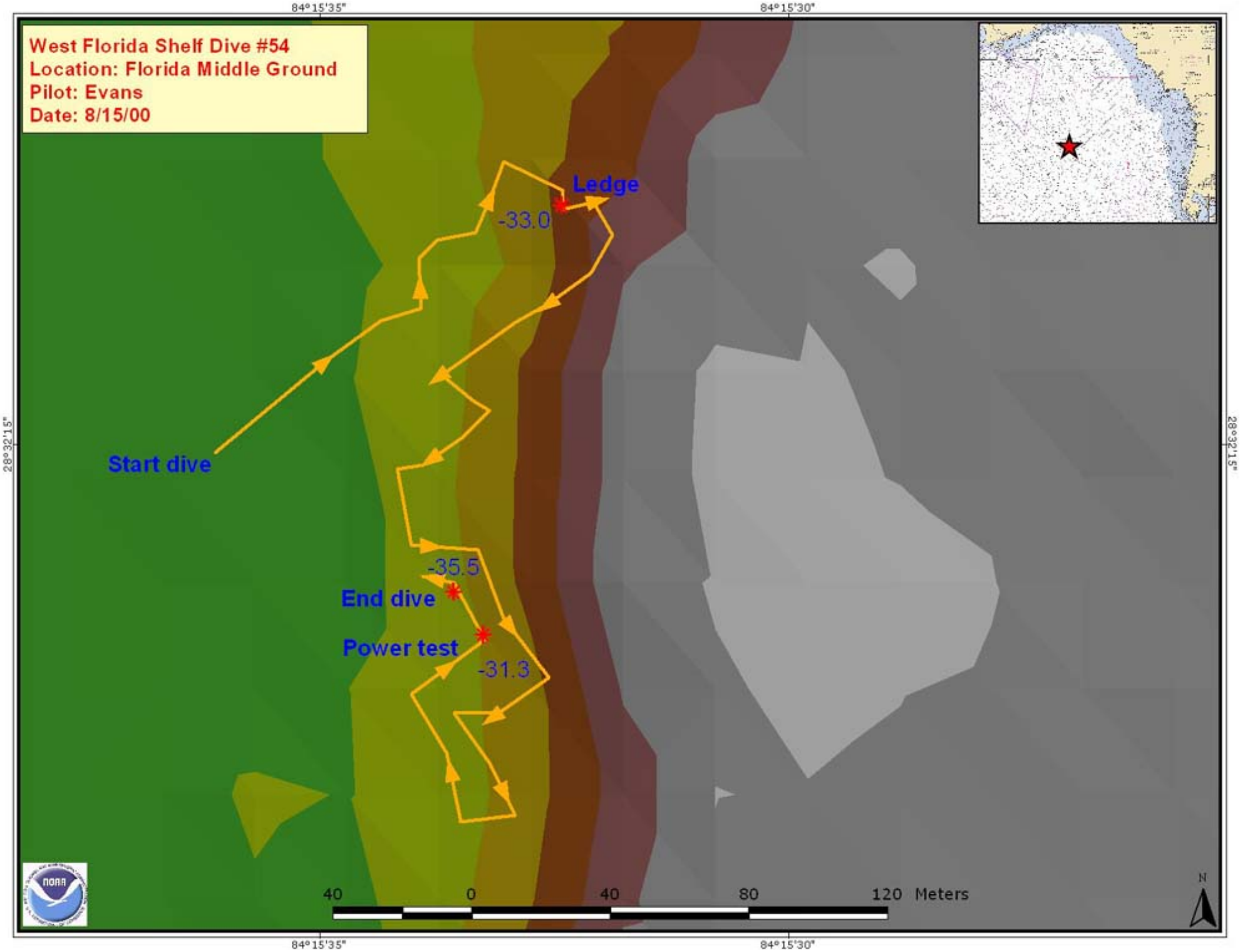

SSE West Florida Shelf Dive #50
Location: Steamboat Lumps
Pilot: Earle
Date: 8/11/2000
84°48'10"
84°48'05"
84°48'00"
84°47'55"
84°47'50"
84°47'45"
84°47'40"
28°8'00"
28°7'55"
28°7'50"
28°7'45"
28°7'40"
Sub on the way up for tow
-64.8
Life supports (no rocks)
-111.9
-111.4
On bottom flat
Stb Tow
Course change to 180
-105.8
-113.2
lots and lots of sand
-113.4
Mound (not sand)
-106.1
Leaving bottom
Depths in Meters
100
0
100
200 Meters
N

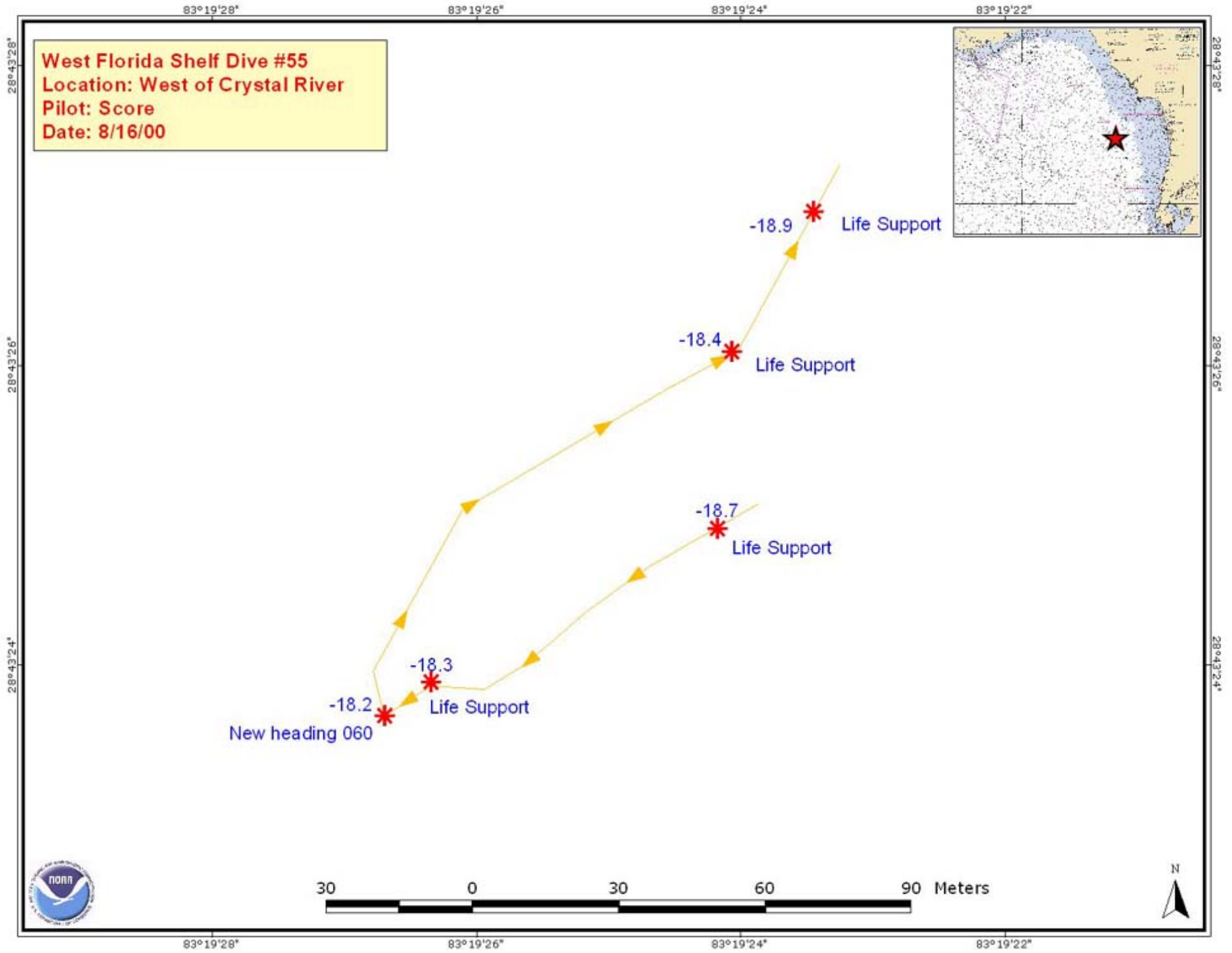

84°48'10"
84°48'05"
84°48'00"
84°47'55"
84°47'50"
84°47'45"
84°47'40"

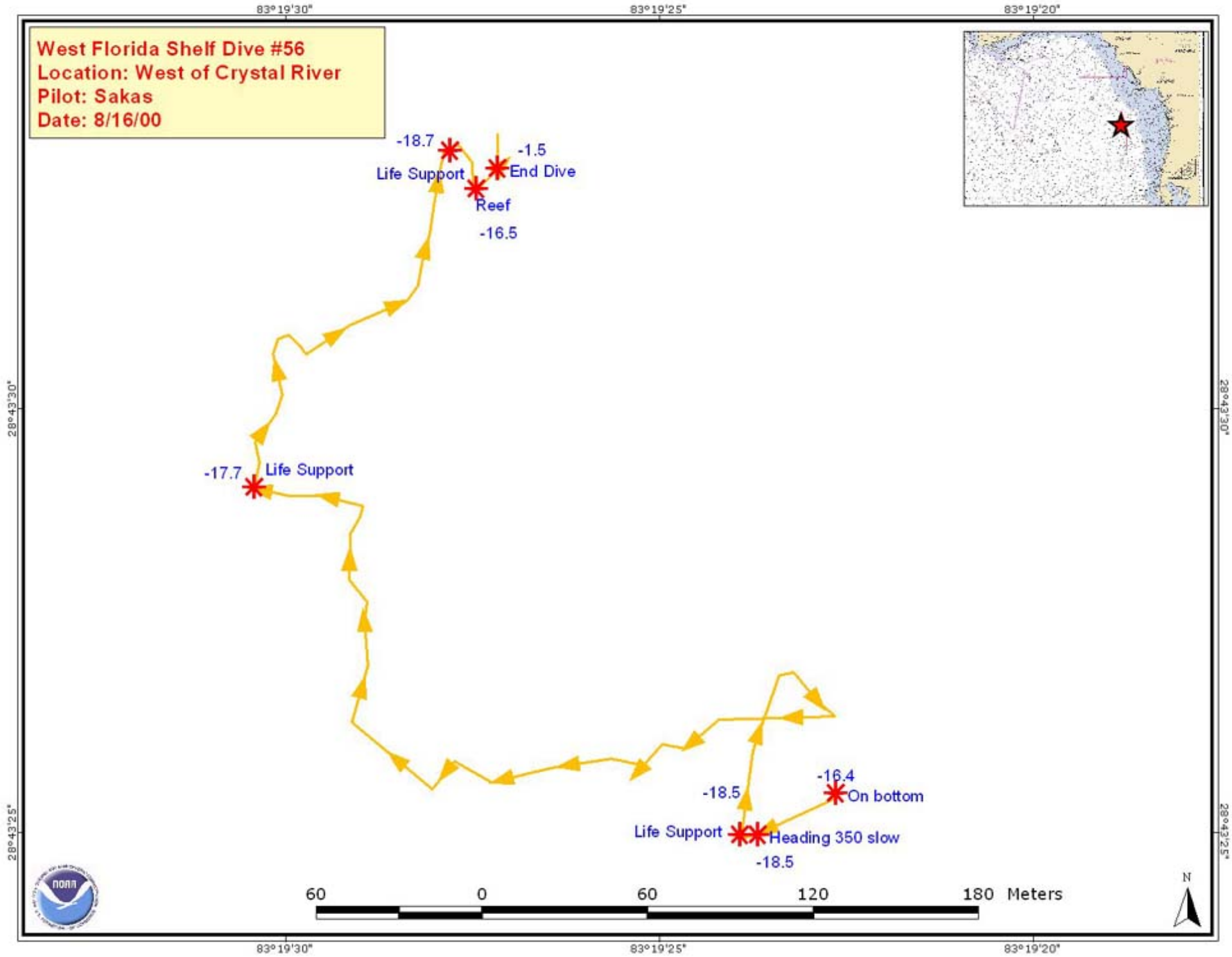

West Florida Shelf Dive #51
Location: Florida Middle Ground
Pilot: Mead
Date: 8/13/00
84°15'35"
84°15'30"
84°15'25"
84°15'20"
84°15'15"
28°32'15"
28°32'10"
28°32'05"
28°32'00"
-29.9
Gale - Starting 160 Heading
-29.4
Found Rocks
Rock formations
-30.9
Rocky outcrop
-28.8
Trying to pick up rock
-28.8
-28.2
Life support and 240 heading
Voltage 225 -end dive
-35.8
Life Support
-35.9
On sand bottom
-37.8
Two rocks
-35.8
Sandy with cobbles (red and brown)
100
0
100
200
300 Meters
N

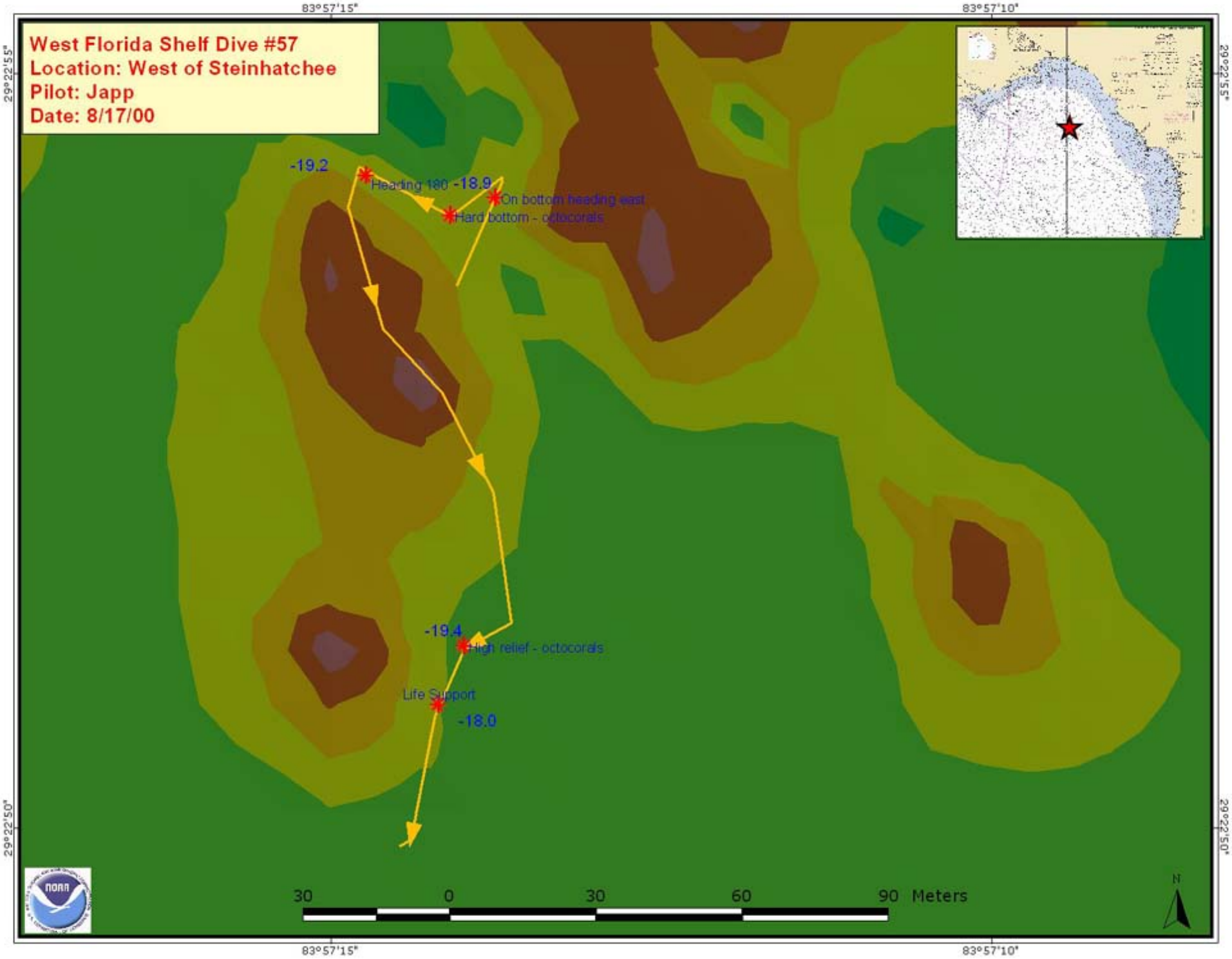

West Florida Shelf Dive #52
Location: West of Clearwater
Pilot: Earle
Date: 8/14/00
DW6- Sylvia is heading to surface
-18.0
Life Supports
L.S.
-18.5
On pink rubble and mollusk shells (clams?).
-18.3
-17.8
Still on sand
Life Support
TOW ON SURFACE
Life Support
-19.7
On bottom
-17.5
N
300 0 300 600 900 Meters
83°14'10"
83°14'00"
83°13'50"
83°13'40"
83°13'30"
83°13'20"
83°13'10"
83°13'00"
28°24'00"
28°23'52"
28°23'44"
28°23'36"
28°23'28"
28°23'20"

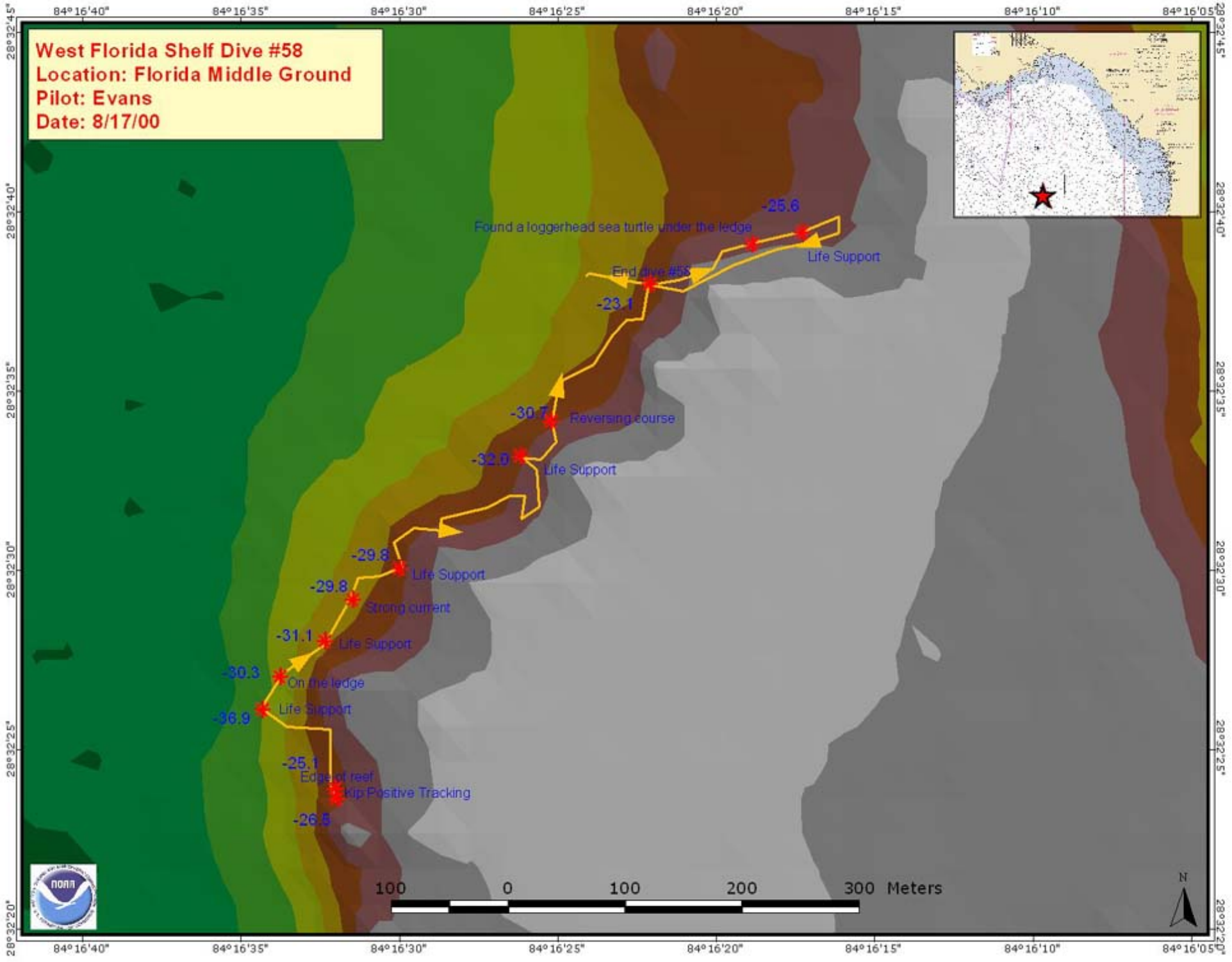

West Florida Shelf Dive #53
Location: Florida Middle Ground
Pilot: Earle
Date: 8/15/00
84°15'36"
84°15'35"
84°15'34"
84°15'33"
84°15'32"
84°15'31"
84°15'30"
84°15'29"
84°15'28"
28°32'10"
28°32'09"
28°32'08"
28°32'07"
28°32'06"
28°32'05"
-18.0
On the way up
-30.6
Huge jewfish
-30.5
-30.4
Moving over ridge
-27.8
Life Supports
-27.5
Sylvia on bottom
reef and rubble
-25.6
30
0
30
60
90 Meters
N

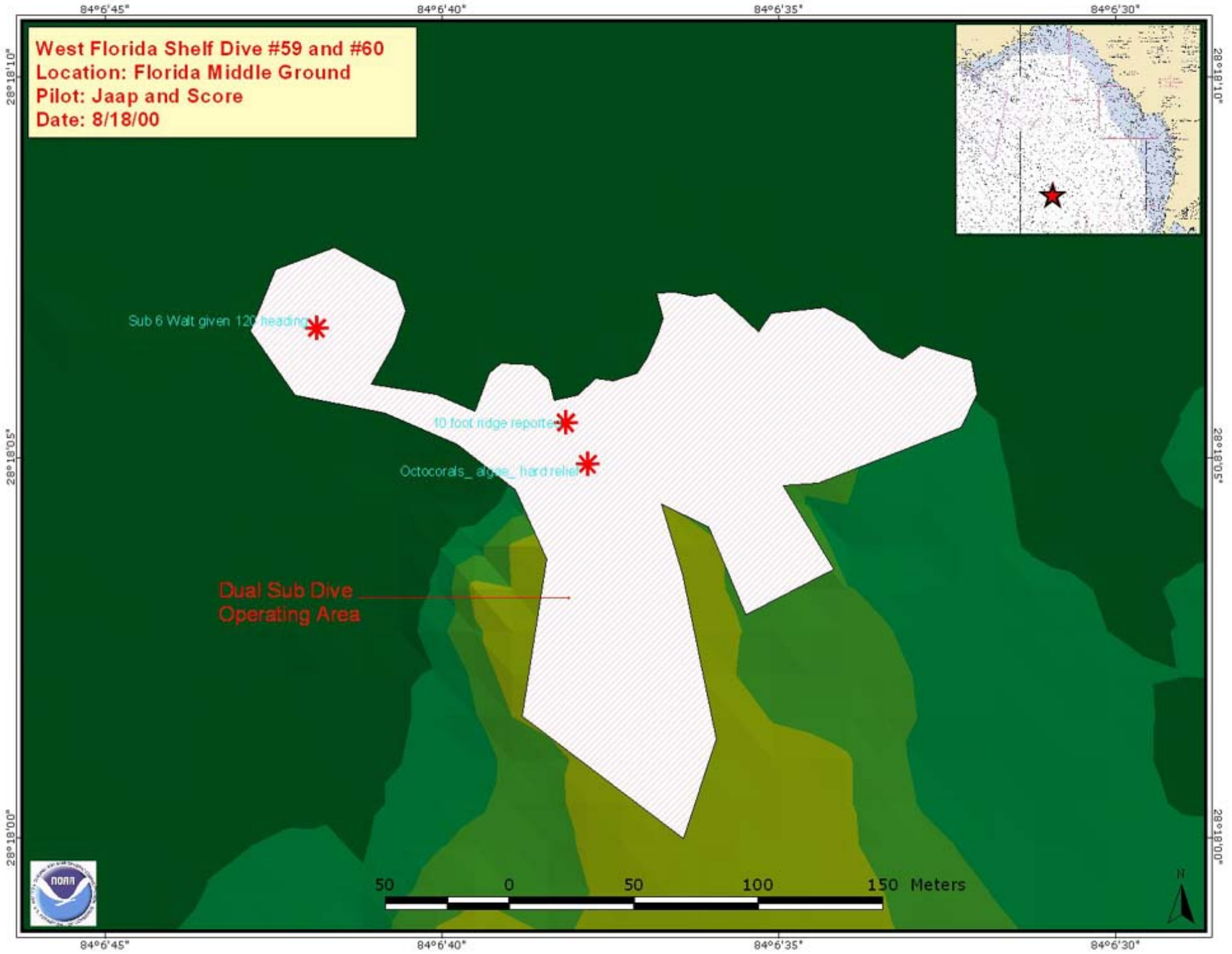

West Florida Shelf Dive #54
Location: Florida Middle Ground
Pilot: Evans
Date: 8/15/00
84°15'35"
84°15'30"
28°32'15"
Ledge
-33.0
Start dive
-35.5
End dive
Power test
-31.3
40
0
40
80
120 Meters
N

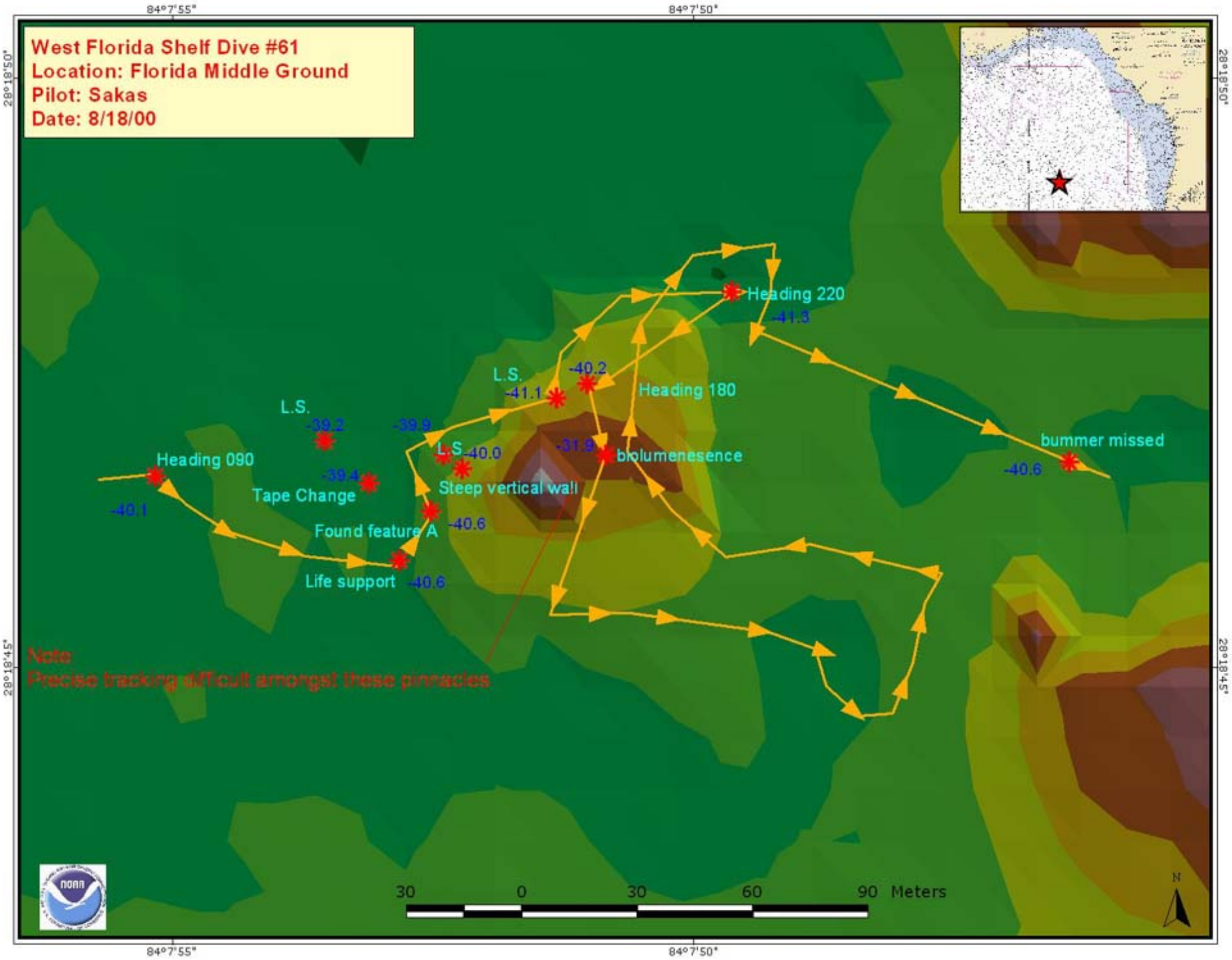

West Florida Shelf Dive #55
Location: West of Crystal River
Pilot: Score
Date: 8/16/00
83°19'28"
83°19'26"
83°19'24"
83°19'22"
28°43'28"
28°43'26"
28°43'24"
-18.9
Life Support
-18.4
Life Support
-18.7
Life Support
-18.3
Life Support
-18.2
New heading 060
30
0
30
60
90 Meters
N

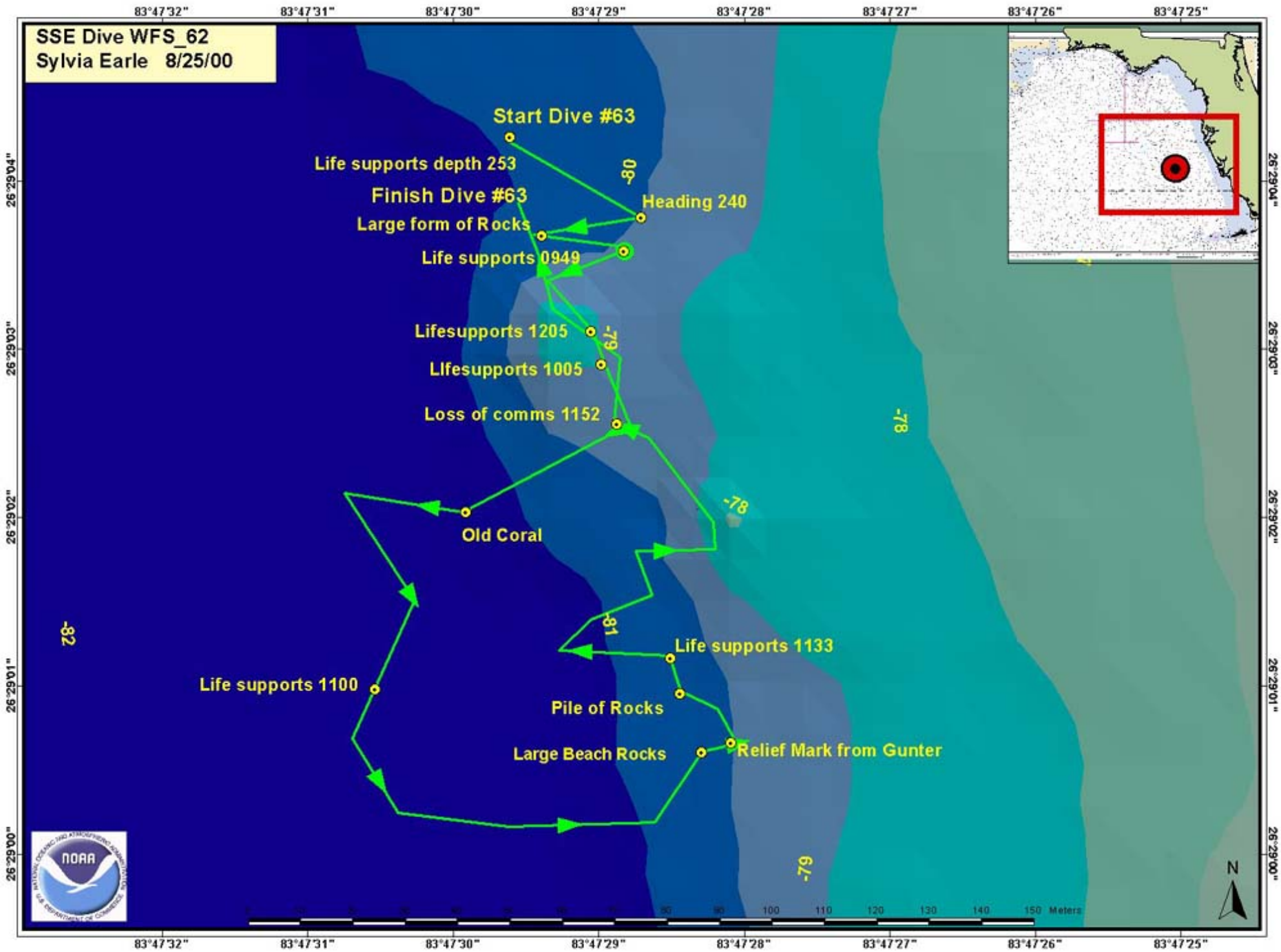

West Florida Shelf Dive #56
Location: West of Crystal River
Pilot: Sakas
Date: 8/16/00
83°19'30"
83°19'25"
83°19'20"
28°43'30"
28°43'25"
-18.7
Life Support
-1.5
End Dive
Reef
-16.5
-17.7
Life Support
-16.4
On bottom
-18.5
Life Support
Heading 350 slow
-18.5
60
0
60
120
180 Meters
N

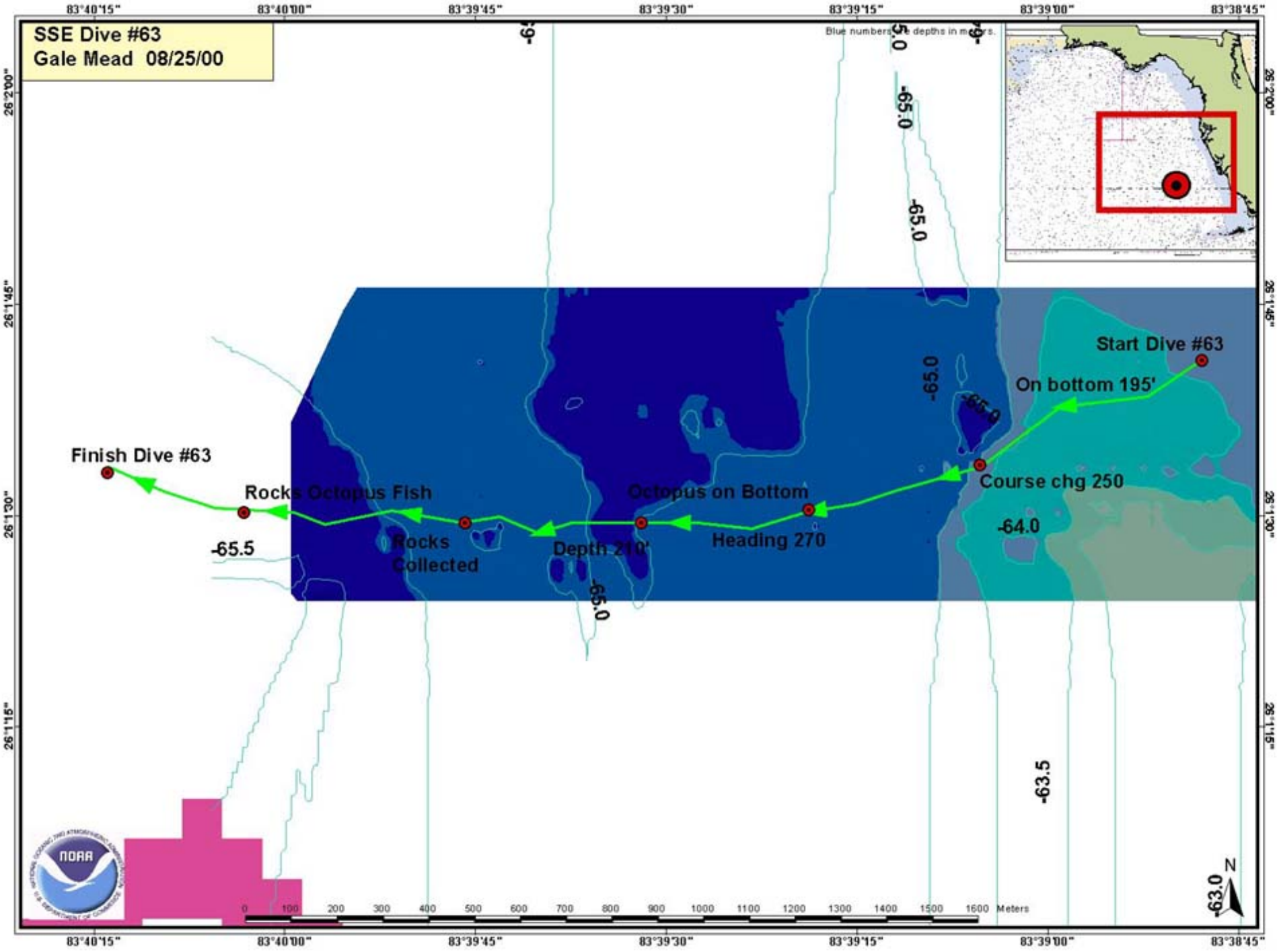

West Florida Shelf Dive #57
Location: West of Steinhatchee
Pilot: Japp
Date: 8/17/00
83°57'15"
83°57'10"
29°22'55"
29°22'50"
-19.2
Heading 180
-18.9
On bottom heading east
Hard bottom - octocorals
-19.4
High relief - octocorals
Life Support
-18.0
30 0 30 60 90 Meters
N

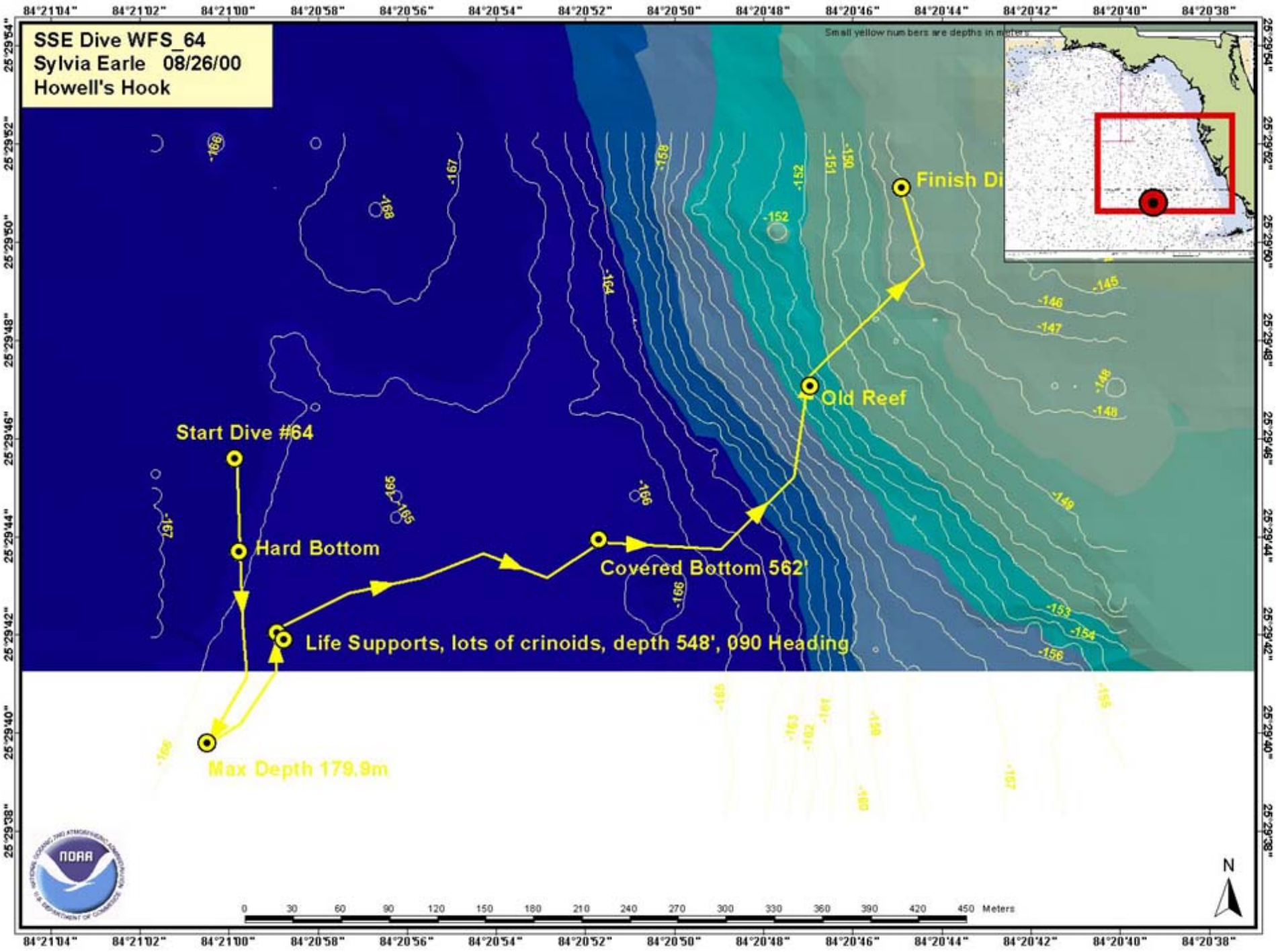

West Florida Shelf Dive #58
Location: Florida Middle Ground
Pilot: Evans
Date: 8/17/00
84°16'40"
84°16'35"
84°16'30"
84°16'25"
84°16'20"
84°16'15"
84°16'10"
84°16'05"
28°32'45"
28°32'40"
28°32'35"
28°32'30"
28°32'25"
28°32'20"
-25.6
Found a loggerhead sea turtle under the ledge
Life Support
End dive #58
-23.1
-30.7
Reversing course
-32.0
Life Support
-29.8
Life Support
-29.8
Strong current
-31.1
Life Support
-30.3
On the ledge
-36.9
Life Support
-25.1
Edge of reef
Skip Positive Tracking
-26.5
100
0
100
200
300 Meters
N

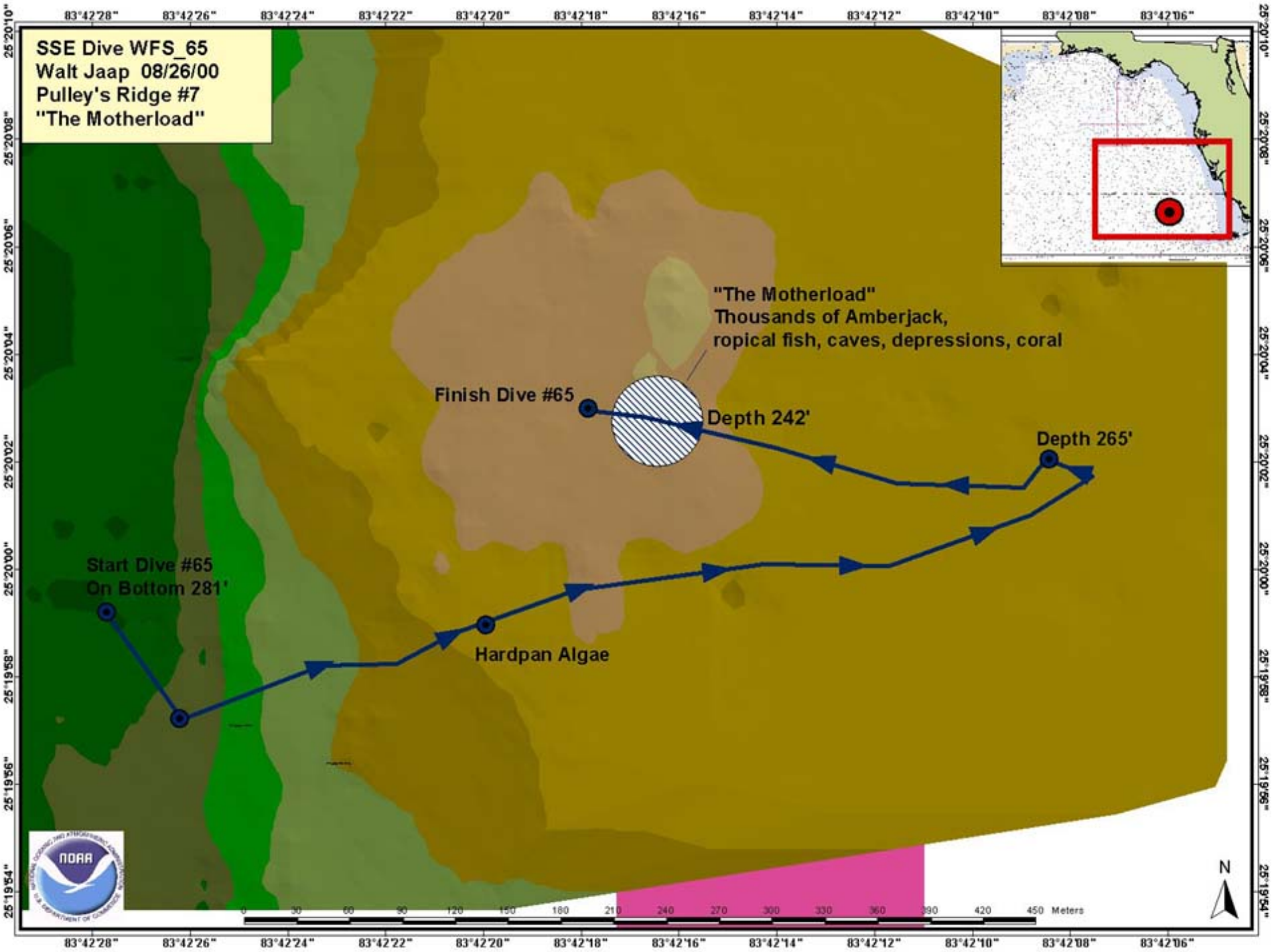

West Florida Shelf Dive #59 and #60
Location: Florida Middle Ground
Pilot: Jaap and Score
Date: 8/18/00
84°6'45"
84°6'40"
84°6'35"
84°6'30"
28°18'10"
28°18'05"
28°18'00"
Sub 6 Walt given 120 heading
10 foot ridge reported
Octocorals_ algae_ hard relief
Dual Sub Dive
Operating Area
50 0 50 100 150 Meters
N

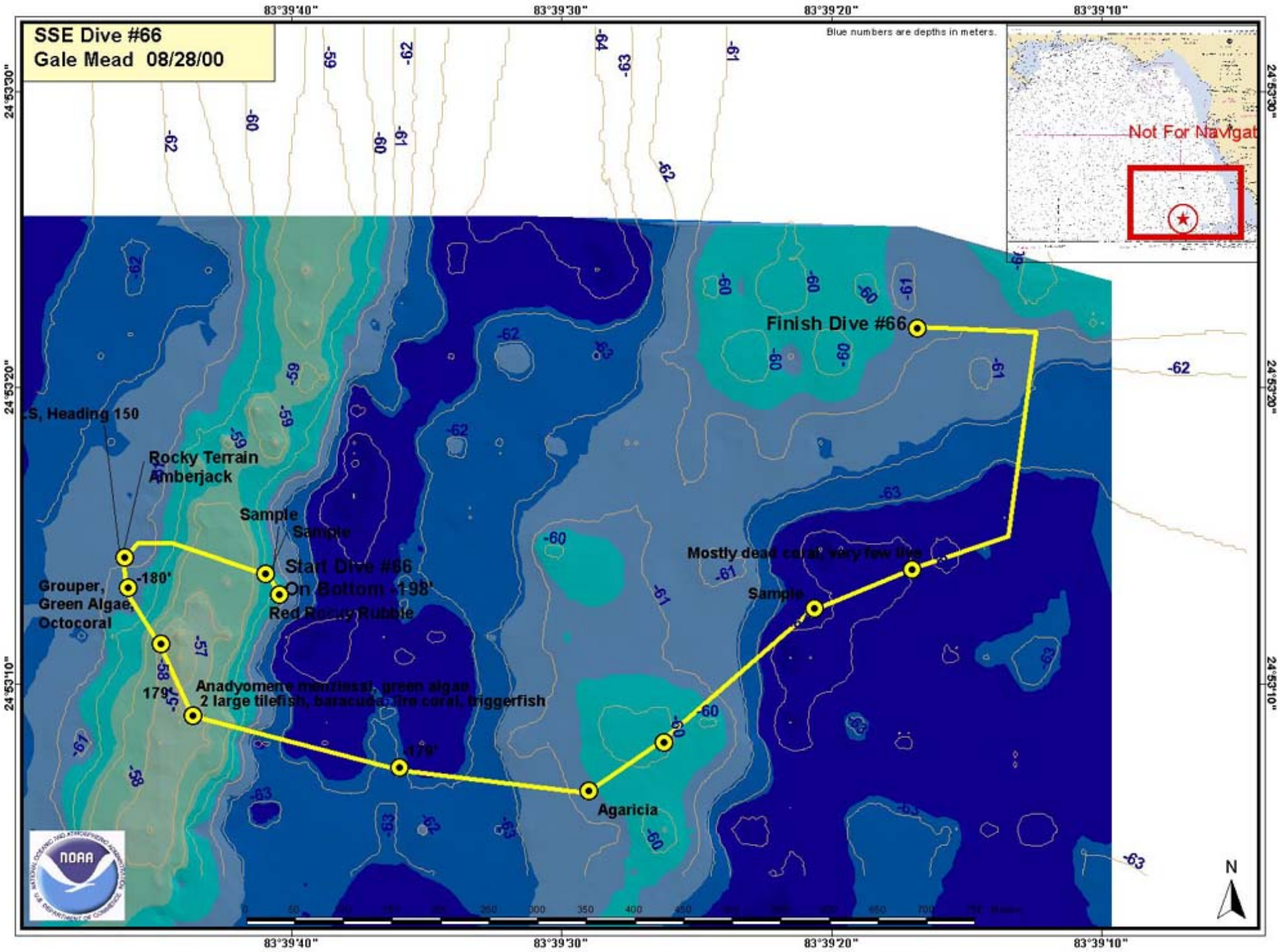

West Florida Shelf Dive #61
Location: Florida Middle Ground
Pilot: Sakas
Date: 8/18/00
84°7'55"
84°7'50"
28°18'50"
28°18'45"
Heading 220
-41.3
L.S.
-41.1
-40.2
Heading 180
L.S.
-39.2
-39.9
L.S.
-40.0
-31.9
biolumenesence
bummer missed
-40.6
Heading 090
-40.1
-39.4
Tape Change
Steep vertical wall
Found feature A
-40.6
Life support
-40.6
Note:
Precise tracking difficult amongst these pinnacles
30
0
30
60
90 Meters
N

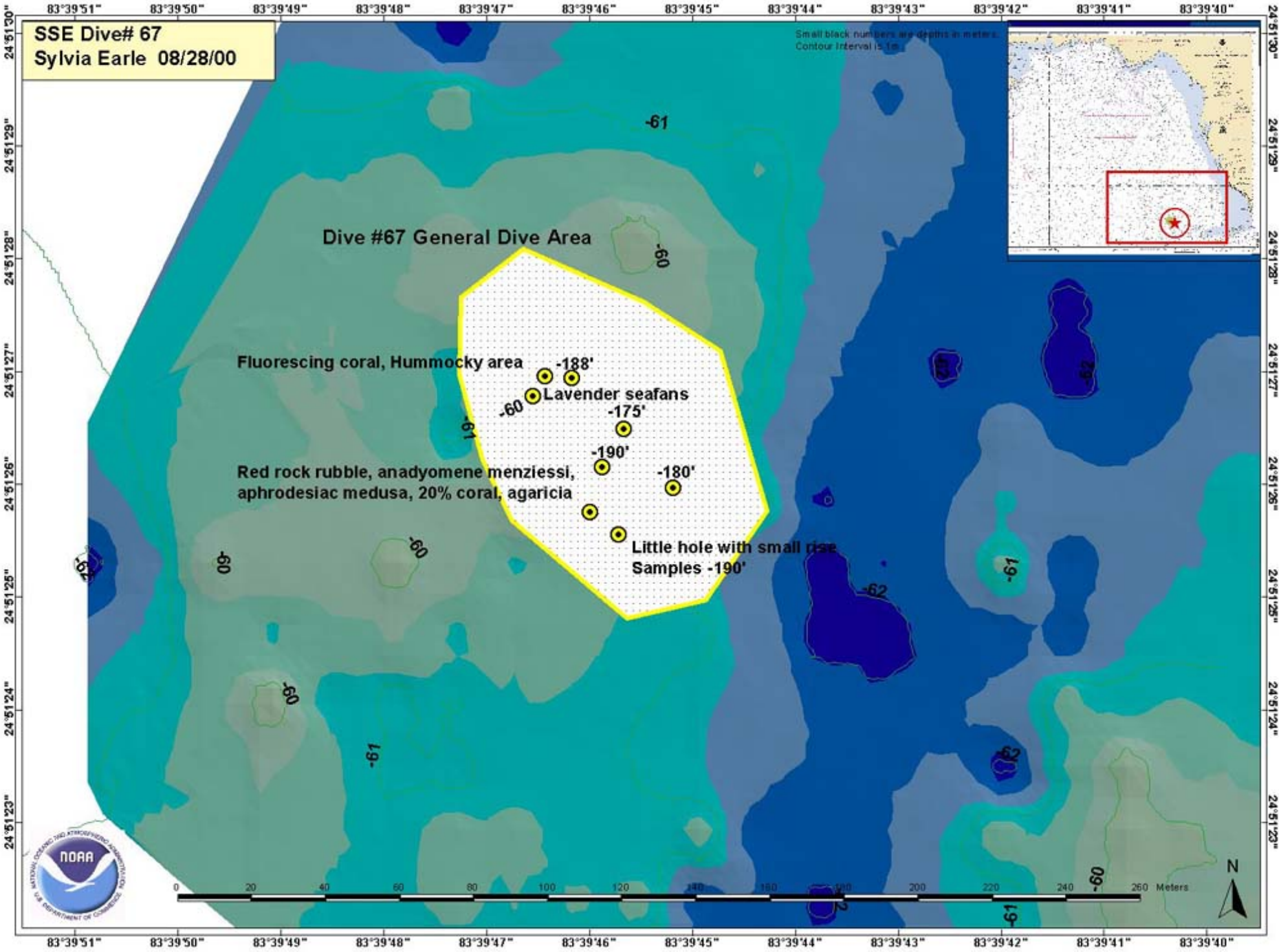

SSE Dive WFS_62
Sylvia Earle 8/25/00
Start Dive #63
Life supports depth 253
Finish Dive #63
Heading 240
Large form of Rocks
Life supports 0949
Lifesupports 1205
LIfesupports 1005
Loss of comms 1152
Old Coral
Life supports 1133
Life supports 1100
Pile of Rocks
Large Beach Rocks
Relief Mark from Gunter
-80
-79
-78
-81
-82
-77
83°47'32"
83°47'31"
83°47'30"
83°47'29"
83°47'28"
83°47'27"
83°47'26"
83°47'25"
26°29'04"
26°29'03"
26°29'02"
26°29'01"
26°29'00"
N
Meters

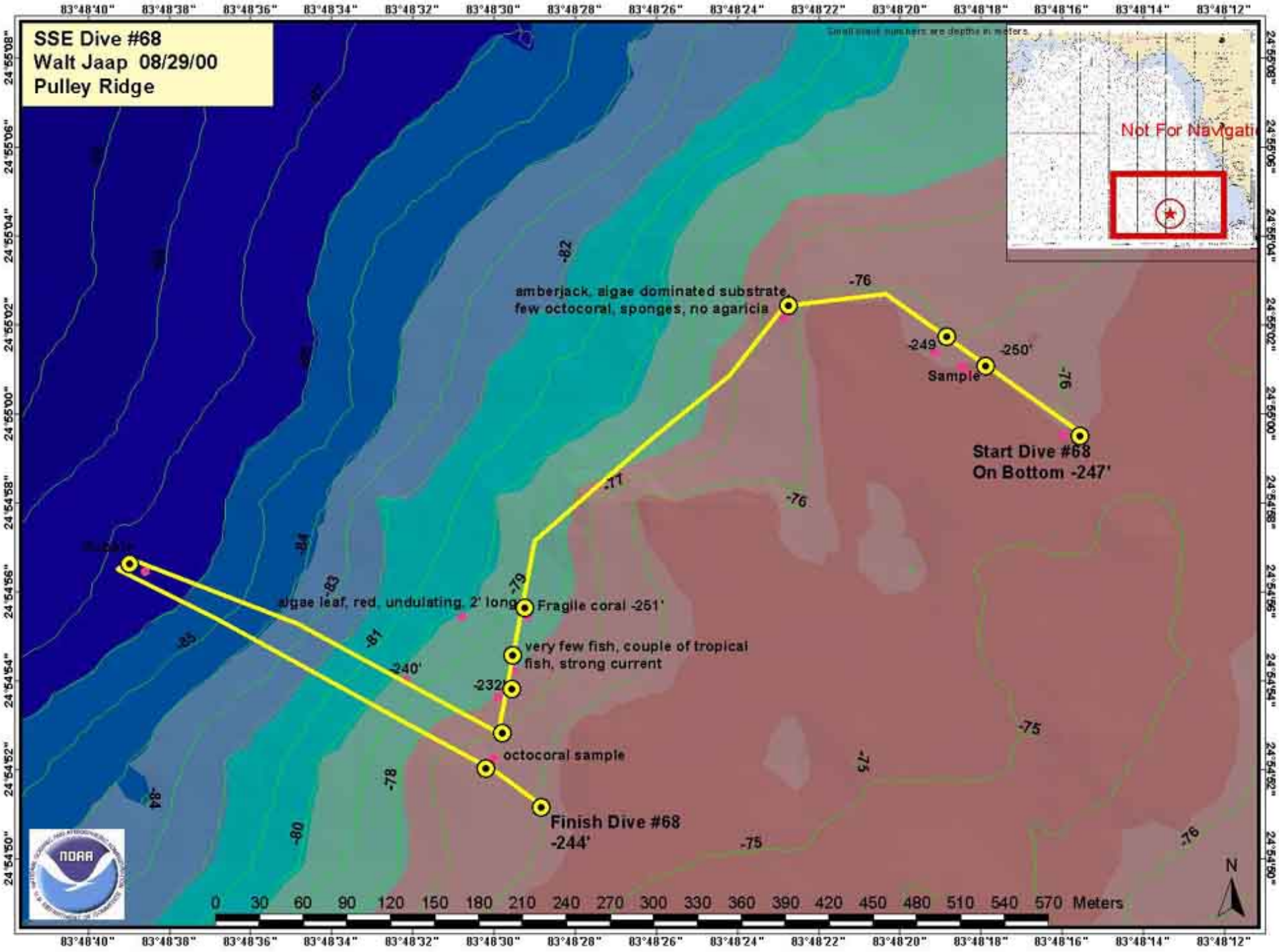

SSE Dive #63
Gale Mead 08/25/00
Blue numbers are depths in meters.
Start Dive #63
On bottom 195'
Course chg 250
Octopus on Bottom
Heading 270
Depth 210'
Rocks Collected
Rocks Octopus Fish
Finish Dive #63
-65.5
-64.0
-63.5
-63.0
-65.0
83°40'15"
83°40'00"
83°39'45"
83°39'30"
83°39'15"
83°39'00"
83°38'45"
26°2'00"
26°1'45"
26°1'30"
26°1'15"
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 Meters
N

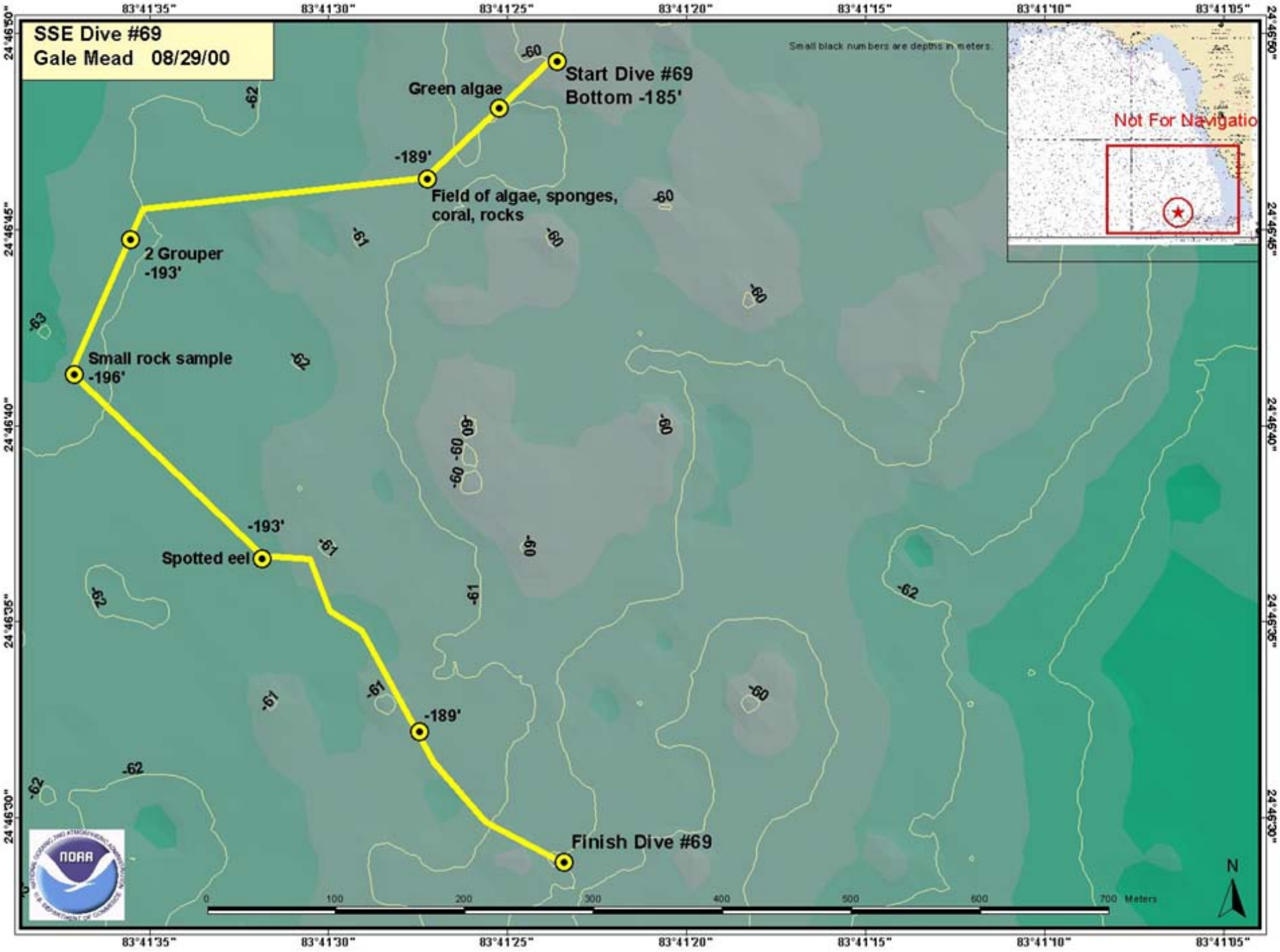

SSE Dive WFS_64
Sylvia Earle 08/26/00
Howell's Hook
Small yellow numbers are depths in meters
Finish Di
Old Reef
Start Dive #64
Hard Bottom
Covered Bottom 562'
Life Supports, lots of crinoids, depth 548', 090 Heading
Max Depth 179.9m
NOAA
N
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 Meters

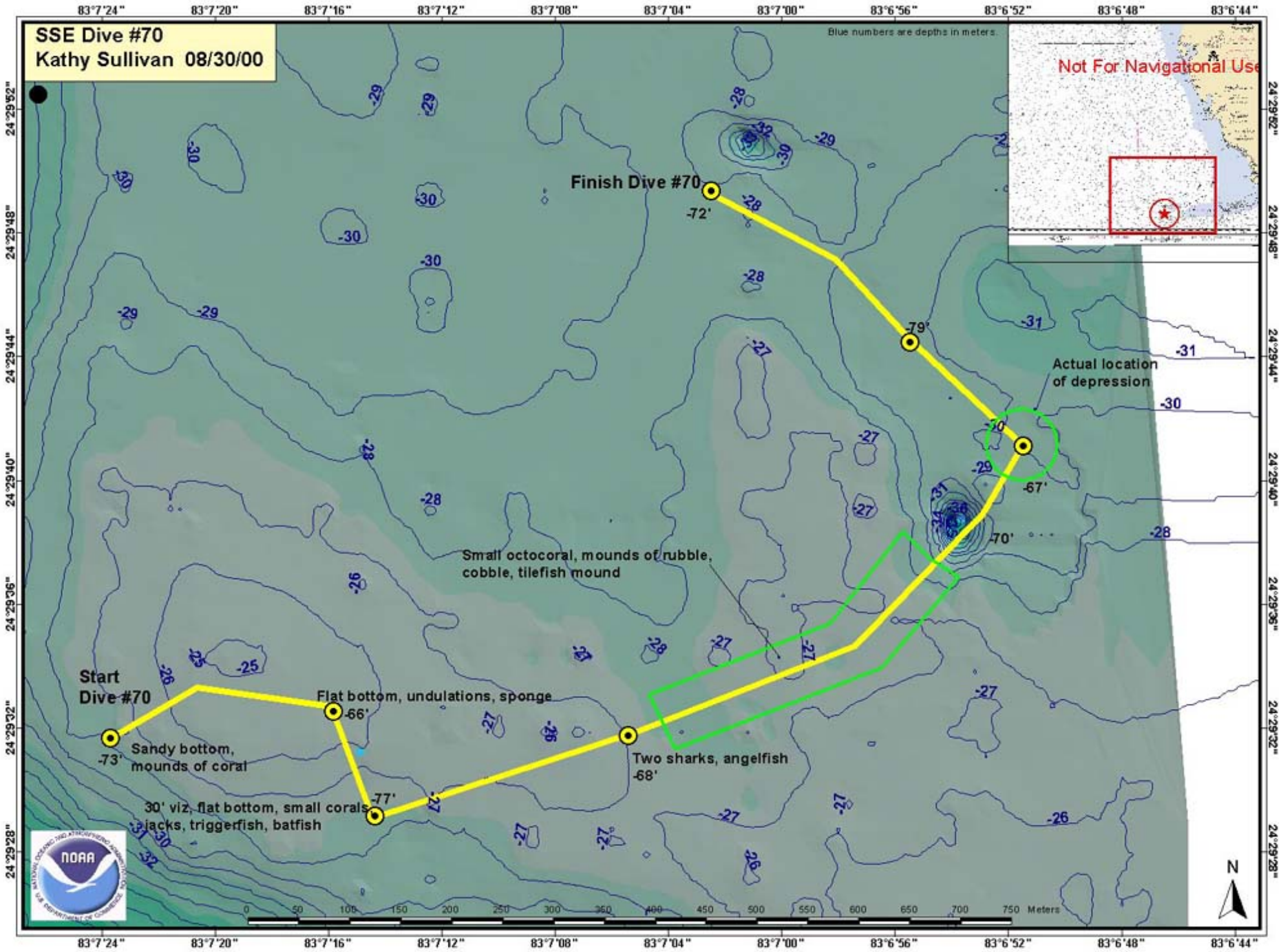

SSE Dive WFS_65
Walt Jaap 08/26/00
Pulley's Ridge #7
"The Motherload"
"The Motherload"
Thousands of Amberjack,
ropical fish, caves, depressions, coral
Finish Dive #65
Depth 242'
Depth 265'
Start Dive #65
On Bottom 281'
Hardpan Algae
NOAA
N
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 Meters
83°42'28" 83°42'26" 83°42'24" 83°42'22" 83°42'20" 83°42'18" 83°42'16" 83°42'14" 83°42'12" 83°42'10" 83°42'08" 83°42'06"
25°20'10" 25°20'08" 25°20'06" 25°20'04" 25°20'02" 25°20'00" 25°19'58" 25°19'56" 25°19'54"

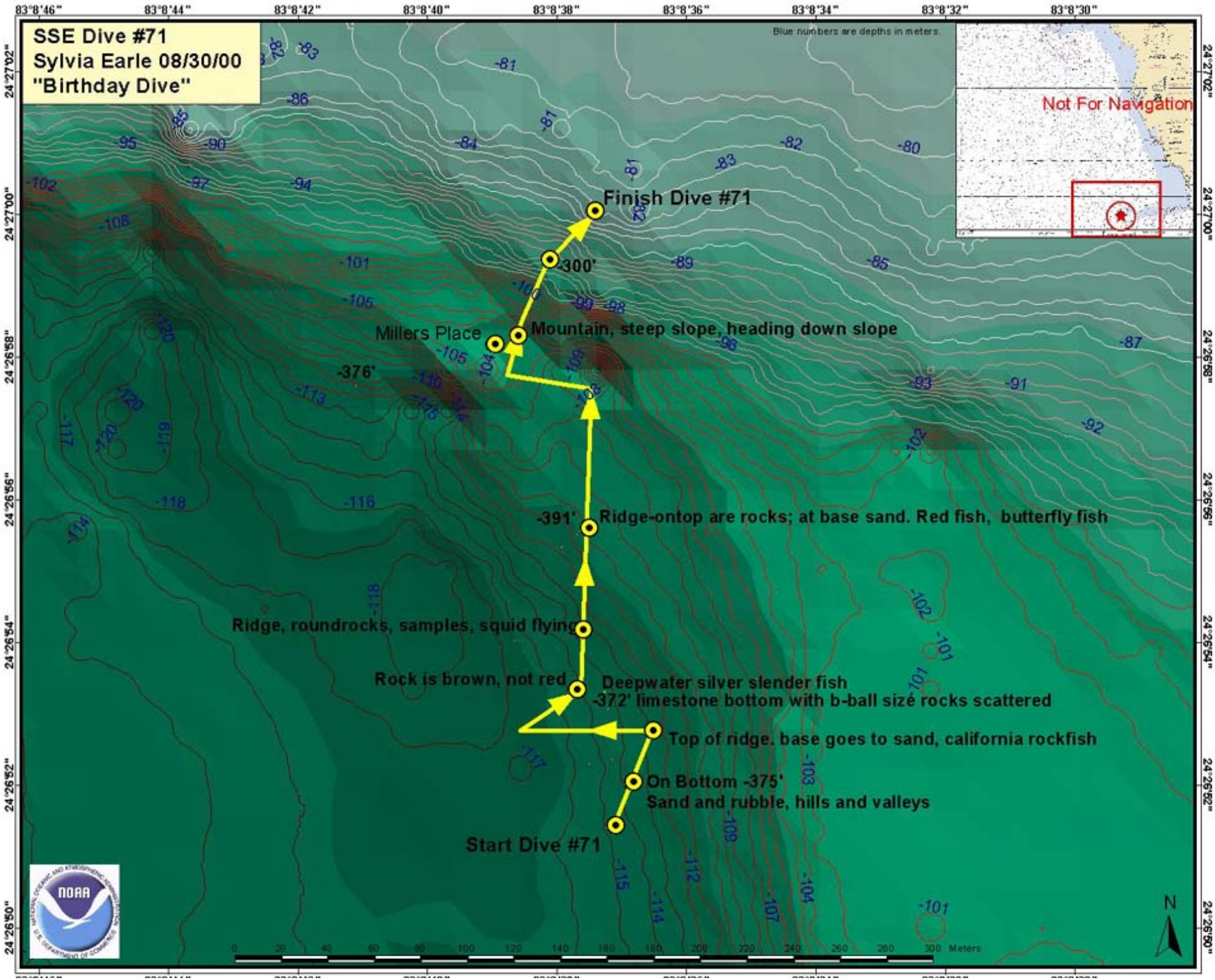

SSE Dive #66
Gale Mead 08/28/00
Blue numbers are depths in meters.
Not For Navigat
83°39'40"
83°39'30"
83°39'20"
83°39'10"
24°53'30"
24°53'20"
24°53'10"
Finish Dive #66
S, Heading 150
Rocky Terrain
Amberjack
Sample
Sample
Start Dive #66
On Bottom -198'
Red Rocky Rubble
-180'
Grouper,
Green Algae,
Octocoral
Mostly dead coral, very few live
Sample
Anadyomene menziessi, green algae
2 large tilefish, baracuda, fire coral, triggerfish
179'
-179'
Agaricia
N

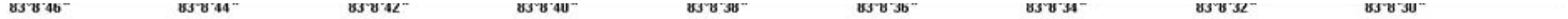

SSE Dive# 67
Sylvia Earle 08/28/00
Small black numbers are depths in meters.
Contour Interval is 1m
Dive #67 General Dive Area
Fluorescing coral, Hummocky area
-188'
Lavender seafans
-175'
-190'
-180'
Red rock rubble, anadyomene menziessi,
aphrodesiac medusa, 20% coral, agaricia
Little hole with small rise
Samples -190'
-61
-60
-62
NOAA
0 20 40 60 80 100 120 140 160 180 200 220 240 260 Meters
N

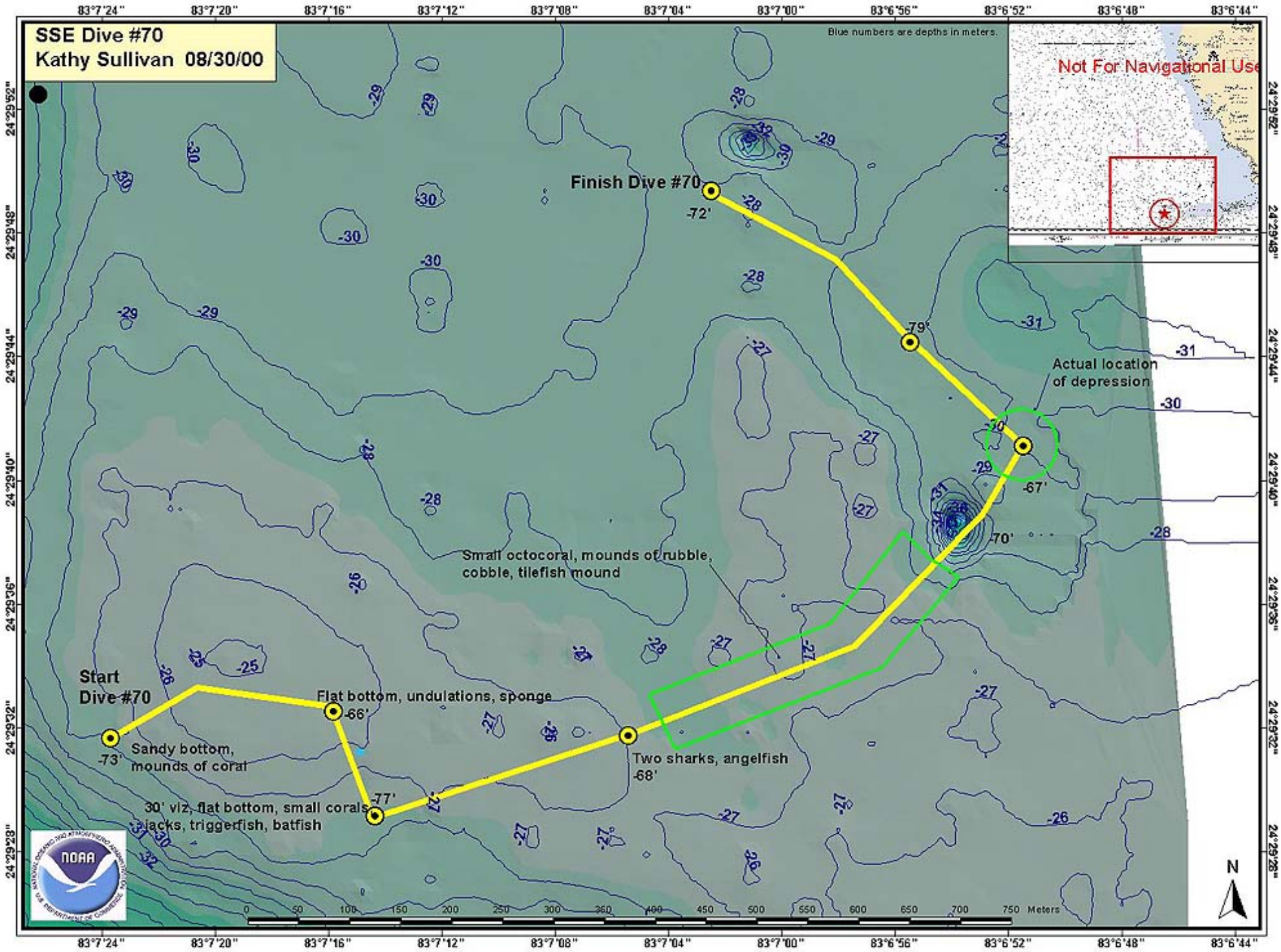

SSE Dive #68
Walt Jaap 08/29/00
Pulley Ridge
Small black numbers are depths in meters
Not For Navigati
amberjack, algae dominated substrate, few octocoral, sponges, no agaricia
-76
-249
-250'
Sample
Start Dive #68
On Bottom -247'
-82
-77
-76
-84
-83
-79
algae leaf, red, undulating, 2' long
Fragile coral -251'
very few fish, couple of tropical fish, strong current
-85
-81
-240'
-232
octocoral sample
-78
-75
-84
-80
Finish Dive #68
-244'
-75
-76
N
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 540 570 Meters
83°48'40" 83°48'38" 83°48'36" 83°48'34" 83°48'32" 83°48'30" 83°48'28" 83°48'26" 83°48'24" 83°48'22" 83°48'20" 83°48'18" 83°48'16" 83°48'14" 83°48'12"
24°55'08" 24°55'06" 24°55'04" 24°55'02" 24°55'00" 24°54'58" 24°54'56" 24°54'54" 24°54'52" 24°54'50"


SSE Dive #69
Gale Mead 08/29/00
Small black numbers are depths in meters
Start Dive #69
Bottom -185'
Green algae
-189'
Field of algae, sponges, coral, rocks
2 Grouper
-193'
Small rock sample
-196'
-193'
Spotted eel
-189'
Finish Dive #69
Not For Navigatio
N
0 100 200 300 400 500 600 700 Meters
83°41'35" 83°41'30" 83°41'25" 83°41'20" 83°41'15" 83°41'10" 83°41'05"
24°46'50" 24°46'45" 24°46'40" 24°46'35" 24°46'30"


SSE Dive #70
Kathy Sullivan 08/30/00
Blue numbers are depths in meters.
Not For Navigational Use
Finish Dive #70
-72'
-79'
Actual location
of depression
-67'
-70'
Small octocoral, mounds of rubble,
cobble, tilefish mound
Start
Dive #70
-73'
Sandy bottom,
mounds of coral
Flat bottom, undulations, sponge
-66'
-77'
30' viz, flat bottom, small corals,
jacks, triggerfish, batfish
Two sharks, angelfish
-68'
NOAA
N
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 Meters
83°7'24" 83°7'20" 83°7'16" 83°7'12" 83°7'08" 83°7'04" 83°7'00" 83°6'56" 83°6'52" 83°6'48" 83°6'44"
24°29'52" 24°29'48" 24°29'44" 24°29'40" 24°29'36" 24°29'32" 24°29'28"


SSE Dive #71
Sylvia Earle 08/30/00
"Birthday Dive"
Blue numbers are depths in meters.
Not For Navigation
Finish Dive #71
-300'
Millers Place
Mountain, steep slope, heading down slope
-376'
-391'
Ridge-ontop are rocks; at base sand. Red fish, butterfly fish
Ridge, roundrocks, samples, squid flying
Rock is brown, not red
Deepwater silver slender fish
-372' limestone bottom with b-ball size rocks scattered
Top of ridge. base goes to sand, california rockfish
On Bottom -375'
Sand and rubble, hills and valleys
Start Dive #71
NOAA
N
Meters


83°0'46"
83°0'44"
83°0'42"
83°0'40"
83°0'38"
83°0'36"
83°0'34"
83°0'32"
83°0'30"


SSE Dive #70
Kathy Sullivan 08/30/00
Blue numbers are depths in meters.
Not For Navigational Use
Finish Dive #70
-72'
-79'
Actual location of depression
-67'
-70'
Small octocoral, mounds of rubble, cobble, tilefish mound
Start Dive #70
-73'
Sandy bottom, mounds of coral
Flat bottom, undulations, sponge
-66'
-77'
30' viz, flat bottom, small corals, jacks, triggerfish, batfish
Two sharks, angelfish
-68'
NOAA
N
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 Meters
83°7'24" 83°7'20" 83°7'16" 83°7'12" 83°7'08" 83°7'04" 83°7'00" 83°6'56" 83°6'52" 83°6'48" 83°6'44"
24°29'52" 24°29'48" 24°29'44" 24°29'40" 24°29'36" 24°29'32" 24°29'28" 24°29'26"

Biographies

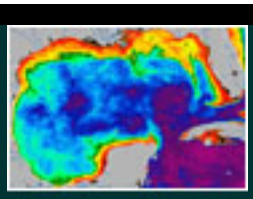
These biographies identify partners in the Sustainable Seas Expeditions' mission to the West Florida Shelf. They are listed alphabetically.

Sylvia Earle

Sylvia Earle, Explorer-in-Residence
National Geographic Society

Marine biologist Sylvia Earle is an Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion --the oceans -- and is the project director of the Sustainable Seas Expeditions. Her research places special emphasis on marine plants and developing technology to access and conduct research in the deep sea. Named one of *Time Magazine's* "Heroes for the Planet" in 1998, Dr. Earle pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She also holds numerous diving records. In the 1980s, Dr. Earle founded her own company, Deep Ocean Exploration and Research Inc., and cofounded Deep Ocean Engineering Inc. She is also a former chief scientist of the National Oceanic and Atmospheric Administration. She has authored more than 100 scientific and popular publications, including the 1995 book, *Sea Change*, and three 1999 books related to the SSE: *Wild Ocean: America's Parks Under the Sea, Dive* and a children's book, *Hello Fish*. As the spokesperson for SeaWeb, a conservation initiative of the Pew Charitable Trusts, she strives to increase public awareness of the pressures facing the world's coastal and oceanic realms. In early 1999, she played a key role in the Clinton administration's decision to double the budget of NOAA's national marine sanctuaries. She holds a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as well as nine honorary doctoral degrees.

Kip F. Evans, Expedition Photographer
Sustainable Seas Expeditions



BIOGRAPHIES

WEATHER

Kip Evans

As the official photographer for the Sustainable Seas Expeditions, Kip Evans captures the visual splendor of scientific discovery, exploration and outreach. For 10 years, he has worked as both a still photographer and an underwater cinematographer. Since 1985, he has logged over 1,000 hours underwater documenting marine life, performing research and participating in search-and-recovery operations. Mr. Evans has worked on a variety of documentaries, including a recent special on the life of Dr. Sylvia Earle, *Her Deepness*, for CNN, and a Discovery Channel news story on the declining squid fishery off the California coast. His photographs have appeared in Rodale's *Scuba Diving, Dive Training, Coast & Ocean* and *Aqua* magazines, and on the front covers of such newspapers as *USA Today*, the *San Francisco Examiner, San Diego Tribune*, and *Santa Cruz Sentinel*. His clients include NOAA's National Marine Sanctuary Program, the National Geographic Society, Oceanic Diving Equipment, and the UnderWater World Aquarium in San Francisco. He holds a bachelor's degree in environmental studies emphasizing marine biology from the University of California at Santa Barbara.

Michael Faught

Michael Faught, Ph.D., Director
Florida State University Underwater Archaeology Field School

Dr. Michael Faught is an Assistant Professor of Anthropology at Florida State University (FSU) and Director of the FSU Underwater Archaeology Field School. An underwater archaeologist, whose specialty is submerged prehistoric sites, his research interests include geoarchaeology, chipped stone analysis, public archaeology, cultural resource management, and shipwreck archaeology. For his dissertation research, Dr. Faught located several submerged prehistoric sites at nearby Apalachee Bay, FL. In addition to his pioneering work on offshore prehistoric sites, he has directed several terrestrial archaeological projects, the Bay County Shipwreck Survey, and was consultant to the Santa Fe River Survey. Dr. Faught is also Courtesy Assistant Curator at the Florida Museum of Natural History.

Bret D. Jarrett, Ph.D. candidate
University of South Florida, College of Marine Science

Mr. Jarrett is currently a PhD candidate at the University of South

Bret Jarrett

Florida, College of Marine Science working under the direction of Dr. A.C. Hine. His dissertation is focused on interpreting the late Quaternary (~125 ka-present) stratigraphic evolution of the south Florida carbonate platform using remote sensing techniques such as seismic reflection, side-scan sonar and multibeam sonar. In addition, ROV analyses have been utilized on the western portion of the south Florida reef tract to determine the western extent of modern and relict reef growth as well as to document modern benthic communities and understand controls on their variability in this region. Mr. Jarrett received his undergraduate degree in Geology from Florida State University in 1992. In 1995, he earned a Master's degree in Oceanography from UNC Chapel Hill (under Dr. A.C. Neumann). There, Mr. Jarrett analyzed rock cores from the Northern Great Bahama Bank to determine the stratigraphy and diagenetic history of shallow-water reef and dune sediments deposited during the last interglacial and Holocene time periods. His areas of specialization include carbonate petrography, carbonate diagenesis, quaternary carbonate sedimentology and interpretation of high-resolution seismic reflection data. He will join the SSE team on the West Florida Shelf to continue his research and share his expertise with the science team.

John Ogden

John Ogden, Ph.D., Director
Florida Institute of Oceanography

John Ogden is a Professor of Biology at the University of South Florida and Director of the Florida Institute of Oceanography (FIO). His years of studying coral reef and seagrass ecosystems and watching their steady decline, convinced him that ecological studies aimed at resources management must encompass the geographic and time scales of ocean processes. With numerous colleagues, he initiated several long-term, large geographic scale ecological studies in Florida and the Caribbean. These were directed at understanding natural variation in coastal marine ecosystems, upon which global climate change and human impacts are superimposed. Dr. Ogden has published over 70 scientific papers, contributed to numerous books, and produced several television films on tropical marine ecosystems. He has served as the Secretary of Commerce appointee for science to the Advisory Council of the Florida Keys National Marine Sanctuary and as an advisor to the U.S. Environmental Protection Agency on coastal ecosystem management. He is a past President of the International Society for Reef Studies, an advisor to the Fellows

Program of Pew Charitable Trusts, and member of the Board of the World Wildlife Fund. Currently Dr. Ogden is involved in science-driven conservation of tropical and sub-tropical marine biodiversity with NOAA, NSF, the Department of State, The World Bank, UNESCO, and numerous non-governmental conservation organizations and private foundations.

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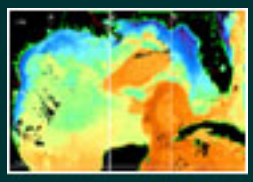
OVERVIEW

REEF HABITATS

PULLEY RIDGE

ARCHEOLOGY AT SEA

GROUPER

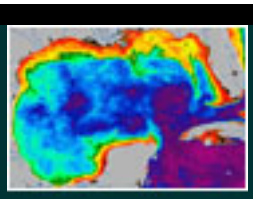
MAPS

Weather

The **National Data Buoy Center**, a part of the NOAA National Weather Service, develops, operates, and maintains a network of buoy and Coastal-Marine Automated Network (C-MAN) stations. These stations provide hourly observations of wind speed, direction, and gust; barometric pressure; and air temperature. In addition, all buoy stations, and some C-MAN stations, measure sea surface temperature and wave heights and periods. Local forecasts for these stations are also available. Links to the buoys for the West Florida Shelf mission are provided below.

Three stations have been selected to provide weather data for this mission.

Click on the appropriate link below to observe near real-time weather information for the selected station.



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Buoy 42036: **Near the Florida Middle Grounds**	Buoy 42003: **Southwest of the Florida Middle Grounds**	C-MAN DRYF1: **Near the Dry Tortugas**

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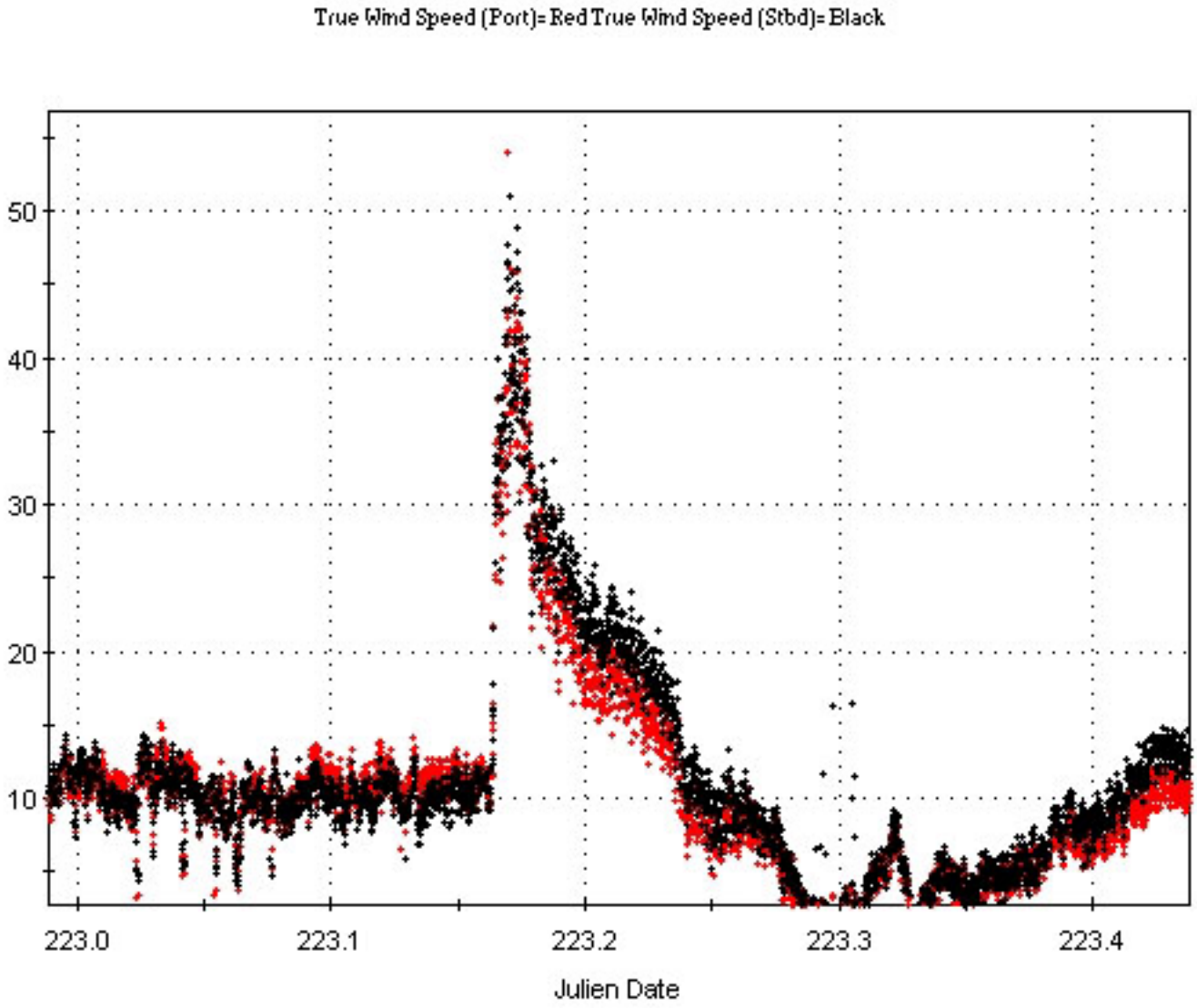
True Wind Speed (Port)= Red True Wind Speed (Stbd)= Black
50
40
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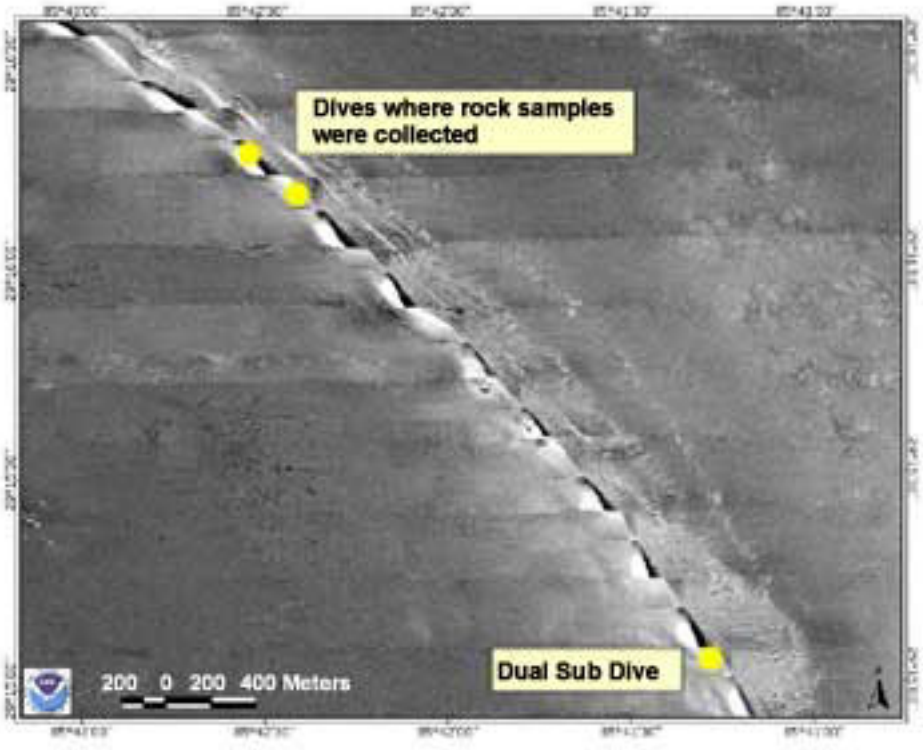
20
10
223.0
223.1
223.2
223.3
223.4
Julien Date


Dives where rock samples were collected
Dual Sub Dive
200 0 200 400 Meters

SUSTAINABLE SEAS EXPEDITIONS

MISSION LOG

GRAY'S REEF

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EXPEDITION UPDATE

July 26 - August 6, 1999

The Gray's Reef National Marine Sanctuary Expedition is underway. July 26 and July 27 were devoted to checkout dives for the scientists.

Wednesday, July 28, we had a very successful satellite uplink during Alex Score's dive, and Bruce Cowden completed a dive in search of fossils.

Thursday, July 29, Bruce had another dive where he was able to do some successful fossil survey work. Thursday night, during Laddie Akin's after-dark dive, he observed Sea Bass eagerly feasting under DeepWorker's lights.

Friday, July 30, saw more dives, both day and night. Be sure to read the report Cathy Sakas filed describing a most spectacular night dive Friday night, including a VERY close encounter with a hammerhead shark!

Saturday, July 31, was spent preparing for the Ocean Fest open house events on the riverfront.

Sunday, August 1, Savannah pulls out the stops to celebrate the Sustainable Seas Expedition. The city holds an OceanFest to showcase the exploration of Gray's Reef. The heat is sweltering but doesn't dissuade record crowds from celebrating SSE.

Monday, August 2, National Geographic's Kip Evans and Gale Mead completed a two-sub dive in the afternoon, but a violent thunderstorm prevented Sylvia Earle's scheduled night dive from taking place. Tuesday is seeing 20-plus knot

LOG

July 26, 1999

July 27, 1999

July 28, 1999

July 29, 1999

July 30, 1999

August 1, 1999

August 2, 1999

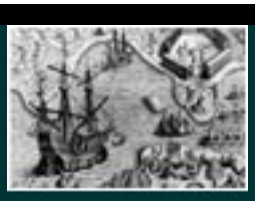
August 3-4, 1999

August 5, 1999

August 6, 1999

August 9, 1999

Summary of Education



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winds, and we're hoping to at least complete some ROV operations while waiting for the weather to improve.

Tuesday, August 3, we had hoped to dive a deep reef 60 miles offshore, but our glassy calm weather conditions did not hold, and the wind and seas were too rough to dive.

Wednesday, August 4, weather conditions were still not ideal, but Tom Potts was eventually able to complete a stunning four-hour twilight-to-night dive.

Thursday, August 5, we had overcast weather, but calm enough for us to complete two terrific dives at a deep reef site 70 miles offshore. Laddie Akins and Tom Potts each took the sub to about 200 feet in beautiful, clear blue water, and will be providing their dive reports shortly.

Friday, August 6, Alex Score took the sub down onto what we've tentatively dubbed "Larry's Ledge," a location midway between Gray's Reef and the deep reef site we dove Thursday. This was the last dive of this expedition. Tune in next week for the Florida Keys mission.

Gale Mead, Expedition Log Editor

Summary of Investigations

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Interview

Interview with Reed Bohne, Manager
Gray's Reef National Marine Sanctuary
July 1999

What does the Sustainable Seas Expedition offer Gray's Reef?

Click here for audio response. (RealAudio), for help see About this Site


Reed Bohne

The Sustainable Seas Expedition is a gift -an extraordinary vision realized by Sylvia Earle's commitment to ocean conservation and her enthusiasm for marine exploration. We will launch our expedition coincident with the 30-year anniversary of the first lunar landing and the 300th anniversary of John Bartram, America's Royal Botanist, who, with his son, William, explored the natural history of Georgia's colonial coastline. In many ways, the expedition to Gray's Reef will also be a journey back in time. The DeepWorker submersible (which, years from now, will also be considered rudimentary technology) will allow us to observe an undersea wilderness environment little changed from colonial times. The expedition clearly gives us a sense of time and place along that continuum of exploration. There is a passage from Rachel Carson's book, "Edge of the Sea", that captures the spirit of this wonderful opportunity that the expedition presents. She wrote, "On all these shores there are echoes of past and future: of the flow of time, obliterating yet containing all that has gone before; of the sea's eternal rhythms--the tides, the beat of surf, the pressing rivers of the currents--shaping, changing, dominating; of the stream of life,

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flowing as inexorably as any ocean current, from the past to an unknown future."

(top)

How will the DeepWorker submersible technology change your views of the sanctuary?

Click here for audio response.

The DeepWorker is, foremost, an observatory. The pilots can observe the reef environment for hours on end. The technology gets us there and guides us underwater, but the pilots must still rely on their own experience and knowledge to understand where they are going and what is before them. There are some parallels here to William Bartram's exploration of the Georgia coast in 1776. At one point, he and a surveyor were inland attempting to determine the course back to the Savannah River. Bartram reports in his book, "Travels", that an Indian chief arrived, and observing the course that the surveyor had fixed for them, said that it was not right, that the river lay in a different direction. The surveyor replied that he himself was certainly right, adding that the little instrument, his compass, told him so, and it could not err. The Indian answered that he knew better, that the "wicked little instrument was a liar," and that he did not agree with its decision. Bartram reported that since it was prudent to be complacent with the chief, the compass was discarded. The chief then "headed the party conducted us on a straight line to the desired place." We, too, will rely on all the "wicked little instruments" in the submersible to guide our course and ensure our safety, but like the Bartram party, we may find at times that the wise course is also suggested by our own knowledge and understanding of the reef terrain.

(top)

How will you use of the DeepWorker to explore the past?

Click here for audio response.

In many ways, I view the DeepWorker submersible as a cousin to H.G. Wells' time machine. We will explore Gray's Reef, which was formed during the Pliocene geologic epoch, some two to five million years ago. We will also dive on a deeper reef 60 miles offshore called Sapelo Scarp, which consists of rock outcroppings from the

Miocene epoch. The fascinating thing about these two reef systems is that during a last major glacial period, the sea level dropped sufficiently to expose both areas. Perhaps 20,000 years ago, Sapelo Scarp was the shoreline and Gray's Reef was 40 miles inland. As the planet warmed and the glaciers retreated, the sea level rose and Gray's Reef eventually became the coastline, perhaps some 8,000 years ago.

Part of our quest during the Sustainable Seas Expedition is to continue to characterize the terrestrial environment of the Gray's Reef of 20,000 to 8,000 years ago by hunting for fossil bones of the large animals such as the mastodon, mammoth, and saber-toothed tiger, which roamed the area at that time. We have recovered many fossils of that era at the reef and have taken core samples of the sediment, which reveal a cold-climate, forested Gray's Reef area containing the pollen and seed of alder, spruce and birch. This view of Gray's Reef--as an ancient place populated with Paleo-Indians and large, long extinct Pleistocene mammals--adds incredible richness to the value and appreciation of this amazing reef habitat. It also is a call for us to redouble our efforts to conserve the viability and health of the reef today. As the author O.H. Frankel once observed, "We are not the equivalent of an ice age or a rise in sea level: we are capable of prediction and control. We have acquired evolutionary responsibility."

(top)

How will the Sustainable Seas Expedition contribute to conservation off the Georgia coast?

Click here for audio response.

We have subtitled our expedition "Rivers to Reefs." Our approach is not only to explore the reef today and its ancient past, but also to tie this lone protected area off the coast of Georgia to its companion estuarine and terrestrial parks, refuges and reserves that safeguard Georgia's barrier islands and marshes. Sustainable Seas will take us to these destinations, such as the Sapelo Island National Estuarine Research Reserve, and the Nature Conservancy's Altamaha Bioreserve, which the Conservancy calls "one of the last great places on Earth." Through our radio and video expeditions to these areas, we will tie the biological and physical elements of these environments together in an ecological continuum of rivers to reefs. Additionally, in October we will begin a two-year process to revise the Gray's Reef management plan. It is an elaborate effort akin to designating the sanctuary anew. The Sustainable Seas Expedition is our first visible step in that effort. This will be an

important phase in the future conservation of reef habitat off Georgia.

(top) **RETURN**

Natural Setting: The Dazzling Colors of Gray's Reef National Marine Sanctuary

Cathy Sakas, Marine Educator
Gray's Reef National Marine Sanctuary

The beautifully wild curved coastline of Georgia is a vibrant place brimming with a life force that has sustained it from ancient times on through to the threshold of a new millenium. The priceless natural features and resources that comprise the whole of our coast are sculpted by the forces of nature and influenced by the flux of the sea and the "freshets" of land born rivers. The sea-green turbid waters of our estuaries are laden with rich nutrients and island building sediments. They are a mixture of salt from the immense Atlantic that mingles with the dark tannin freshwater of the rivers that flow into it. It is a glorious coastline of 13 major barrier islands providing a natural palette of green subtropical forests, sugar fine cream colored beaches, bright white sand dunes and an endless span of green and gold marshes.

Running through it are the dark veins and arteries of the black fresh water rivers that feed it from the land and the saltwater rivers born of the ocean spreading through the marshes like roots branching from a tree trunk. Off shore the desert like expanse of the ocean floor gives way to the colorful oases of live bottom reefs. These luxuriant gardens in the sea are a place where fish and other marine animals from the warm waters of the

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tropics meet and commingle with those from the cooler waters of the mideastern seaboard. Here Loggerhead Sea Turtles find a place to rest and food to eat and right whales birth their calves. Here is where life is at the mercy of the sea yet influenced by the rivers that flow from the land. Here is Gray's Reef National Marine Sanctuary.

Heavy materials from the mountains are transported through the Plateau and Piedmont by the streams, creeks and rivers of the water transport system. These materials, coupled with the tremendous amounts of nutrients in the water, reduce visibility at Gray's Reef, especially during periods of heavy rain.

Gray's Reef National Marine Sanctuary is located 20 miles from the wide beaches of Sapelo Island near the middle of Georgia's coast. It encompasses 17 square miles of rippling sand and garden-like oases of live bottom. The live bottoms as they are called locally are areas of limestone outcroppings with overhanging ledges that are encrusted with myriad invertebrates. The attached invertebrates range from wispy soft corals to low profile finger-like hard corals, from shapely vase-like sponges to colorful clusters of sea squirts, and from curvaceous tube worms to feathery hydroid colonies. Among the many mobile invertebrates are lanky brittle stars, ponderous sea cucumbers, curiously configured crabs, sinuous worms, plodding snails, and agile octopus. These invertebrates in turn provide habitat and food to an amazing array of vertebrates most of which are fish. The fish range in size from tiny gobies to huge sharks and rays. With adornments of spots, bars, stripes, bands, speckles and monochromatic color schemes these fish complete the food pyramid of this incredibly productive site. The flora and fauna of Gray's Reef are a blend of tropical and temperate water species. During the summer months the water temperatures are within the tropical range, but during the winter months the water temperatures fall below the lethal thermal minimums for most tropical fish.

Gray's Reef is also a haven for sea turtles. On trips to the reef, turtles, mostly loggerheads and occasionally leatherbacks, greens and Kemp's ridleys, can often be seen surfacing for a breath and perhaps a quick peek at new boat arrivals. While diving, researchers frequently encounter loggerheads resting under the overhanging

Shifting sands and a lack of firm substrate preclude most sessile forms from settling along slopes and in sandy areas of the reef. Burrowing clams, mobile snails, sea stars, and burrowing polycheate worms are better adapted to life in these loose sediments.

ledges. Depending on the water's temperature loggerheads can stay submerged for a half hour to several days. The warmer the water, the higher their metabolic rate, and the more frequently they must surface to breathe. Turtles find food among the slower moving fish and macro-planktonic jellyfish as well as from any of the bottom dwelling mollusks. As youngsters however they may become food themselves for larger fish and pelagic birds as they leave the safety of their beach-bound nests swimming nonstop out to sea, past the reefs to havens in the flotsam and jetsam of the Gulf Stream. As juveniles they return to the estuaries and eventually the reefs of Georgia, in particular Gray's Reef.

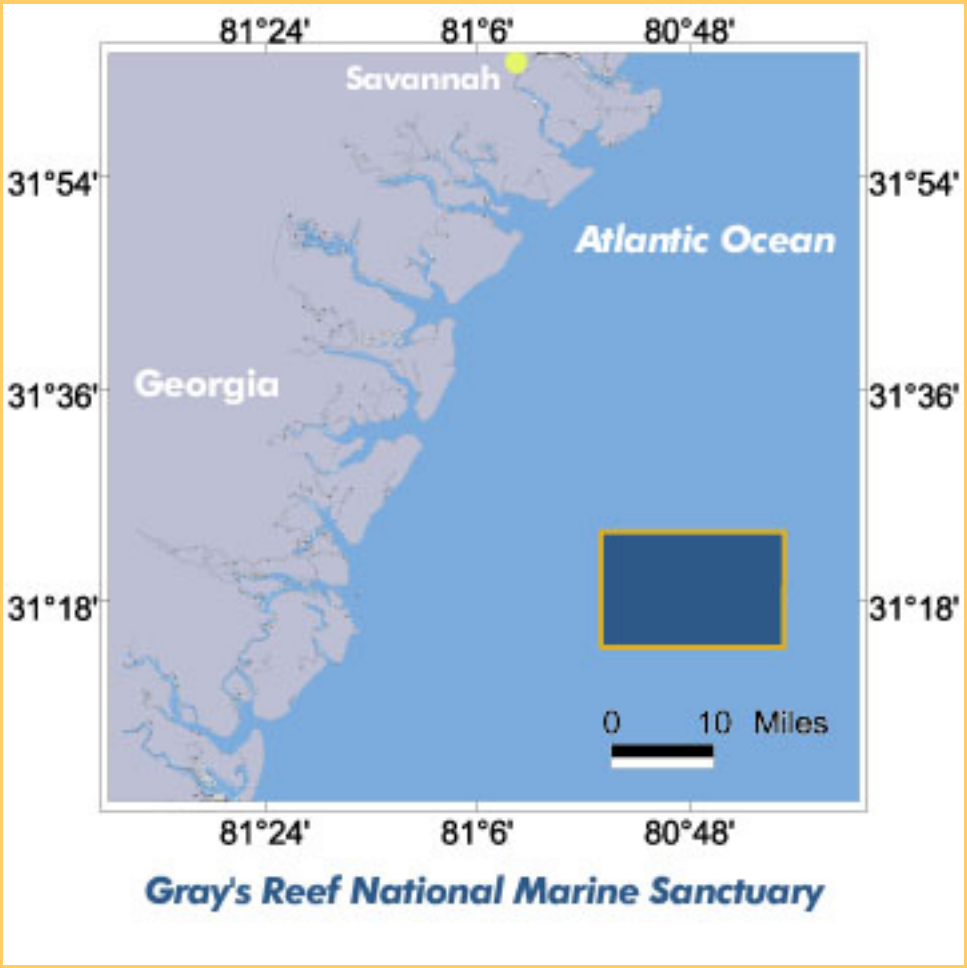
Northern right whales, the most endangered of the world's great whales, can also be seen at Gray's Reef. The northern right whales spend their summers off New England and Nova Scotia feeding in the nutrient rich cold water upwellings. At the end of September they begin their southerly 2000-plus mile migration, and usually by the end of October or early November adult females and the young of both sexes show up off the coasts of Georgia and northern Florida. The adult females make the journey to give birth to their calves in our relatively warm waters. During the winter months the temperature of our waters are actually slightly warmer than those of the northeastern coast during the summer.

While Gray's Reef is not the only live bottom reef or habitat in this area it is certainly one of the best examples. Live bottom reefs extend throughout most of the Georgia Bight stretching in a band for several hundreds of miles from northern Florida to southern North Carolina. Gray's Reef is in 60 to 70 feet of clear sea-green water and offers a visual cornucopia for diver's and a rewarding spot for sport fishers. This low profile reef is healthy, and in this era of tropical reef degradation it is refreshing and heartening to see the natural beauty of this glorious subtropical reef.

(top) **RETURN**

Maps

The Sanctuary



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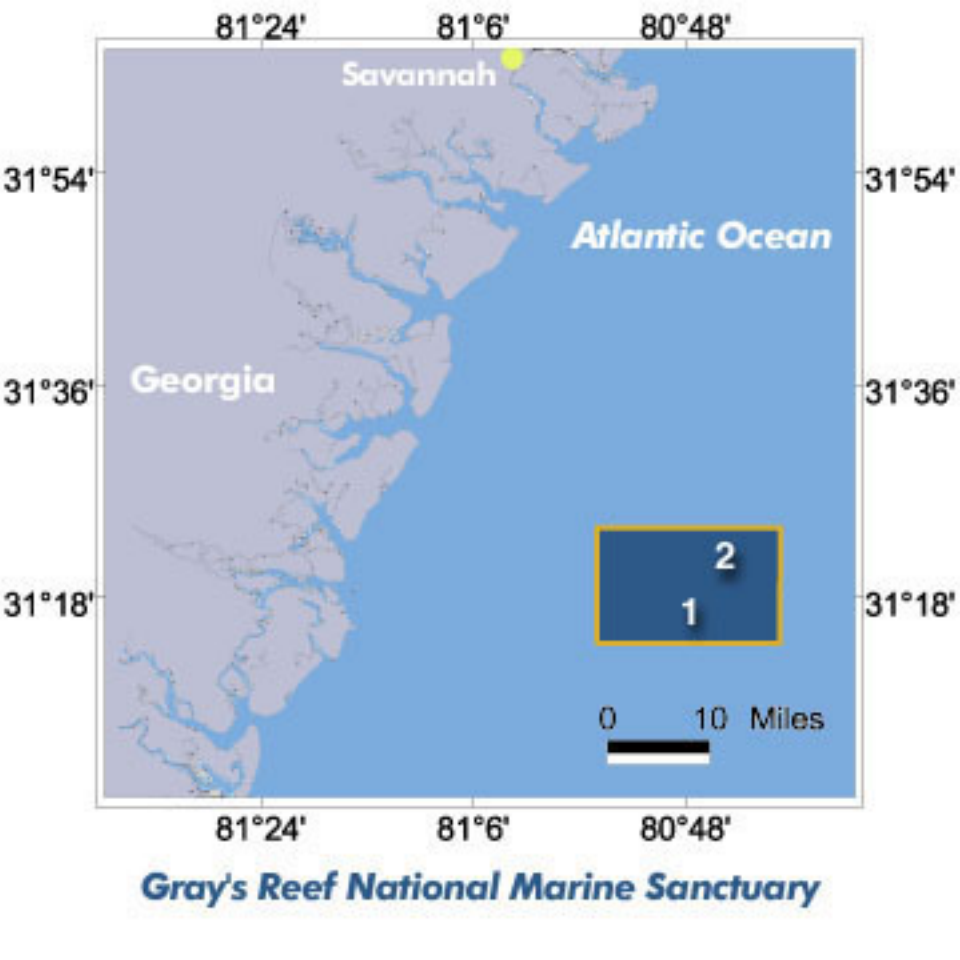
(top)

The Mission



1. The dive site is from the bottom of Gray's Reef and areas east out to the continental shelf. 2. Projects will span Gray's Reef and will include areas adjacent to the reef and along the inner, middle and outer edge reefs of the Georgia Bight.

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Research
Exploring the Georgia Bight

Thomas Potts, Research Coordinator
National Underwater Research Center
Gray's Reef National Marine Sanctuary

Alessandra Score, Information Systems Coordinator
Gray's Reef National Marine Sanctuary

The first comprehensive study of Gray's Reef was conducted by scientists in 1961 while surveying the near shore area off the University of Georgia's Marine Institute on Sapelo Island, Georgia. During these surveys, scientists were surprised to see the immense diversity in invertebrates and fish fauna. Although scientists first investigated this site in the 1960s, the area that is now known as Gray's Reef, had been referred to as "Sapelo Reef" for many generations.

The R/V Jane Yarn is a 65 foot converted Navy vessel that has been renovated for marine science and education at Gray's Reef National Marine Sanctuary. Since 1981 research has focussed on studies of the reef's living marine resources, cultural resources, and human activities.

Since Gray's Reef was designated a National Marine Sanctuary in 1981, research has focussed on studies of the reef's living marine resources, cultural resources, and human activities. In recent years efforts have emphasized long-term monitoring and assessment of natural resources including reef fish populations, invertebrate characterization, oceanographic conditions, loggerhead sea turtle habitat use, and visitor use.

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In 1995 Gray's Reef initiated a long term monitoring assessment program that encompasses resources of significant importance to the sanctuary, including reef fish, invertebrates, loggerhead sea turtles, and visitor use.

The Sustainable Seas Expeditions offer an excellent opportunity to explore and compare the different reefs found in the Georgia Bight and to add data to our long-term monitoring programs. Our focus will be to use the DeepWorker submersible to compare inner shelf reefs, such as Gray's Reef, to outer shelf reefs that range between 200-300 feet in depth. The primary objectives will be to assess benthic invertebrate and reef fish populations, paleo-environmental and archeological resources, and the loggerhead sea turtle population. Data collected will be analyzed with information from existing monitoring programs and used to develop educational and outreach materials.

Exploring the Sapelo Scarp, an outer shelf reef at depths between 200-250 feet, will provide interesting comparative information regarding reef habitats and community structure in the Georgia Bight. The DeepWorker gives scientists the ability to study areas at depths beyond scuba capabilities and spend about three hours at a time observing and collecting data at one site. Little is known about the biological composition of the Georgia shelf reefs and how they might affect the composition of fish and invertebrates of Gray's Reef. This knowledge will help us understand the link between different types of habitats leading from land to the coast and from the coast to the continental slope.

Scientists face a few challenges in compiling data while using the DeepWorker since most data will be collected by a video camera. Presently, video transect protocols for censusing fish and invertebrate communities have yet to be established for DeepWorker 2000. Numerous issues have been identified and will be addressed during submersible dives at Gray's Reef and outer

shelf reefs in order to obtain the highest quality of scientifically valid footage. During the submersible dives scientists will be evaluating criteria such as:

- Submersible speed and distance from the substrate and vertical relief
- Camera position in relation to the sub and camera angle in relation to the substrate
- Field-of-view quantification (in order to obtain a reliable estimate of transect area)
- Laser placement and adjustment (in order to obtain organism size estimates)
- Incorporation of ancillary audio capabilities to augment video footage

Comb jellies are extremely fragile transparent bioluminescence organisms that do not sting. Comb jellies, such as this Warty comb jelly *(Mnemiopsis mccradyi)*, feed primarily on small crustaceans and mollusks in the plankton. The DeepWorker gives scientists the ability to study the biological composition of the reefs and how they affect the composition of fish and invertebrates such as these jellies.

The DeepWorker provides an unprecedented opportunity to extend our understanding and appreciation of reef habitat off Georgia. This is particularly true for the video footage to be obtained from the Sapelo Scarp area. These views of this deep reef environment will provide a qualitative snapshot of the fish and invertebrate communities. Most of this footage will be directly comparable to transects conducted on shallower reefs within sanctuary boundaries.

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Education and Outreach Program Overview

Cathy Sakas, Marine Educator
Gray's Reef National Marine Sanctuary

The lush semi-tropical coast of Georgia is as rich in marine life as it is in marine educational opportunities. Because local students are already well served by several facilities and centers in the area, Gray's Reef National Marine Sanctuary has concentrated on developing curriculum and providing programming for students outside our immediate area: students not readily able to come to the coast to learn first hand about the vast marine environments we have to offer here.

The beautiful subtropical live bottoms of Gray's Reef National Marine Sanctuary are located 20 miles due east of Sapelo Island in the middle of the Georgia coast in 60 to 70 feet of seagreen ocean. From land it is a two to five hour trip depending on the type of boat used and where on the coast the trip originates. While the trips out to the reef are long they are also rewarding in and of themselves. Bottlenose and spotted dolphins ride the bow waves, and loggerhead and leatherback sea turtles usually make appearances. The distance and expense of getting to the reef limit the number of visitors who can experience the reef directly. Therefore our education programs are designed to bring the reef and its creatures to the students.

Through Georgia's distance learning network we are able to teach and interact live with as many as seven classes across the state simultaneously. With slides and video footage we are able to bring the reef to life. Students in downtown Atlanta and from the peanut farms of Plains and in the mountain community of Helen go beneath the ocean with us to explore Gray's Reef without ever getting wet. The students ask us questions about the fish and especially the sharks we see, and if we've ever run out of air while diving there.

The students are spell bound by the program on northern right

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Gray's Reef staff shares information with the public.

whales with video footage of a mating group churning the waters in what researchers call the "washing machine." In the popular Florida Manatee Program students are particularly fond of the footage of the large round tailed 12 feet long mother nursing her small wrinkled calf under her front flipper. By weighing the skulls of a manatee and a dolphin we illustrate the fact that even though these two marine mammals can achieve the same length, they are not of the same weight. A manatee's closest land relative is the elephant, and its dense bones make that point very believable. Dolphins on the other hand are of the same lineage as deer, and their less dense bones and sleeker skeletal structure bears that out.

Outreach events are popular amongst schoolchildren.

To further aid teachers locally and throughout the state and especially those not able to bring students to the coast, Gray's Reef has developed several different educational modules. The modules help teachers instruct their students about endangered species in various ecosystems, encourages students to discover creatures in their own backyards, motivates students to investigate fresh water ecosystems and reveals the fascinating secrets of the northern right whale. These modules include a teacher's guide with work sheets for copying, complete activity descriptions, posters and in the northern right whale module a video tape as well. The activities have all been classroom tested and deemed educational and fun by participating students. The modules are targeted for different grade levels and are free for the asking. A list of the materials available from Gray's

Reef is posted on this website.

In addition to the distant learning programs and the educational modules, Gray's Reef provides the opportunity for local area high school students to participate in the Savannah Student Ocean Council program. Throughout the school year, 17 local area high school students participated in the first series of Savannah Student Ocean Council programs. It was such a success, many students have already requested space for next year's Council.

The requirement for the students to enter the program was that they have an interest in learning about the ocean and ocean-related careers. One afternoon each month, the students gathered at various sites around the community to interact with professionals established in their ocean-science-related fields. At each of the sessions the students were asked to solve problems that the professionals had actually encountered during the course of their work. The ideas generated by the students were useful in many ways to the professionals and to the staff of Gray's Reef who requested input on specific questions.

Curious hands grasp for understanding at a Gray's Reef outreach event.

Some other examples of issues the students have worked on: During one session the students were asked to generate guidelines for the management of the sanctuary from sport fishing, sport diving and conservationist perspectives. The students were also asked to critique the aquarium with which Gray's Reef is associated to make it more useable to visitors and to help design a recoverable turtle radio tag. All the professionals that participated in the program were impressed with the students' comprehension levels of the presented materials and their creative ideas and solutions to the posed problems. The students came from public and private high schools as well as a home school. Last year's schedule of programs is included at the end of this section.

Because learning is not limited to just one age group or education level, the staff of Gray's Reef National Marine Sanctuary has strived to provide speakers for all types of venues when requested. While our presentations cover a variety subjects, mostly we speak on the colorful wonders and importance of Gray's Reef as one of the

premiere examples of a southeastern live bottom habitat. Our staff has spoken at fish fries, scuba diving club meetings, fishing tournaments, kindergarten classes, Rotary Club meetings, gatherings of retired corporate engineers, teacher workshops, marine educators conventions, symphonies, political hearings, and many more. Our programs are geared to the audience and their area of interest. Recurrent throughout our presentations is the importance of a clean environment which is essential to the continued good health of Gray's Reef and all of our coastal waters.

In an effort to take advantage of the willingness of our local media to work with us in informing the general public about Gray's Reef we have embarked on a partnership with the local NBC affiliate WSAV-TV and our local Peachstate Public Radio Station WSVH-WWIO on a series called Rivers to Reefs. The series is designed to inform the general public about Gray's Reef and its intimate connection to the land. Gray's Reef is directly influenced by the Altamaha River Watershed that brings fresh water from deep inside the interior of Georgia flowing through 250 miles of urban sprawl and rural farm lands to the coast and an additional 80 miles offshore to the continental slope where it joins the warm swift waters of the Gulf Stream. The main message is that the continued good health of Gray's Reef is dependent on the waters that bathe it. Those waters are a mixture of salt from the ocean tempered with the fresh water of the rivers that drain the coastal plain to the coast. A complete outline of the series is included at the end of this section.

Gray's Reef National Marine Sanctuary has undertaken a variety of programs that are designed to add to our scientific knowledge of semitropical live bottom reefs and the organisms that depend on them. Concomitant with that mission is educating, taking the information we gain and making it understandable and useful to students and the general public. South African environmentalist Bada Deone accurately described what education is all about for us when he said, "For in the end we will conserve what we love. We will love what we understand. We understand only what we have been taught." Our ever pesent hope and ongoing efforts are geared towards making sure that Gray's Reef becomes a familiar place to those who don't know it yet, and that it continues to be understood, loved and protected.

(top) **RETURN**

Shades of Gray

Reed Bohne, Manager
Gray's Reef National Marine Sanctuary

Petrochirus diogenes, Loligo pealeii, Pennaria tiarella, Oculina arbuscula; unfamiliar yet lyrical words, the scientific names of hermits crabs, squid, hydroids and corals that populate Gray's Reef. These names, as mystical to us as the creatures themselves, create, as the poet James Dickey once wrote " a kind of shade, and because the names themselves are strange, special and beautiful...call up an entire flora and fauna that hover with Edenic colors in the readers uninformed - that is, still virgin mind."

William Bartram explored coastal Georgia's natural history and terrain from 1773-1776.

Our reefs and oceanic communities remain largely unexplored, new territory, poorly understood, yet magnificent to behold. It is still the realm for exploration, for celebration by the scientist and the poet. Dickey's quote was a preface he wrote to the 20th century publication of colonial explorer William Bartram's book *Travels*. Bartram explored the natural environment of coastal Georgia from 1773-1776. *Travels* blends scientific nomenclature with romantic prose and evocations of God in nature to catalog his expeditions along the coast.

Bartram's spirit shades our exploration of Gray's Reef during the

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Sustainable Seas Expeditions. For like the colonial traveler in the new world, we only now have the

Stamp commemorating John and William Bartram's explorations.

rudimentary tools to explore the undersea continents and fully marvel at the discoveries before us. Out yonder, down under, in the ocean we can still be the first person ever to set eyes on a particular reef, patch of kelp forest, or submarine volcano belching out a black mineral soup. Today, Bartram's wonderment at the magnificence of the virgin-like territory of colonial America echoes across the centuries to us as we venture into our own new world beneath the waves.

"How the mind is agitated and bewildered at being thus as it were placed on the borders of a new world. On first view of such an amazing display of the wisdom and power of the supreme author of nature, the mind for a moment seems suspended and impressed with awe."

William Bartram 1774

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Cultural Resources Characterization

Bruce G. Terrell
Archaeologist, MSD

A brief Cultural History of Gray's Reef and Coastal Georgia

Gray's Reef National Marine Sanctuary is a 17 square nautical mile "live bottom" reef that was historically known by local fishermen as the Sapelo Ground but was re-named for Dr. Milton B. Gray, a prominent zoologist who conducted studies in coastal Georgia.

Archaeological studies of coastal Georgia indicate evidence of Paleo-Indian habitation about 12,000 years ago. Coastal island sites also show the presence of Archaic peoples who lived there about 8,000 years ago. This culture, which subsisted primarily on fishing, is thought to be related to a "parent culture" in the Caribbean.

The earliest 16th-century Spanish missionaries encountered the native Guale people. Georgia's coastal region is still sometimes known as the Guale coast. These Indians were driven out after the 1670s and replaced by the Yamassee tribes who supported the British incursions into the area from the Carolinas. The coastal tribes were accomplished canoe builders and fishermen and subsisted on the resources of the inland waters. By the mid-18th century, disease and English aggression had virtually exterminated the Yamassee people.

The Creek tribe lived in the coastal region by the time of James Oglethorpe's arrival in 1733. Oglethorpe developed a good relationship with the Creeks and was permitted to build a trading town which became Savannah. In the 1830s, the Creeks were evicted by the American government in order to open western Georgia to American settlement.

The Georgia coast was initially included in Spain's claim to Florida.

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Sixteenth-century Spanish sailors met with marginal success in the Christianization and enslavement of the coastal Guale people.

After failed attempts to settle the area in the early-16th century, Governor Pedro Menendez de Aviles built a series of coastal forts to serve as bases to protect Spain-bound treasure flotas traveling up the Florida Straits towards the Gulf Stream off Cape Hatteras. Adjunct missions built on various coastal islands met marginal success in the goal of Christianizing and managing the local Indian populations.

The southeastern coastal region was an arena of conflict between the Spanish and English through the mid-18th century as both European powers sought to control the coast. While their skirmishes were usually played out on land, both sides were supported by ships and coastal watercraft.

By the early-18th century Britain had encroached on Spain's claim to coastal Georgia. Oglethorpe's 1733 settlement at Savannah, near the mouth of the Savannah River, provided England with a deep-water port that provided access to the pine forests of the interior. The forests provided naval stores such as timber and pitch for the ships of the English navy.

Until the American Revolution, settlement in Georgia was centered primarily in the coastal region. Rice, indigo, lumber products, and naval stores were economic mainstays and were all exported by ship. Savannah was the main colonial port for coastal Georgia and most trade took place between that port and the British colonies at Charleston and Barbados. A large portion of the population was composed of freed indentured servants from Barbados and the British Caribbean.

During the 18th and 19th century, Savannah was considered a strategic port and various attempts were made to blockade and capture it. Savannah was in British hands during most of the American Revolution. The only direct confrontation to the English came in 1779 during an unsuccessful French attempt to blockade the mouth of the Savannah River off Tybee Island. The French fleet was dispersed by a sudden gale.

Small-scale naval conflicts often took place between individual ships

as small, fast American privateers raided English shipping in both the sounds and coastal waters. Privateering was a favorite tactic among nations with extensive seacoasts and small naval forces. Under government-issued letters of marque, privately-owned vessels fought the enemy with a war on commerce. Privateering was essentially government-sanctioned piracy. This pattern of naval warfare was again conducted against the British in the War of 1812.

Georgia's coastal settlement continued after the Revolution. As the native tribes were removed to the west, inland settlers stimulated trade. Raw upland produce such as tobacco, cotton and lumber were shipped downriver to Savannah and thence to larger, regional commercial centers such as Charleston, Boston and the West Indies.

In the 19th century new port towns developed at Brunswick on St. Simon's Sound and Darien on the Altamaha River. Darien became a large national lumber supplier. Most coastal vessels carrying produce in and out of Georgian ports passed through or near the Gray's Reef area.

Much of Georgia's maritime commerce was sustained by black labor. Many slaves and some free black sailors worked on inland vessels and aboard coastal schooners and fishing boats. After the Civil War, much of the regional commercial fishing (as with much of the south) was conducted by black fishermen.

Coastal commerce of the 18th and 19th centuries was carried primarily by small sloops and schooners. Cotton and rice were the main coastal exports while naval stores such as pitch, timber and spars were valuable inland exports.

As previously noted, Gray's Reef was originally known to local fishermen as the Sapelo Ground. Most early-19th century fishing was relegated to the local Savannah and Charleston markets. The post-war improvement in steam and rail service made it possible to ship fish to northern markets in winter months. The principal offshore species that were caught on the Sapelo Ground were black sea bass, flounder, red-snapper and the various jacks. Until the late-19th century, they were usually caught on handlines and were kept alive in live wells built into the fishing boat's deck. Seine nets were introduced in the 20th century. An influx of northern fishermen encroached on the area in the 1880s, after the northern grounds were over fished. By the 1890s, Savannah was the primary market for Georgia and northeast Florida's fisheries.

Many distinctive boat types evolved on the southeast coast. The sinuous rivers and sounds demanded shallow draft vessels that

could serve as passenger transport or bulk cargo carriers. Boats were propelled by all means available from poling, to rowing and sailing.

Vessels such as dugout canoes, periaguas, and the flat-bottomed bateau were enlarged, reduced or modified in numerous ways, to fit their required tasks. Small sloops and schooners were used for the offshore fisheries and the coastal trade. These were often little more than open boats with short fore-decks and a single fore and aft gaff-sail.

The regional coastal trade saw the finely-crafted, single-masted, Bermuda sloops that were built in the West Indies in the 18th and early-19th centuries. In the late 1880s, numerous northern smack schooners infiltrated the area, as New England fishermen came south to fish for black bass during their own slack seasons.

By the early 1800s Savannah had become a regional shipbuilding center. Two and three-masted schooners, brigs, and ships were constructed for regional use. Locally-built vessels were used in 19th-century coastal trade between Charleston, Savannah and smaller coastal towns including Darien, Brunswick, and Fernandina.

The SS Savannah, built in the Savannah shipyards in 1819, was the first trans-oceanic steamship.

Coastal Georgia's steamboat heritage is, perhaps, best known for the construction of the first trans-oceanic steamship, SS Savannah in 1819. Many small inland steamers were also used at Savannah to navigate the numerous rivers and sounds. Larger coastal steamboats were used to carry passenger traffic between Savannah and the southern coastal cities. While steamboats moved much southern passenger traffic, sailing vessels tended to carry bulk goods. The introduction of the railroad in the mid-1800s usurped much of the passenger traffic and carriage of perishable goods.

Savannah was an important southern port during the Civil War and was blockaded by the Union Navy in late 1861. While the Confederate Navy maintained a strong squadron of gunboats and

ironclads at the city, there were no naval confrontations offshore in the Gray's Reef area. Unlike Wilmington to the north, the mouth of the Savannah River was too heavily blockaded to allow the entrance of blockade runners.

The Georgia coast again became a focus of naval activities during World War II. The southeastern U.S. coastal waters were part of the battleground for the Battle of the Atlantic. In 1941 and 1942 German U-boats sank several allied merchant vessels near the present sanctuary's boundaries. In April, 1942, three merchant vessels were sunk in waters adjacent to Gray's Reef, immediately off of St. Simon's Island.

Research on the Cultural Resources of Gray's Reef

Researchers are presently examining Gray's Reef for possible prehistoric human cultural remains. During the last glacial stage of the Pleistocene, Georgia's coast extended at least 60 miles farther out into the ocean than it does today. The region of Gray's Reef existed as an exposed land form. Recent geomorphological studies reveal that the sanctuary's submerged landforms include river valleys, submerged terraces, and hard bottom outcrops, all of which are potential sites of prehistoric activity.

Based on findings from nearby land archaeological sites, prehistoric cultural remains in the Gray's Reef National Marine Sanctuary could include shell middens (refuse piles) which could contain Paleo-Indian and Archaic-stage food and botanical remains. Additionally, cultural materials such as stone tools, flakes, and ceramics (from the Archaic period) could also remain. Habitation and camp sites may also be preserved beneath the submerged substratum. In addition, there have been recent reports of extant fossil remains of prehistoric mammals found on the sanctuary's seabed. Geophysical survey and modeling, followed by testing, may reveal the remains of such prehistoric cultural sites. The discovery of any prehistoric cultural materials would be of extreme significance.

The potential for historic cultural remains is slim but not negligible. Previous surveys of the small sanctuary have revealed no obvious historic . Additionally, few hazards exist within the sanctuary which would threaten navigation such as shallow reefs, unusual weather patterns, or currents or proximity to land forms. Fishing vessels wrecked by storms or accidents have, perhaps, the greatest potential to exist within the sanctuary.

The cultural resources of the sanctuary have a moderate priority level. There are no (yet) known shipwreck sites in the sanctuary and the threat to potential prehistoric sites would be low. Research

and survey for such sites, however, is considered necessary for this sanctuary because of the probability of sites based on previous research.

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"The Pine Casket"

from Sapelo Stories by Cornelia Bailey

Cornelia Bailey

Cornelia Bailey was born Cornelia Walker in the Belle Marsh community of Sapelo Island just before the mid century mark. Her father Hicks, the cast net weaver, and her mother Hattie Mae raised their family on the back side of the island on the edge of the marsh where Cornelia learned to fish and crab in the bountiful salt water creeks. Cornelia's family as well as almost all of the other African American families on Sapelo are direct descendents of the slaves of Thomas Spalding, the scientific agriculturalist who ran a successful plantation on the island from 1802 to the beginning of the Civil War. Cornelia and her parents, and mostly the older members of the community, still speak Geechee, the native dialect. Referred to by many as Gullah, Cornelia will be quick to correct the uninformed that Gullah is spoken by South Carolinians; Geechee is spoken in Georgia and specifically by residents of the Hog Hammock community where the families have been consolidated since the 1960's. The people's connection to the land is what makes Georgia's coast so special. The love and respect its people have held for it have resulted in some of the wildest coastline in the USA. This is Cornelia's story of her connection to the land.

Why do I have such a strange feeling about Belle Marsh? I am here on a small island, Sapelo Island, about 12 miles by 4 miles, and the south end feels different, like I am in a strange country-it don't belong to me. I feel on the outside looking in. Why? Why this feeling? But when I travel on the west perimeter road going north toward Belle Marsh I begin to feel great, different, as if I am

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connecting with myself. There is a peace that comes over me that belongs to me only. The trees, noises, sound, smell, is all mine. I hear voices, I see faces, I remember things, but only at Belle Marsh. Why? The marsh where we swam at high tide, the field with corn and peanuts and peas, the rowboat tied in the creek at Moses Hammock--it's all mine.

Do you think it's because I was born there? Yes! That must be it, or because I died there and came back to life, or maybe because my father's roots are there. It feels great, it feels just right. We had a two-room A-frame house with wooden shingles and wooden windows. When it leaked, it rained inside and drizzled outside. We loved and lived in that house, we died in that house. It was my papa's folks' house before it was his.

My feeling is all in me, waiting for a door to open. I was happy. We had a Sears Catalog and a battery radio to unite us to the outside. Why did we trade off? I would have love to remain there. It's only about 80 acres but to a child, that's heaven, and to the child in me it's still heaven. Papa must have love it also, to have live there for 46 years, to have walk all those miles to work for Howard Coffin and Richard Reynolds in cold, hot or wet weather, all for his family, and then return in the afternoon.

But let me go back to the beginning. About 40 years ago I was born at Belle Marsh. It was Tuesday and my grandfather name me Cornelia. Mama had seven before me and six before the seventh, she thought six was all she were going to have. Then along came my brother Asberry and two years later, me. My brother was the seventh child and a son, so he was suppose to be wise and smart-that's another story!

A bundle of joy, I were helped into this world by Mrs. Katie Hall Underwood, the local midwife. She had to travel from Hog Hammock to Belle Marsh. My papa went in the wagon to get her. Right away I became Papa's favorite child. Grandpa John Bryant said I would be intelligent and wise beyond my years.

Life at Belle Marsh was happy for us children because we had love and felt love. So it didn't matter that we didn't have the proper food to eat or decent clothes to wear, we had each other and ourselves in our own little world.

When I was about three I became very sick, no one knew what was wrong. There were no money to go to the doctor, so home remedy and lots of prayer were all my folks had. After about 48 hours, the thing my parents fear the most happen: I died. Yes, died. They had already lost two sons earlier from fever and now me. Mama ran

almost 3 miles to our nearest neighbor Jessie Mae's at Lumber Landing and told her she lost another child.

Cornelia Bailey and Viola Johnson

Now it is a very old tradition on Sapelo to ring the church bell in a very mournful tune when someone dies. In this way news about my death were sent out across the Island and my father who was working at South End at the time, receive the news of my passing. He came form work to be with the family and to measure me for the casket. Then he took that long walk back to South End where he and his cousin, who was a carpenter, built my casket of yellow pine. Papa said he cried all the way there and back.

By this time people from all over the Island began to arrive at our house for the wake. I wish I could have seen them! Mama, Aunt Mary and the other ladies cleaned me up and put on my best dress for burial. Papa and Charlie Walker came home in the company truck and place my casket and rough box in the living room. The ladies lined it with clean sheets.

Uncle Nero was there and said "Put her in the casket-what are y'all waiting on?" He was drinking. At a wake there always were a bit of drinking. My mother said she just couldn't bring herself to place me in that box.

Then Aunt Mary said to Mama, " This child is not dead!" She sent her daughter next door to dig up some garlic which she mashed into bits and forced into my mouth and under my nose. Coughing and crying, I began to come out of whatever I was in, was it a coma? Or did I really die and come back, as so many of the elders believe? Everyone was so happy! Can you imagine how drunk they got? They really celebrated!

I am here to testify I was once believed to have died and return to the living, and to this day everyone think that I can look into the future and will be blessed with long life.

In Belle Marsh, life went on. Ours were the only house there by 1949, but I was not lonesome at all. My brother Asberry and I decided that casket would make a nice boat, so at the age of five and seven we drag it out of the house and push and pull until we got it into the water at high tide, behind our house.

At this time, Mama and Papa were also raising Michael, my sister

Ada son. He were three when we went boating and we took him along also. It just so happens that Papa came home early that day and decided it was high time to go hunting shore birds such as gannet. Michael had on a white shirt and a gannet is also often colored white and black and gray. So Michael was sitting out in the water playing, along came Papa with his double barrel shotgun and took a dead aim on what he thought was a gannet in the marsh. Michael stood up in the casket just before Papa squeeze the trigger, boy was Papa mad with us! Out of that water we came and was marched ahead of him back to the house for a sound whipping. We did not go boating again in my casket!

They were the times of joy and sadness for someone so young. The joy of learning the tides at an early age to go gathering crab by ourselves, they joy of digging fresh green peanuts on Moses Hammock and boiling them in an old tin can full of salt water from the creek, the joy of pretending everything in a Sears and Roebuck Catalogue was yours, the joy of eating fresh bake sweet potatoes fresh out the fireplace.

The sad part was leaving it at age five. I can still see it, feel it and regret it all. Belle Marsh had its ups and downs for a little girl of five, things I don't understand back then and wonder if I ever will.

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Paleoarcheology: Searching for the Past in Gray's Reef

Erv Garrison, Ph.D.
University of Georgia, Athens

"Paleontology" is the scientific study of ancient life forms and their fossilized remains. Most life forms studied by paleontologists are now extinct such as the dinosaurs, perhaps the most famous of all the subjects of paleontological study. "Archaeology" is the scientific study of past human groups. Paleontology and archaeology can overlap when the fossils of ancient animals and the artifacts of ancient humans occur in the same place. Gray's Reef may be one of those places.

Dr. Erv Garrison examines fossil specimens with some Georgia Islands managers. Over two dozen fossils of horse, camel, bison and mammoth have been found, as well as what may be a piece of fossil antler that was modified for use as a tool.

Since 1994, research divers from NOAA and the University of Georgia (UGA) have found over two dozen fossils of extinct animals such as horse, camel, bison, and mammoth at Gray's Reef. Along with these exciting finds, researchers have found what may be a piece of fossil antler that was modified for use as a tool. The possibility of ancient animals and humans living at the spot of today's Gray's Reef is a real one.

How could ancient humans or animals live at a place located 70 feet

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Fossilized mastodon bones are part of a rich assemblage of fossil species found at Gray's Reef.

below the surface of the Atlantic Ocean? During the last Ice Age - 10,000 to 30,000 years ago - the oceans of the world were as much as 300 feet lower than today thereby exposing large parts of the shallow coastal margins of America. Gray's Reef was dry land for over 20 millennia so great numbers of animals could have lived and died on this coastal plain. We see the remains of these animals today as fossils lying on or near the sea floor. Gray's Reef is clearly rich in the number and kind of fossils that have been found to date and will be the focus of scientific study in the years to come. During the Sustainable Seas Expedition missions, the DeepWorker will be used to explore for fossil remains in new areas of Gray's Reef, expanding ongoing paleoarcheological research.

These fossils found in 1996 are rib like bone fragments over 150 mm in length and radiocarbon dated to 8,000 years. One is less mineralized and identified as an extinct species of bovine (such as bison) animal.

The National Geographic/National Public Radio RADIO EXPEDITIONS team went to Georgia to record an archeological dive with Dr. Erv Garrison from the University of Georgia and Bruce Cowden from Gray's Reef National Marine Sanctuary. To listen to this radio expedition, point your web browser to:

http://www.npr.org/programs/RE/archives/970825.grays.html

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Selected Poetry for Gray's Reef National Marine Sanctuary

These poems have been graciously shared with us by members of the Poetry Society of Georgia in celebration of the Sustainable Seas Expeditions at Gray's Reef National Marine Sanctuary. While all the poems submitted were excellent, the three featured here related the best to our mission. Each author passionately expresses their connection to the sea in skillfully rendered verse. We are fortunate they chose to share with us.

Sea Query

Who can tell you all
of this deep sea?
Though searchers come and go
they have not measured
its immensity.

Many have heard the talk of water
moving in pale caves of chalk,
and found along far islands
water gardens on sunny ledges,
and brought you ambergris
and tales of wandering
through some dim abyss.
But of that ceaseless ebb and flow
Who has told the all there is to know?

Go down web-footed, helmeted.
Explore black caverns where
you creep with eyeless beings
on the ocean floor.
Find your way to barriers of glass
frozen for aeons
in the under tide,

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see mountains none can pass.

And then return to sun and sky
and sit upon the golden sand
and stare, helpless,
on that glittering ebb and flow
of which who knows
the all there is to know?

-Gerald Chan Sieg

Turning the Soft Fish

Ancient people leathered to copper by ancestors and sun,
Haunched down in circles at marsh edges,
Among moist dunes lapped and scalloped by
every tide since time.
Smiling, nudging, they cracked oyster against oyster
Sucking out the mellow plush-gray beastie,
The soft fish.
Whole half-shells were ceremoniously stacked aside
Like iridescent razor-spoons.

"The sea that eases our life is both deaf and loud,"
They say,
"It vomits its treasures and howls for more.
The sea is like the sky."
They pick up the shells--pearl inner surfaces shimmer
Spectrums of pastel. "Look. Look," they cry,
"Everywhere it turns, a rain-sky is painted. Look.
The sky and sea are one."

These scraggy copper-fleshed folk grasp life
On the glut and suck of tides.
They yearn to a faith that tells of lavendar essences
In scaly vermillion robes, blue-heron wings flashing
Thru forests of kelp, meadows of writhing seagrass.
After every flushing rain, these stormy spirits
Rise unto the roof of the sky and wait.
The gaudy parrot fish, blue-fin tuna and lemon shark,
Freckled, toothy eels sleek and fierce as lightning
Come with the mottled, limp pink octopus glaring,
Rippling upward with humpback whales in hefty grace.
Especially in the time of warm suns, they take turns
Sending their bright spirits up to commingle rainbows
And praise the skies for rain.

The copper-skinned people become rituals, streaking themselves
With berries and clay, pollen and tree-bark to urge
The colors of their spirits to ascend with those from the sea.
A numbness of awareness suffuses them
Into highest ethereums of arching light.
They stiffen and luminesce. They join
The sea's rain-sky in all ways.

Milleniums tell how the copper people could generate rainbows
Alone.
When the sea was too distressed.
"The sea and the sky are one with us,"
They said, turning the pearly shell
Of the soft fish reverently in their dark, hard hands.

-Bob Strozier

SEA CABIN

See that cabin there
With seaweed by the door?
That is my destination
When I reach the shore.
See how the sea breeze passes
Blowing sea and sand?
I will make my home there,
On that point of land.
Watch as the boat comes closer,
Soon we will be there!
Stay with me a moment,
The day is warm, and fair.
Each of us needs a harbor
A place of quiet keep.
Mine is by the ocean
Where the years stand deep.
See that cabin there
With driftwood near the door?
Stay with me a moment
When we reach the shore!

-Patricia Robinson-King

Credits:

Gerald Chan Sieg:

Ms. Sieg was born of the first Savannah Chinese family on October 1, 1910. At the age of 16 she won the Poetry Society of Georgia's first high school prize and became a life long member of the Society. In the 1999 Savannah Literary Journal: this announcement was printed: "The Savannah's Writers Workshop is pleased to announce that the recipient of the Irene Tromble McAlister Literary Prize for 1999 is Gerald Chan Sieg. Ms. Sieg's finely crafted, delicate poetry captures in a few words the reality of a time or place or feeling. She has shown by example that a poet can achieve excellence in art and inspire others to pursue that goal."

Bob Strozier:

A member of the Poetry Society of Georgia since 1955, Dr. Strozier taught for over 30 years at Armstrong-Atlantic State University as a Professor of American Literature. During his career he served as the Department Head of Languages, Literature and Dramatic Arts as well as the Director of Public Relations. A native Georgian he has lived in Savannah since 1946 admiring and writing about the beauty of our coast.

Patricia Robinson-King:

Born in Kittery, Maine in 1926 on the Fourth of July, Ms. King moved to Georgia in 1947 bringing with her a deep love and respect for the ocean. While her poems were written for the cold waters of the north, the feelings and emotions she expresses are universal and intimately relate to the warmer waters of ours. She often refers to the poet inside herself and others as "a common cord that the written language can strike." Ms. King has been a member of the Poetry Society of Georgia for over 32 years.

(top) **RETURN**

Loggerhead Turtles

Alesandra Score,
Gray's Reef National Marine Sanctuary

Gray's Reef National Marine Sanctuary is one of the largest near shore live bottom reefs found in the South Atlantic Bight. As such, it is an important habitat for sea turtles including the threatened loggerhead, Caretta caretta. The ledges and overhangs of the reef provide the loggerhead sea turtle with protected resting spots, a bountiful resource of food, and close proximity to nesting sites on barrier island beaches.

Over the years, researchers have learned much about loggerhead's nesting behavior (i.e. seasonality, number of eggs, sites), but little is known about the animal's behavior when underwater, away from the beach -- especially for the relatively small Georgia/South Carolina nesting population.

Although observations by sanctuary staff have documented the presence of loggerhead sea turtles within the sanctuary and along the Georgia Bight, little is known about the turtle's daily and seasonal behavior, nor their use of the different ocean habitats. Many studies have focused on nesting behavior and post nesting movement of adult females, while little work has been conducted on offshore turtles especially males and juveniles. Management plans that include the protection of this species are confined by a limited amount of data.

This project will contribute information of the offshore loggerheads found at Gray's Reef pertaining to demographic affinities for foraging, resting, nesting, and breeding, both spatially and temporally. Conservation issues at Gray's Reef pertaining to loggerhead sea turtles can be addressed more fully using

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To capture a loggerhead underwater, the turtle is directed by divers into a hand held net, carried to the surface, and lifted onto a boat. Turtles are returned to the capture site following a blood sample and the attachment of a satellite transmitter.

knowledge gained from this project.

This project will analyze habitat availability, utilization, and preference with use of satellite telemetry and by cohort tagging with reflectors. Seasonal use of ocean areas and general patterns of movement within feeding, resting, and nesting sites will be studied. Data that contributes to the recognition of ocean pathways, areas of use by male, female and juvenile loggerheads, and general dive patterns (depth and time at depth) will significantly enhance current and future efforts for protection of this species.

During Sustainable Seas Expeditions underwater transects with the DeepWorker will provide data in which to assess localized loggerhead population, habitat usage, and collect observations on behavior patterns.

By learning more about the daily and seasonal movements, genetic information, and sexual maturity of loggerheads, researchers can better protect this prehistoric species. Here scientists at Gray's Reef are taking an ultrasound of a loggerhead.

(top)

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HIGHLIGHTS
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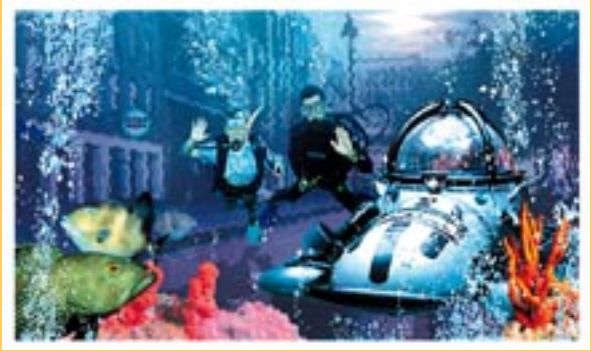
Savannah's Ocean Fest
Sunday, August 1, 1999

NOAA's Gray's Reef National Marine Sanctuary is proud to sponsor the Savannah Ocean Festival on Sunday, August 1, 1999. The event will take place on River Street, Rousakis Plaza, from noon until 5:00 pm Ocean Festival represents the land-based celebration of the Sustainable Seas Expeditions, a two-week mission to rigorously explore the ocean world offshore of the Georgia Coast and specifically at Gray's Reef National Marine Sanctuary.



An Ocean Fest mural.

The Ocean Festival will bring together a variety of exhibits highlighting our colorful ocean world from children's art and poetry to hands-on touch tanks of sea creatures. The NOAA Ship R/V FERREL will be docked adjacent to the plaza and host tours throughout the afternoon. A full-size model of the one-person submersible DeepWorker 2000 will also be available to explore. Live music will be provided by the "World Famous" Crabettes, Savannah Folk Music Society, "Call the Cops" and the Gospelaires. Come join the fun while learning about Gray's Reef and the importance of our vital ocean resources.

The Gray's Reef National Marine Sanctuary is administered by the National Oceanic and Atmospheric Administration (NOAA) and was designated in 1981. The sanctuary protects one of the largest nearshore live bottom reefs off the southeastern United States. Gray's Reef consists of a series of sandstone outcroppings and ledges up to three meters in height, in a predominantly sandy flat-bottomed sea floor. The live bottom and ledge habitat support an abundant reef fish and invertebrate community making Gray's Reef one of the most popular sport fishing and diving destinations along the Georgia coast.

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All the activities of the two week project at Gray's Reef will be described on the special National Geographic Society-NOAA web page for the Sustainable Seas Expeditions. To explore our colorful and fascinating ocean worlds nationwide go to www.sustainableseas.noaa.gov.

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SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

GRAY'S REEF

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July 26, 1999

Reed Bohne, Manager
Gray's Reef National Marine Sanctuary

Laddie Akins, Executive Director
Reef Environmental Education Foundation

'The ship, a fragment detached from the earth, went lonely and swift like a small planet.'

-Joseph Conrad

Gray's Reef research vessel Jane Yarn and the NOAA Ship FERREL departed Savannah to begin the Sustainable Seas Expedition at Gray's Reef. Conrad's quote, except the reference to swift, applies to our departure as we hope we will be self-sustaining for a week offshore.

Gray's Reef Research Vessel Jane Yarn

NOAA Ship FERREL

The seas were calm and the air was heavy with temperatures approaching 100 degrees. The two lumbering planets plowed through the seas and equally thick humidity for the 4-hour transit from Savannah to the sanctuary. Upon arrival both ships settled in to their stations. The Yarn tied up to a mooring buoy near the center

of the sanctuary and the FERREL about a mile to the south to begin deployments for the check-out dive by the Gray's Reef pilots. The heat refused to be ignored and pressed in on the pilot's plans. Precautions must be made to keep cool in the acrylic-domed sea capsule. Like the days before air conditioning, blocks of ice in front of the ventilation fans would do the trick, if we could only figure out how to rig it. The ship, its crew, and the pilots were ready to go, and go they did!

Here's Laddie's report:

"Initially I had mixed emotions about being the first sub dive at Gray's Reef. It is standard to have bugs to work out when you're launching the first dive of a project. But excitement won out and I was ready for action when we got to the final predives on the sub. Around noon we were ready to go."

"The hatch is closed and we are pulling a slight vacuum prior to launching. Everything feels very familiar and I am 'comfortable' but hot during the launch. I can't wait to get to the bottom and start exploring this new area of hard bottom, a mile or so to the south of the normal research area. Even though the prime objective of this first dive is to serve as the checkout dive, we are hoping to locate a new ledge of hard bottom."

'Touchdown!' I wish Larry Munsen could call this one. Visibility is very good, we'll call it about 25 to 30 feet, and I have positioned the sub only a few meters from a nice little hard bottom community. Lots of 1 to 2 foot high sponges, tunicates, and fish. That's what I am here to study."

"I work for the 'REEF' environmental education foundation, based out of Key Largo, FL. We are a non-profit organization with over 15000 members whose primary program focus is on educating people about the marine environment and providing them with a way to collect data that is used by sanctuary managers and other scientists. This data is publicly accessible on our web site at **www.reef.org**. The database now houses more than 17,000 surveys."

"The program originally began in the Florida and Caribbean region in 1993, expanded to the Gulf of Mexico in 1995, California in 1996, and the Pacific Northwest last year. We have been working with the staff and science team at Gray's Reef National Marine Sanctuary to implement this program in the South Atlantic waters and have just kicked off a new curriculum and focus on involving the public in gathering this data."

"For me this excursion into Gray's Reef's waters is a bit of a homecoming. My family is Georgia born and raised since before the Civil War and I have relatives spread throughout various towns throughout south Georgia. I never knew Georgia had this kind of underwater treasure. I moved to Florida to find the reefs and now find myself coming home to do the real exploration."

"I hope I can introduce this underwater habitat to other dive enthusiasts in the state. They don't know what they are missing. So how does this sub work help? First, the depth of the water at Gray's Reef is about 60 to 70 feet. Using scuba we are severely limited in the time we can safely spend at that depth, about 40 to 50 minutes

maximum. The sub gives us the capability of extended underwater time, and we make no bubbles that might frighten some species of fish."

"Second, the deeper areas adjacent to the sanctuary are thought to contain valuable hardbottom communities and large numbers of fish, but their depth of nearly 200 feet prohibit safe scuba exploration. The sub is going to give us our first look at some of these deeper areas and the ability to bring back images of first hand accounts of what we find. My big questions revolve around the capabilities of the submarine to objectively observe fish assemblages. Would fish run from such a space age intruder? Would pilots see the smaller species well enough through the acrylic dome port to conduct a subsurface survey comparable to one done on scuba?"

"The answers to my questions are not far away. As I park the sub motionless on the bottom, I can see numbers of small slippery dick wrasses swimming about just in front of me. For them, I must seem like a big rock on the bottom and they pay me no mind. I begin to explore the area around me and find that the fish don't scatter at all and often seem even curious to see what this big rock is doing, moving around down there.

"I begin my fish survey and record on my checklist the species I see and the relative numbers: black seabass, bank seabass, blue gobies in the distance. The familiar friends are all very easy to pick out. I look up towards the surface and see four orange file fish swimming twenty feet overhead, new species for our Gray's Reef list.

"I have been exploring awhile and seemed to have covered much of the same type of low profile, live bottom community but no ledge so far. Then I see a nice sheepshead swimming towards me and a dark horizon starts to take shape across the bottom. I can make out the beginnings of a two foot ledge and see lots of fish activity here.

"As the ledge becomes clearer, I can see the tails and bodies of five nurse sharks parked together under a single overhang, many more black seabass, and now a half dozen blue angel fish join them. A school of tomtate, grunts, and finally two nice gag grouper. I have been waiting to test out the subs stealth on these wary fish and I'm very surprised to find them easily approachable. I can get closer than ten feet to them before they start slowly to adjust their position to keep their distance. I have been working with the video and still cameras to get comfortable with their operation and the practice is now paying off, as I can frame the fish and squeeze off a few frames before moving on. I can't wait to get a look at the finished product.

"Topside has been in touch with me every 15 minutes or so to check on my life support readings and see how things are going. And now they have called to say it is time to come up. It has been nearly two hours since I dropped in and I feel like I'm just getting started. My fish surveys yielded 18 species, including two species new to our database for this location. I brought her up to the surface and waited for the NOAA ship FERREL to swing around to pick me up. I have hardly begun to tap the sub's life support capabilities, using only a hundred psi of oxygen and none of my ballast air during the two hour dive."

"As the hatch is opened up, everyone waiting on deck has questions and I am all smiles. A resounding success as far as I'm concerned. As I step out of the sub, I can't help but feel a slight tinge of longing, like getting out of the car after your first drive to the store on your new license, but I'll be back soon."

Reed continues:

Night arrives and the ship, seas and sailors settle into the quiet rhythm of the evening. A rich almost-full moon lights the night and the waters, and I am reminded of William Bertram's eloquent description of twilight, written in 1776:

'Dewy evening now comes on, the animating breezes, which cooled and tempered the meridian hours of this sultry season, now gently cease; the glorious sovereign of day, calling in his bright beaming protection of the silver queen of night, attended by millions of brilliant luminaries.'

(top) **RETURN**

July 27, 1999

Reed Bohne, Manager
Gray's Reef National Marine Sanctuary

Today dawned like any other, in Hades, the warm wet atmospheric blanket wrapped closely around the seafaring crew. Even the seas complained it was too hot and humid to be very active, which is our great fortune, creating calm nights and placid conditions for launch and recovery. Today we will continue with check out dives in the DeepWorker and conduct a full dress rehearsal of our planned live Webcast on Wednesday.

Today the good folks from NASA join us, arriving on the daily shuttle boat from Savannah. Andrea McCurdy and Karen Dodson are good-natured spirits from space that arrive with large luggage loaded with gizmos. Our Inspectors Gadget unload their compact gear and set up for a dialogue with the cosmos. Out of one suitcase appears what looks like a diminutive plastic picnic table, but there are no tykes aboard for lunch. This in fact is the transmitting apparatus.

Transmitting aparatus used for satelite communication.

Wires, tiny TVs, phones, and frequency devices begin to multiply out of the suitcases and we stand around them waiting for the clowns to pop out. The array of materiel begins to envelope the ship, an electronic Chia pet gone mad.

This maelstrom mixes with the divers suiting up with double tanks and cables for direct communication to the surface, creating a mad mess of entanglements on our suddenly tiny research vessel Jane Yarn. This Tuesday test is perfect because everything goes wrong. The divers head the wrong way underwater and end up exhausted by the time they reach their mark for broadcast to the surface.

The communications gear from the divers to surface garbled the voices beyond recognition. Our downlink sites receive no signal so they think the show tomorrow will

Andrea McCurdy and Karen Dodson from NASA unload communications equipment.

be a bust. The special film clips planned for the event have not arrived so we're winging the content. We all know now what not to do.

I know this all sounds terribly terrible, but I meant what I said above: "We do now know what not to do!" And so as badly as this dress rehearsal may have gone, we are confident that the real broadcast will be a success, provided we apply what we've learned from these experiences. And we also completed more successful checkout dives, which means this was, indeed, a very productive day.

Closing with another 1776 quote from William Bartram:

'...the well contrived system at once becomes chaos: every idea of happiness recedes; the splendor of glory darkens, and at length totally disappears; every pleasing object is defaced, all is deranged, and the flattering scene passes quite away, a gloomy cloud pervades the understanding... But let us wait and rely on God, who in due time will shine forth in brightness, dissipate the envious cloud, and reveal to us how finite and circumscribed is human power, when assuming to itself independent wisdom.'

(top) **RETURN**

July 28, 1999

Gray's Reef Goes Global

Reed Bohne, Manager
Gray's Reef National Marine Sanctuary

Last night, we convened on the FERREL to reformulate our plan for the live Webcast. Dana Wilkes, Chief Scientist for our first leg of the cruise, orchestrated the revisions to today's concert, and we all agreed that the simplification to the plan should bring success.

We decided to conduct narration from the surface and communicate below directly with the DeepWorker through the sub's more reliable through-water communication system. Kip Evans, National Geographic's intrepid videographer, will be tended by two other divers to keep cable lines in order. Andrea and Karen have calmed the roiled waters in the hinterland, assuring folks trying to link into the broadcast at the Coastal Zone 99 conference in San Diego, California, that all will be well.

Showtime:

At 1 pm EST the camera rolls and we're broadcasting live from Gray's Reef. Cue cards are flipping, questions for our expert panel rolling in, Karen is spinning knobs and flipping switches to go from live on deck to videotape to Kip and his cameras below on the reef to observe Alex Score piloting the DeepWorker and fielding questions from the surface.

The broadcast apparently is coming in just fine at CZ99 and we are joined by phone from the conference by Deputy Assistant Secretary for Oceans and Atmosphere, Sally Yozell, who sends greetings and joins in the conversation on board. Cathy Sakas and Laddie Akins are providing running commentary with a naturalist's tour of Gray's Reef that is

Alex Score, piloting the Deepworker and fielding questions for the live web cast.

spectacular. Our third expert aboard for the webcast is Sherri Littman of the University of Georgia. Sherri talks about the time 10,000 years ago when sea level had dropped and Gray's Reef was a cool temperate forested area. Right now it sounds very inviting. The show itself litterally sizzles with everyone off camera wearing towels on their heads trying to keep cool under the 100 degree Georgia sun.

Andrea and Karen from NASA have worked wonders for us all by bringing the reef to the world on the Internet. It's high fives all around after the broadcast. The old saying that a joy shared is a joy doubled truly applied on the Jane Yarn that afternoon.

An archive of the event will be available in a couple of days at:

http://quest.arc.nasa.gov/ltc/ram/sse0728-v.ram

We repair below decks for some lunch and liquids. The meal is most welcome and the cool air refreshing. We have, however, been visited by a swarm of biting flies on the boat. It seems incredible that 20 miles offshore these pests should find us and so thoroughly enjoy our company. The word has gone out to the shuttle boat to bring back not water but fly swatters and pest strips. Nature is not always serene, and we consider adding this singular tormenter to our wildlife species list for the sanctuary. Our fellow traveler William Bartram encountered similar circumstances in his journey along the coast in 1776.

William Bartram wrote:

'These biting flies are of several species, and their numbers incredible; we traveled almost from sunrise to his setting, amidst a flying host of these persecuting spirits, who formed a vast cloud around our caravan so thick as to obscure every distant object... the species lies in ambush in shrubby thickets and cane brakes near water; whenever we approach the cool shades near creeks, impatient for repose and relief, almost sinking under the persecutions from the evil spirits, who continually surround us and follow us over the burning desert ridges and plains.'

(top) **RETURN**

July 29, 1999

Bruce Cowden, Marine Operations Coordinator
Gray's Reef National Marine Sanctuary

Laddie Akins, Executive Director
Reef Environmental Education Foundation

What an incredibly satisfying, productive two days we've had! Bruce has done some successful fossil survey work, and Laddie has been very busy indeed, doing fish census dives with both scuba and the sub.

Here's Bruce's dive report:

"10 Fathom Fossil Foray"

"Today, I had a wonderful (albeit hot and sweaty) two and a half hours of 'mowing the lawn.' Dana Wilkes and I sat down and figured we would do a complete scientific survey of an entire gridded area to look for possible fossil sites. This also gave Lori Sutter, our GIS expert from NOAA's Coastal Services Center, an opportunity to track and map the sub on GIS and correlate that with satellite imagery.

"We planned that I would take a still photo every 5 minutes to compare my position on the bottom with the location coordinates Lori was logging. The dive went like clockwork. Everything worked perfectly: all the sub's systems, navigation, everything. I ran the videotape cameras on a series of transects, going 15 minutes to the north, 10 minutes to the east, 15 to the south, and 10 the west. I did 3 line transects, which covered about a square mile. The entire dive went beautifully.

Bruce Cowden in the DeepWorker

"The area where I started my survey was some nice live bottom habitat, which I was able to observe quite closely. As I moved further along, I found a large fossil bone on the bottom, probably the shaft and joint of a bison leg, black phosphate in color. The

location was recorded and I took some still footage and video of the fossil.

"During the first transect, I also came upon a big ol' loggerhead turtle sitting on the bottom. She saw me and flipped off the bottom, then curiously looked at me and my alien craft. I followed her for awhile, and she didn't seem to get spooked, so she just kind of hung out in the neighborhood.

"This first full-length dive at the reef was a great experience. I could finally see for some distance, unlike the cloudy water we trained in. As soon as I got down to the bottom I could see everything, with great points of reference. Steering was very responsive, and I could keep nice straight lines. When I saw the turtle there were schools of bait fish swimming around it and they stayed with me for the rest of the cruise. They were like puppy dogs on a leash. It was tremendous fun. The fish seemed to be publicity hounds too, because every once in awhile they would zip around in front of the camera for a picture.

During the past few days, Laddie Akins has been busy doing scuba reef surveys from the other ship, the Jane Yarn. Then late Thursday night, he had a chance to dive the sub again.

He provided the following report on both activities:

"I've been chomping at the bit to get back into the sub since my first dive on Monday, but there are many other members of this team who are also patiently waiting their turns as well. So while most of the sub operations are taking place from the NOAA ship FERREL, I'm getting good research dives in by staying on the sanctuary's research vessel Jane Yarn. Also on board the "Yarn" are fisheries scientists Roger Mays and Tom Potts (who also will be piloting the DeepWorker this week and next), Roger's wife, Ginnie, and National Geographic photographer Kip Evans. Kip has been actively shuttling back and forth between the Yarn and the FERREL most every day.

Laddie Akins in the DeepWorker

"Roger and Tom have been working on fisheries issues at the Gray's Reef sanctuary for a few years now and we share a great camaraderie regarding fish stories--the unusual and bizarre things we've seen here and abroad. The methods we are using are slightly different, designed to generate different information on the fish assemblages that we're seeing. Roger and Tom are using a method developed by Dr. Jim Bohnsack at the National Marine Fisheries Service. It requires them to sit still on the bottom for five minutes and record every species they see in an imaginary 7-meter circle around them. Three are permanent stations where each count takes place every year. After they compile their list, they then make one complete rotation for each species and count the exact numbers of that species. The method is good to give density measures that can be statistically

analyzed very easily.

"The method I am using is the Roving Diver Technique developed by REEF. I swim the reef system looking for as many different species as I can find, wherever they may be - under ledges, inside sponges, in the sand near the hardbottom. As I compile my list, I also record abundance in relative categories: 1, 2-10, 11-100, or more than 100 for each species on my list. Though the numbers are not as exact, I can get a good picture of species richness and for many fish like wary groupers, I am able to include them on my count where they would seldom get within the 7 meter radius of Tom and Roger. Both methods have their advantages and disadvantages, but together we are helping to paint a good picture of what fish are found here and how many there are.

"One of the benefits we've found in the REEF method is that we can also train volunteer divers to conduct these surveys, and the higher the sample size, the more statistically powerful the information becomes. And it's fun! Divers enjoy having an activity to engage them during their dives, especially an activity that helps provide information for managers to better understand the resource. We're looking for a large number of divers to do these surveys at Gray's Reef on a continual basis.

"Ginnie Mays and I have buddied up on a few dives so far and she is really getting into the fish surveys. On Tuesday, we dropped down to a plain sandy bottom near the anchor and she immediately waved me over to point out a wonderful little fish called a blue spotted sea robin. Only six inches long, the Sea Robin has large wing-like pectoral fins, armor like bony plates over the head and crab like ventral fins for crawling across the bottom. We watched it for a good 10 minutes as it moved slowly about the sand looking for little invertebrates to eat. When we got too close, it spread its wings out over the sand to display the brilliant blue colors hidden in their folds. What a sight!

"It's thursday night, and I'm eagerly preparing for my next sub dive, the first night dive of the cruise. I can't wait to see what's going to come out from daytime hiding.

"I've been shuttled to the FERREL and jump right in to pre-dive mode. Cathy Sakas is my dive technician and we work though all of the pre-dive schedule quickly and efficiently. Prep of the sub is becoming second nature to us all.

"At 8:45 pm the hatch is closed and the FERREL crew is setting me into the water near an area we want to explore. Commander Paul Moen, an old friend from the Keys now Commanding Officer of the FERREL, advises me over the radio that I'm about 3/10ths of a mile from the supposed ledge. I get clearance to dive and drop quickly from the dim surface. The sub is equipped with its own halogen 'headlights' as well as two high intensity lights for the photographic equipment. As I settle to the bottom, I can see a small area of sand in front and slightly to my sides. Otherwise, my field of view is only of a deep black.

"Cathy radios from the chase boat above to take a heading of 150 degrees, and I'm off. Compared to a day dive, the only big difference is lack of good peripheral vision. I can see fine where my lights illuminate the sandy bottom in front, but nowhere else.

"It seems as though I am a popular item down here tonight. My lights are attracting all kinds and numbers of interesting little critters. Small larval fish, shrimp, and worms swarm around the brightness of the HID lights. Their numbers and activity bring in the Round Scad that we've seen up near the surface during the day. At times it's difficult to see the bottom three feet away for all of the life blocking my view. As I fly the sub barely over the bottom, the entourage keeps pace and follows my every move. A couple of small squid jet into the lights and grab a quick meal from the buffet, but they don't stay around to play.

"I've been traveling the desert sands for an hour and a half and finally come into a nice hardbottom area. Still not the ledge that I was looking for, but at least I have some bottom structure now. I set the sub down to focus in on the camera systems for a minute, and when I look up, I see a few black sea bass have wandered up under my lights. Only a foot or so in length, the sea bass are not even slightly intimidated by my sub. I watch for a few minutes and focus in with the video.

"A short jump off the bottom by one of the fish catches my eye. I watch the sea bass closely and see the quick jump again. One more time and I realize that it's feeding! The small little worms and shrimp drawn in by my light are a delicacy for this bass. As this one continues to grab a bite every 30 seconds or so, others are drawn in to do the same. I work the video to see if I can get two in the same frame. When I look up again, there are 15 then 20 of the Sea Basses all under my lights and all eagerly feasting.

"These sea bass are what we refer to as ambush predators. They feed by getting very close their prey and then opening their mouths wide to create a vacuum that slurps dinner right down. Every morsel is indicated by a wide white flash of the inside of the bass's mouth. I am fascinated and mesmerized by the show.

Black Sea Bass Feeding

"At 10:45 pm, topside calls again and Cathy relays that I've got another fifteen minutes before my dive is over. I've spent almost an hour watching my little bass friends! I want to try a quick experiment and shut down all of the lights. Black. My computer screen and control panel lights are the only sources breaking the darkness. I was hoping to see some bioluminesce in the water, but nothing so far. The small fish and shrimp seem to have dissipated, but I can't tell for sure. A few want to join me in the sub and are resting on the top of the acrylic dome, but for the most part, there is quiet and dark. Ten minutes later I turn my lights back on. The snowstorm of life that had hovered around my sub when the lights were on has gone, and the scene before me is tranquil and quiet. But not for long.

"The flurry of activity quickly resumes around my lights. The Sea Bass are back, as are the larval fish, Scad, shrimp, and soup of life that has followed me around since

Black Sea Bass

the beginning of the dive. It's time to ascend, now, so I shut down the cameras and stow the manipulator controls, recording deck, and survey slate. It's a short ride to the surface and topside is waiting when I arrive. The FERREL radios from a short distance away and I'm back to reality again.

"At 11:30, I'm lifted onto the deck of the FERREL without as much as a bump or sway. As the hatch to the sub is opened I'm greeted by all familiar faces and questions of what it was like. How do you put into words the magic of the ocean? The best I can manage for the first few minutes is to stammer out 'That was one fine ride!'. Then the stories of the dive begin to flow, amid smiles and laughter and a fine feeling of camaraderie.

William Bartram (1776) adds

"Time now admonishing me to rise and be going, I, with reluctance, broke away from this assembly of maritime beauties".

(top) **RETURN**

July 30, 1999

Midnight at the Oasis

Cathy Sakas, Marine Educator
Gray's Reef National Marine Sanctuary

Friday night, Cathy Sakas completed the second night dive of the mission, a most spectacular dive at that.

She provided the following report:

Cathy in DeepWorker

At 6:00 p.m., the seas were calm, and only the slightest puff of breeze kept the deck from being a complete convection oven. The thermometer read 130 degrees Fahrenheit in the direct sun on the steel deck of the NOAA research vessel FERREL. Needless to say I was soaked with sweat as I went through my pre-dive check with Alex Score, who was serving as my technician. With my splash-in time fast approaching, we were working efficiently to thoroughly prepare the sub for my night dive, completely checking every detail. I did not want anything to go wrong with the equipment. I wanted it to be perfect so there would be no excuse to abort this dive-of-a-lifetime, this incredible opportunity to observe the change from diurnal to crepuscular to nocturnal (day to dusk to night) activity on a spectacular live bottom reef, my reef, Gray's Reef.

At 7:25, I was in the sub with the hatch closed and the vacuum being drawn to get my cabin pressure to negative-one atmosphere. This negative cabin pressure would allow me to add air for breathing while keeping the hatch properly sealed. I was focused on my equipment and getting my oxygen level up to 20.8%, but I still had an ear-to-ear grin on my face that is still there this morning. I just knew everything was as it should be and that I was in for an incredible experience. With the sun nearing the water, the hazy low stratus clouds took on a pinkish yellow hue. It was mellow.

Within ten minutes I was hoisted up by the ship's crane and dipped in the ocean. With my tag lines unhooked and the tracking line and buoy secured to my dome I was ready to submerge. Captain Paul Moen of the FERREL had maneuvered the ship to .5 nautical miles upcurrent of my target, so by the time I hit bottom I had drifted to within a hundred yards of the ledge with sparse soft corals and sponges leading up to it. I was thrilled. Once the problems with the through-water communication system were worked out I was ready to go to work.

My first task was to find a good patch of rocky outcropping and sit and watch what happened. I maneuvered the sub up off the bottom a bit and moved forward. Within a few minutes I located a good spot and set the sub gently down on a sandy patch adjacent to the small garden-like oasis of reef. The sun was about to set, but the light was still quite bright below. I watched a group of spottail pinfish and a few porgy nosing around the soft coral as the light began to fade. Just to the edge of my field of vision a five-foot nurse shark cruised the sand with two remora in attendance as well as a small entourage of pinfish. Then, as if a bell had sounded everything seemed to ghost away. Nothing was stirring. It was like a shift change had occurred without any visible evidence of scurrying bodies. They just simply weren't there anymore. I sat longer.

A brown Mottled Octopus

Darkness came to the reef, and the bottom seemed still. I wanted to see bioluminescence but didn't. The surface glowed a soft gray green but the bottom was inky. After a few more minutes of straining to see the iridescent green of any bioluminescent creature I decided to turn my lights on to get some video footage. Within a matter of seconds, black sea bass started coming into the light. First a few, then more. While I was giving life support readings to Alex, a brown mottled octopus stole up to the base of a vase sponge and curled up into an indistinguishable heap. A few seconds later, it reached out with two arms and pulled the other six and its ponderous head into the full circle of light. In a blur of brown and beige the octopus lashed two arms towards a black sea bass. The black sea bass was quicker, its life-saving reflexes responding just in time. The stealthy fluid movement of the octopus was impressive but expected; its flash speed lunge was not. The interesting thing is, I did not even know this whole scene had even taken place until 1:00am the next morning when I reviewed my tapes. I had been looking at my gauges giving life support readings, so for just a few seconds my head was turned away from the lights. It was long enough for me to miss this incredible natural history Kodak moment first hand, but I was very glad the tape was rolling.

With several minutes of good black sea bass feeding activity and single appearances by a lizard fish and a trunk fish and oh, yes, a peacock flounder, I decided to sit again with my lights off. I positioned myself in a good spot, so in case I drifted with the current I wouldn't hang up on anything. A few minutes after my lights died I was treated to the soft eerie glow of bioluminescence.

Off to my port bow was the best show. As the sub moved at a snail's pace down current, it left a wake of soft green glows. Some of the glows were globular in shape, and I guessed that those creatures were the ctenophores, the comb jellies that I had seen before shutting off my lights. The other glows were from the soft corals and the dinoflagellates hitting the sponges. Every now and again a squiggle of green light, most likely from a small worm, would wiggle by the dome. There were a few quick streaks of green too,? a small fry no doubt blessed with making its own cold light.

After 20 minutes or so it was time to give life supports again so I turned on my camera lights and was informed that divers were coming down for a photo session. Before diving, I had worked out a series of hand signals with the project's official videographer Kip Evans of the National Geographic Society. He was accompanied by the FERREL's Executive Officer Dave Score, Alex's husband. As soon as they entered the water I could see the bright lights of Kip's camera descending in a scene befitting a science fiction film of a space ship landing in a misty fog.

The duo reached me in a minute or two and we proceeded as planned. Kip made signals, and I responded, moving in this direction or that, making a wide lazy circle, stopping and sitting still to talk about what I was seeing. The plan was for me to engage the inside camera with audio while he was shooting me outside. We planned to mesh the two together to make a super video. Unfortunately, the audio from inside the sub didn't happen. My tape had already run out. The footage Kip shot was spectacular, and it was awesome to see the density of small fry that was attracted to my lights. At one point the whole sub was covered in this cloud of tiny undulating white and silver bodies with bigger white and silver bodies cruising through every now and again. It was incredible stuff. After the half-hour photo session, the divers returned to the surface, and I was given permission to resume my work.

The night before, on Laddie Aikins' night dive, I had served as his technician and had the opportunity to sit in the chase boat for two and half hours with NOAA SSE Mission Coordinator Dana Wilkes. I had told Dana that I wanted him to promise me that he would guide me as directly as possible to the ledge that had eluded Laddie. We knew the coordinates, but Laddie had run out of time in pursuing it. The afternoon prior to my dive Alex and Dave had found it while scuba diving, so we had a visual confirmation of it as well.

Dana was true to his word, and gave me good headings complimenting me on running a true course. But I had only been running a few minutes with all my lights on when out of the hazy green black a large hammerhead came in fast. The big male, with claspers apparent and a remora attached, swung his large head fitfully from side to side. Then with remarkable agility he doubled up on himself as he turned towards the sub. With beautifully graceful fluidity he swam towards the dome and hit it with his head! I guessed he was smelling with the chemoreceptors on the lobes of his head. The lights had guided him in, but perhaps the smell of the divers was still present. I was ecstatic. What a sight to behold! I was transfixed by how well-suited for his environment this great fish was. His gray skin and supple fins rippled as he moved effortlessly through the water. His lithe body, with those odd-looking lobes beautifully lit from the glow of my camera lights, are an image that will be indelibly fixed in my memory. This was on my wish list, and I was one lucky lady to have this wish fulfilled.

A drawing by Gray's Reef's Bruce Cowden, depicting Cathy's encounter with the hammerhead shark. (click on the image for the full size drawing)

With a few more course corrections from Dana, I was at the ledge and gave a whoop for the beauty of it. I had been traveling at ten feet from the bottom with an entourage of scad and a host of fry. At times my view was blocked with the density of these fish. But when the ledge appeared it was apparent and spectacular. My fear that I would miss it for the cloud of fish was unjustified. In my lights the ledge was grape, fuschia, and salmon with some mauve and orange in there too. The encrusting sponges, soft corals and tunicates were brilliant in my night high intensity lights. I was thrilled. How could one person be so lucky to experience all of this? I was and am humbly grateful.

I watched for just a moment and video taped and took some stills. Then I was ready to complete my mission by sitting again in total darkness to look for bioluminescence, the cold green light that marine and terrestrial organisms emit for different reasons. Fireflies or lightening bugs are probably the most familiar to everyone. That green light they flash is the same chemical reaction that some sea creatures produce. I was curious to know whether the bioluminescence would be more or less here, if at all, as compared to what I had seen in the soft coral and sponge flat live bottom.

With my lights turned off I had to shut off my computer screen that controlled the sonar and cameras. It was way too bright. I didn't want to turn off my touch screen that controlled some vital equipment, so I put my hand towel over it to darken it. But even the green light from the control panel and the red light from the camera control panel gave off too much light. I sat with my head against the inside of the dome with my hands cupped on either side of my head to give me a window of darkness. As I sat there, hair and clothes soaked from my sweat in the over three hours of the nearly 90 F temperature inside my capsule I was not uncomfortable, just wet, and totally transfixed at what was happening outside my dome.

As if I were a giant alien sitting in my huge spaceship watching a Lilliputian village respond to darkness, small pinpoints of light began to glow. It was the most spectacular natural history moment I have been privileged to see yet. One by one the green dots appeared over the ledge. They popped up in long lines like lights on a radio tower and spread over the surface like landing lights on a runway. What a sight! The upright lines of lights swayed ever so slightly in the vacillating current. I was completely mesmerized. I guessed that the radio towers were the soft corals and

erect sponges, and the runway lights were the encrusting sponges and tunicates or at least dinoflagellates on them. I'll just have to make more of these dives to find out.

I knew my time was about up and that my support crew would be ready to end the dive. It takes a lot of people to make a dive happen, and at 11:30 at night, these people were ready to call it a day. I, on the other hand, was ready to spend another three hours just watching this natural wonder take place on my reef, this phenomenal Gray's Reef.

Thousands of Fish

Colonial Explorer William Bartram (1776) writes

"Behold, for instance, a vast circular expanse before you, the waters of which are so extremely clear as to be absolutely diaphanous or transparent as the ether...At the same instant innumerable bands of fish are seen, some clothed in the most brilliant colors... with free and unsuspicious intercourse performing their evolutions: there are no signs of enmity, no attempt to devour each other; the different bands seem peaceably and complaisantly to move a little aside, as it were to make room for others to pass by.

But behold yet something far more admirable, see whole armies descending into an abyss, into the mouth of the bubling fountain, they disappear! are they gone forever? is it real? I raise my eyes with terror and astonishment,---I look down again to the fountain with anxiety, when behold them as emerging from the blue ether of another world, apparently at a vast distance, at their first appearance, no bigger than flies or minnows, now gradually enlarging, their brilliant colors begin to paint the fluid.

Now they come forward rapidly, and instantly emerge, with the elastic expanding column of crystalline waters into the circular bason or funnel, see now how gently they rise, some upright, others obliquely, gently lifted or borne up, by the expanding fluid towards the surface, sailing or floating like butterflies in the cerulean ether: then again they as gently descend, diverge and move off; when they rally, form again and rejoin their kindred spirits.

This amazing and delightful scene, though real, appears at first but as a piece of excellent painting: there seems no medium, you imagine the picture to be within a few inches of your eyes, and that you may without the least difficulty touch any one of the fish, when it is in reality twenty or thirty feet under water".

(top) RETURN

August 1, 1999
Oven Baked Aquanauts

Reed Bohne, Manager
Gray's Reef National Marine Sanctuary

Alex Score, Educator
Gray's Reef National Marine Sanctuary

Cathy Sakas, Marine Educator
Gray's Reef National Marine Sanctuary

Reed writes:

The heat is on. Even at this early hour, as we set up for our SSE OceanFest, it raps around us like a fur coat in a sauna. NOAA's Weather Service is issuing heat advisories warning that the heat index today will be in the 120 degree range. We're sure this will affect turnout at the festival, and we brace for a crowd of mad dogs and Englishmen.

NOAA Ship Ferrel had over 800 visitors during the open house in Riverstreet.

The FERREL is dressed for the occasion, with signal flags flying and banners celebrating the Sustainable Seas Festival draped over the sides. Our special festival tents are populated by children's art submitted especially for the expedition, and aquaria and displays from the University of Georgia Marine Education Center and the Coastal Encounters program from St. Simons Island, GA. Under other tents the DeepWorker 2000 is on display and Gray's Reef videos and exhibits dress the scene.

Here's Alex Score's report of her work, manning the booths and working with the event's young visitors:

The Ocean Fest in Savannah's Riverstreet August 1, was like no other event I have ever experienced in Riverstreet before. For one, the heat was excruciating, over 120 heat index, yet people kept coming around the booths to learn more about the Georgia's ocean and about the Sustainable Seas mission.

The NOAA Ship FERREL had over 800 visitors touring the boat and coming in close contact with the three DeepWorkers on the deck. I helped kids jump in and out of the DeepWorker mock-up, and watched their eyes widen once the hatch went down, and then watched as BIG smiles lit up their faces. "This is really cool", a 9 year old boy told me, "Can I drive it one day'"

I told him he can do whatever he believes he can do in life as long a he has a dream, just like Sylvia Earle once had a dream of exploring our oceans and envisioned this incredible mission with the DeepWorker that will explore our nations marine sanctuaries. The most common question I was asked over and over again was if I felt claustrophobic inside the DeepWorker. I would smile and explain how I was small framed and I fit comfortably. The dome allows a 360 degree view from inside, and being underwater with fishes and bottom invertebrates was enough for me to forget the small space and heat inside.'

photo

Coastal Encounters Nature Center and University of Georgia Marine Extension Center had hands-on activities and sea creatures for kids to handle.

Reed takes over the narrative again:

Our first musical group, Bob and Judy Williams, with the help of Melanie Mirande from the Savannah Folk Music Society, take the stage to warm up the sweaty crowd.

The crowd amazes us! Right from the opening at noon the plaza is packed with families touring the exhibits and boarding the FERREL for a look at the ship and the three DeepWorker submersibles on deck. Congressman Jack Kingston from Georgia's First Congressional District and his son John joined us for a tour, trying the subs on for size and touring the ship courtesy of the FERREL's Commanding Officer Paul Moen.

The crowd kept a steady flow throughout, with tremendous interest in the subs and their operation. Bob and Judy finished their outstanding set and turned the stage over to the Gospelaires, an a cappella group from Pinpoint GA. Their glorious harmonies wash over the festival, a perfect blend for a Sunday afternoon.

The festival staff and volunteers are starting to wilt as the unrelenting sun presses on. To lighten our spirits, the World Famous Crabettes take the stage, mixing vaudeville, polka oom paa paa, and nostalgic music for the appreciative festival crowd. Gray's Reef's own Cathy Sakas takes the mike for a sultry rendition of Summertime.

The livin' is easy in the late afternoon as the sun abates a bit and the festival begins to wind to a close. Dr. Sylvia Earle arrives, delayed a bit by airline rescheduling, but in time for the student summit and book signing at the appropriately named store 'Washed Ashore'.

photo

Sylvia's new book, *Wild Ocean*, just released from National Geographic Books, is an amazing blend of evocative prose and stunning imagery of America's National Marine Sanctuaries. This book, as well as her two recently released children's books, *Dive* and *Hello Fish* (also from National Geographic Books) are a huge hit.

Congressman Jack Kingston had the opportunity to sit inside the DeepWorker while Gray's Reef Marine Operations Coordinator, Bruce Cowden explained how the DeepWorker life support systems operate.

Cathy Sakas leads the student summit with Sylvia and picks up the story here:

photo

'The students (high school students from Gray's Reef's Savannah Student Ocean Council and the college students from Skidaway Institute of Oceanography) had been at the festival on and off all day, taking occasional breaks from the relentless heat waiting for a chance to speak with Sylvia and to learn from her vast experiences in studying the oceans.

Our own Cathy Sakas, Gray's Reef Marine Educator and SSE pilot, joined in with the Crabettes to sing a song during the Ocean Fest.

'Before Sylvia arrived, the students spoke with Sarah Mitchell, Laddie Akins, Tom Potts and me, all DeepWorker pilots, about our various projects. We asked them how they would use the subs to study their area of interest. Their answers were surprisingly in line with ours. Explore, observe and make a plan to answer questions that were not initially answered.

'Once Sylvia arrived they closed in their circle of chairs around Sylvia to catch her every word. She offered them the same career advice she's always offered her own children: 'Do what makes your heart beat fast!' She urged the students to study what they felt most passionate about, despite any obstacles put in their path.

Click here for audio clip of the Crabettes. (RealAudio), for help see About this Site

'She also suggested that sometimes, in order to get a foot in the door, you have to take the initiative and start observing on your own time and with your own resources. In other words, you have to make things happen for yourself. Her other pearls of wisdom were strung throughout the summit, but perhaps the most passionate was her charge to them to be unrelenting stewards of the oceans and concomitantly our planet.'

photo

Kids gather along the DeepWorker for a turn to sit inside the DeepWorker.

photo

Kids gathered around to create "Ocean" art during the festival.

William Bartram (1776) writes

"How glorious the powerful sun, minister of the Most High, in the rule and government of this earth, leaves our hemisphere, retiring from our sight beyond the western forests! I behold with gratitude his departing smiles, tinging the fleecy roseate clouds, now riding far away on the Eastern horizion; behold they vanish from sight in the azure skies!"

(top) **RETURN**

About this Site

World Wide Web offerings for the Sustainable Seas Expeditions (SSE) are provided on two sites, here and at the National Geographic Society. This site presents the perspective of NOAA's National Marine Sanctuary program, and is intended to provide readers with up-to-date information on the status of the project and reports from expedition participants. The principal offering on this site is the Sanctuary Log, a day-to-day account of the adventures and discoveries of expedition participants. This site also provides other expedition material, described below in the **Content Sections**. Many related offerings are available on the official Web site of NOAA's **National Marine Sanctuaries Program**.

We appreciate your comments. Please email them to:

SSEcomments@noaa.gov

Content Sections

The **Home Page** provides access to all major SSE offerings. Three special sections of the Home Page -- Current Events, Live Events, and Did you know? -- will be updated regularly as the expeditions unfold. The home page will highlight expedition adventures, facts, and events.

The **Sanctuary Log** is the principal means of documenting the missions. For each expedition, readers can review background information, follow day-to-day happenings, and read a series of informative logs. A variety of authors will contribute.

About the Expeditions is a summary statement of the goals and strategies of the Sustainable Seas Expeditions.

Schedule of Events is a broad calendar of expedition activities. Due to the nature of conducting at-sea projects, variables such as poor weather and sea state can postpone or force the cancellation of certain expedition activities.

Technology pages provide summary descriptions of the technologies used in the expeditions. This section will expand during the expeditions as new technologies, such as geographic information systems and side scan sonar, are deployed.

Live Events bring the Expeditions directly to readers around the country. There are two types of events: live Web chats with participants of the expeditions, and live video broadcasts from the SSE team. The section previews upcoming chats and links users to pages for registration, participation, and observation. Summaries are also offered.

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Technical Information

Browsers. This site is designed to be completely compatible with Netscape Navigator (v3.0 and above, recommended) or Microsoft Internet Explorer (v3.0 and above, recommended); however, other browsers can also be used.

Access Time. Many pages contain photographs or streaming video. The purpose of these images is to enhance the visual appeal of the page and provide supplemental information. Some images have been provided with captions that allow those readers who do not load images immediately to select specific images for viewing.

Fonts and Type Sizes. Verdana, Arial, and Helvetica are the default fonts for this site; sizes vary with specific sections and pages. While other fonts will work, it is recommended that readers do not override this font selection. These fonts have been chosen for easy reading and to be visually pleasant.

Printing Pages. This site has been designed to ensure simple printing. We recommend printing in portrait format at 100% with backgrounds turned off.

Navigation. Navigation through the site is straightforward. To ensure ease of access, a pull-down navigational menu is available on all pages. This provides access to all of the major sections of the site.

Site Index and Search. These two pages provide additional access assistance. The site index is a complete listing of the higher levels of the site. Search is a standard word/phrase search through all text on the site's pages.

Advanced Features

Several special features are in use. Streaming audio is offered as RealAudio; streaming video as RealVideo and/or QuickTime; virtual reality movies as Quicktime; computer generated animations as Shockwave/Flash.

RealPlayer can be downloaded at:
http://www.real.com/products/player/index.html

QuickTime can be downloaded at:
http://www.apple.com/quicktime/download/index.html

Shockwave can be downloaded at:
http://www.macromedia.com/shockwave/download

For Additional Technical Information. If you would like information about any technical aspects of this site, please send an email to:

SSEwebmaster@noaa.gov.

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Sustainable Seas Expeditions: The Sanctuary Perspective

The Sustainable Seas Expeditions is a five-year project of underwater exploration and discovery of the marine world with special emphasis on the national marine sanctuaries of the United States. The expeditions are the brainchild of Dr. Sylvia Earle, scholar and Explorer -In-Residence of the **National Geographic Society**. Led by Dr. Earle, the expeditions are a project of the National Geographic Society in cooperation with the **National Oceanic and Atmospheric Administration (NOAA)** and other government agencies, industry, and private institutions, made possible by a grant from the **Richard and Rhoda Goldman Fund**. The world renowned National Geographic Society, an institution recognized for over a century of achievement in exploration and conservation, has project oversight. Ship and staff support are provided by NOAA, the federal agency responsible for managing the **National Marine Sanctuary Program** and known for its extensive experience in marine research, exploration, data acquisition, and product development.

Project Goals

The expeditions have four goals: exploration and discovery, scientific research, use of cutting edge underwater technologies, and public awareness of the marine environment with an emphasis on protection of marine species and ecosystems.

1. Exploration and discovery. Exploration and discovery are the centerpiece of the expeditions. As Dr. Earle has said: "The submerged part of the continent is less well known now than the western United States was to explorers Lewis and Clark when they set out across North America nearly 200 years ago." How can we begin to protect these areas and the life that inhabits them for future generations when we know so little about them? With the assistance of new

technologies, the expedition team will explore areas never, or only rarely, visited before. These explorations will be documented by the observations of the pilots and video and still imagery.

2. Scientific research. In the years ahead, humanity faces many challenges in the ever-expanding and complex world of ocean management and resource protection. The marine science community will be called upon as never before to provide insights to complex questions on ecosystem health, economic impacts and tradeoffs, and long term trends. The expedition team will conduct many scientific investigations, such as habitat characterization, predator-prey relationships, and productivity assessments.

3. New Technologies. The ocean is a challenging and hazardous work environment. Effective exploration and research require the right tools. Pressure and absence of breathable air make the sea an inhospitable place for humans. Technologies to explore the depths can be expensive and require considerable logistical support. SSE will employ the DeepWorker, a compact, one-person submersible capable of diving to 2,000 feet, well beyond the depth achievable with SCUBA gear. Other technologies that will be used include compact ROVs, new camera systems, shipboard tracking systems, navigational tools, and geographic information systems.

4. Raising Public Awareness. The spirit of adventure inherent in the exploration of an uncharted and dangerous world is captivating to young and old alike. The compelling nature of the expeditions focuses public awareness on the marine world, its wonder and fragility, its special nature and importance to human survival. Throughout every field season and at every site, numerous educational and outreach events are offered. Young people are provided opportunities to participate. National and local media are engaged. And the story of the expeditions is chronicled daily to the entire world on this Web site and on the official site of the expeditions at National Geographic.

The National Marine Sanctuaries

Sylvia Earle explained how she decided to focus the Sustainable Seas Expeditions on the U.S. national marine sanctuaries:

> "It was tempting to undertake something global -- exploration of coral reefs worldwide, a thoughtful mission of polar research or a much-needed effort to evaluate the status of deep sea fish and creatures that live in the open sea. But after some thought, it seemed to me that the best way to use this extraordinary opportunity to make a difference would be to focus attention on this nation's aquatic backyard-- the underwater part of the United

States, from the shore to the edge on the Exclusive Economic Zone -- and to build on the nation's 27 year old National Marine Sanctuary Program. Presently, there are twelve sanctuaries that loosely ring the continental U.S. with additional sites in Hawaii and American Samoa. The need to explore and protect these special areas is urgent."

Taken together, the twelve national marine sanctuaries provide a wealth of exploration possibilities. From Stellwagen Bank in the northeast to the stressed coral reefs of the Florida Keys to the canyons of Monterey Bay to humpback whale populations in Hawaii, the sanctuaries represent much of this nation's marine diversity.

NOAA embraced the idea of focusing the Sustainable Seas Expeditions on the sanctuaries and welcomed the opportunity to enhance the research and educational dimensions of the sanctuary program. NOAA offered support for the project from the outset, providing research vessels, scientific expertise, and its organizational network. In partnership with the expedition team, sanctuary staff have devoted themselves to planning and supporting the expeditions.

Year One -- 1998

The first year of the project was dedicated to essential planning and preparation. Everyone knew at the outset that this project would be complex, technically challenging, and fraught with the uncertainties that are ever present in ocean exploration and research. Much had to be done: logistics, training, safety protocols, advisory committees, submersible engineering, scientific review, and more. Without this essential preparation, the critical field work conducted in 1999 and beyond could not have been undertaken.

Year Two -- 1999

The second year of the project was the first field season. April 1999 marked the inauguration of the at-sea phase of the project. In total, the expedition team completed nine missions last year, a very ambitious schedule that rigorously tested the team's abilities. The nine visited sanctuaries were:

Gulf of the Farallones National Marine Sanctuary (April 16-26)
Cordell Bank National Marine Sanctuary (April 27-May 6)
Monterey Bay National Marine Sanctuary (May 9-22)
Channel Islands National Marine Sanctuary (May 26-June 3)
Olympic Coast National Marine Sanctuary (June 17-30)

Stellwagen Bank National Marine Sanctuary (July 9-15)
Grays Reef National Marine Sanctuary (July 26-August 6)
Florida Keys National Marine Sanctuary (August 16-27)
Flower Garden Banks National Marine Sanctuary (Sept. 1-13)

Throughout the field season, activities were taking place at sea and on land. 138 successful DeepWorker dives were completed; there were 12 open houses, over 30 educational events, eight student summits, and two teacher workshops.

Year Three -- 2000

This year the expedition team has already visited a tenth sanctuary, the Hawaiian Islands Humpback Whale National Marine Sanctuary for two weeks in January.

The major work of 2000, the summer season, will see the team return to three sanctuaries for extended periods: Channel Islands (June 3-24), Monterey Bay (June 25 - July 20), and the Florida Keys (August). In addition the team will conduct work in the eastern Gulf of Mexico, in an area known as the Florida Middle Grounds, a possible candidate for designation as a national marine sanctuary. The thrust of these expeditions will be research and exploration with emphasis on habitat characterization assessment of important threatened species, and evaluation of the effectiveness of marine protected areas.

In the Channel Islands, the research team will examine the relationship of fish species distributions to the geologic character of the sea floor, explore deep-water benthic habitat, and gather information on krill abundance and blue whale feeding behavior. In Monterey Bay, SSE scientists will compare species abundance and composition in pristine places versus areas of high human impact. Other studies will include observations of mid-water species in and around the Monterey Canyon and continuation of the blue whale work started in the Channel Islands. In the Florida Keys, the expedition will focus on deep-water habitats with particular emphasis on identifying unstressed and stressed environments that could serve as natural comparisons for long term study. During work in the eastern Gulf of Mexico, scientists will investigate potential prehistoric sites of human habitation along the relict stream channels, explore fish population dynamics in the Florida Middle Grounds, and examine drowned coral reefs north of the Dry Tortugas.

SSE's exploration and research activities will be wedded to numerous education and outreach programs through events and activities in all of the national marine sanctuaries, and others independent of the sanctuary program. The National Geographic Society is developing a

wealth of outreach and education materials, and has launched a world class Web offering to bring SSE to the world. Student summits, open house events and museum exhibits will provide direct contact between students and other members of the general public, and the explorers and scientists of the SSE team.

Although exploration and research are the focus of this year, numerous education events will also take place, both at these three sanctuaries and at other sanctuaries in the system. A wealth of education and outreach events are planned including student summits, open houses, museum exhibits, and others. The entire expedition team is looking forward to this year's work. A successful year will be a significant step towards preserving these special marine areas as our legacy to those who will follow.

Read the May 2000 **Press Release**

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Press Release
May 2000

SUSTAINABLE SEAS EXPEDITIONS: A PROJECT DESCRIPTION

For Immediate Release

In April 1998 the National Geographic Society, the National Oceanic and Atmospheric Administration, and the Richard & Rhoda Goldman Fund announced an unprecedented mission for the oceans. With a $5 million grant from the Goldman Fund, the Society launched Sustainable Seas Expeditions (SSE), a five-year project of deep-water exploration and public education in NOAA's National Marine Sanctuaries.

The 12 marine sanctuaries conserve, protect and enhance the biodiversity, ecological integrity and cultural legacy of the nation's marine environment. Ranging from American Samoa to New England, the sanctuaries include Pacific and Atlantic haunts of whales, sea lions, sharks, rays and turtles; significant coral reefs and kelp forest habitats, and the remains of the Monitor Civil War shipwreck off North Carolina.

Dr. Sylvia Earle, a National Geographic Society Explorer-in-Residence, is leading the expeditions, using a remotely operated vehicle and the newly designed DeepWorker, one-person submersibles that can dive to depths of 2,000 feet. These innovative submersible technologies are enabling the expeditions to:

- Undertake the first systematic exploration of the marine sanctuary system to depths of 2,000 feet.

• Photodocument the natural history of each sanctuary's plants and animals.

• Establish protocols for the first systemwide monitoring network in the marine sanctuaries.

Ultimately, through its discoveries, compelling images and public involvement, Sustainable Seas Expeditions is generating increased public support for ocean conservation.

Since April 1999 SSE has been sending DeepWorker submersibles to the sanctuaries. These small, maneuverable subs provide pilots with the gift of time to explore depths that are unattainable using conventional means. With their spacecraft-like nature, these manned subs have attracted broad public interest in what the "aquanauts" observe. Like astronauts reporting their direct view of Earth from space, DeepWorker aquanauts are able to capture a sense of the ocean from within.

The deep sea is as uncharted as the vast interior of the nation was when President Thomas Jefferson commissioned Meriwether Lewis and William Clark to explore and document the resources of the American West. SSE has the potential to produce significant scientific discoveries and extraordinary educational experiences for millions of participants who watch on shore. In addition, the data gathered will provide a foundation for future marine research and conservation policies.

"Whatever else is achieved, however, the ultimate success will be in the project's overall impact on dispelling ignorance about the sea," said Project Director Earle. "With knowing comes caring, and with caring there is hope that an ocean ethic will arise that will secure a sustainable future for ourselves and for the seas."

The success of SSE depends on the contributions of collaborators. They have included the U.S. Navy, NASA, U.S. Geological Survey, U.S. Environmental Protection Agency, Monterey Bay Aquarium Research Institute, Environmental Systems Research Institute, Mote Marine Laboratory, SeaWeb, RACAL Pelagos Winfrog, YSI Inc., CIS Lunar and the JASON Foundation.

For more information on SSE and the National Marine Sanctuaries, please visit:

National Geographic Society SSE Web site
National Oceanic and Atmospheric Administration SSE Web site

Contact:

Barbara Moffet (National Geographic Society)
(202) 857-7756

Matt Stout (National Oceanic and Atmospheric Administration)
(301) 713-3145, x173

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SUSTAINABLE SEAS EXPEDITIONS

SCHEDULE OF EVENTS

SITE INDEX

The day-to-day activities of the Sustainable Seas Expeditions have been carefully planned. This calendar allows anyone to follow the missions as they progress. Most activities of the expeditions are here, from Habitat Research to Student Summits to Open Houses onboard NOAA ships. Maps are also included to orient you to the location of activities during the missions. The calendar will be updated as new activities emerge and as later expeditions are planned.

Note: This calendar was derived from mission schedules. These are a guide as to how the research projects are expected to progress. Unforeseeable events such as weather, operational problems and equipment failures can change the schedule at any time.

2000 Missions

- Hawaiian Islands Humpback Whale National Marine Sanctuary (January 10 - 25)
- Channel Islands National Marine Sanctuary (June 5 - 24/ July 14 - 19)
- Monterey Bay National Marine Sanctuary (June 26 - July 12)
- West Florida Shelf (July 27 - August 31)
- Florida Keys National Marine Sanctuary (September 1 - September 23)

1999 Missions

- The calendar for the missions completed in 1999 is available for viewing.

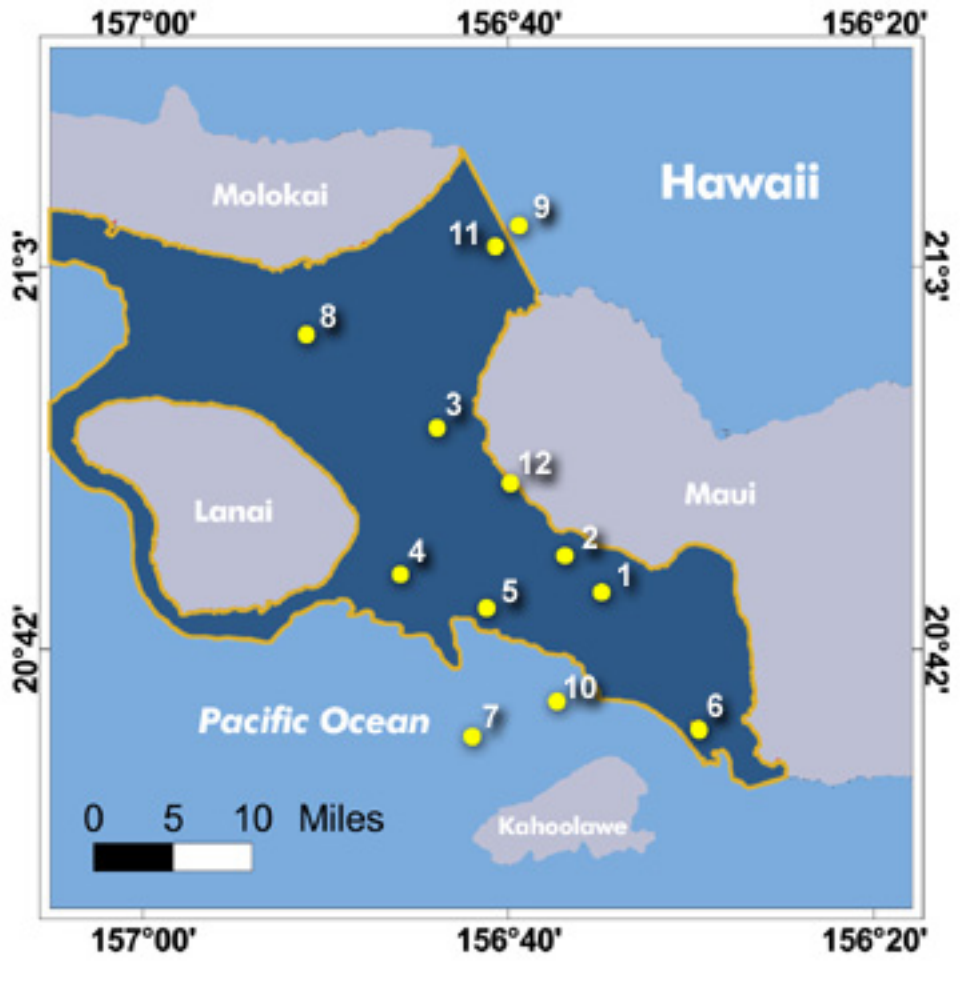
2000

JAN | JUN | JUL | AUG | SEP

JANUARY 2000

January 10 - 24 Sustainable Seas Expedition to Hawaiian Islands Humpback Whale National Marine Sanctuary

The main goal of the expedition at the sanctuary will be to characterize humpback whale habitat. There is still much to be discovered about the humpback whale at this newest sanctuary. Using the DeepWorker to view the habitat up close may help scientists gain insight on the whales. Other research goals during the mission are to locate and record singing humpback whales, to videotape bottom fish habitat, and to collect samples of fossil coral reef for study.



The SSE mission will consist of two legs. The first leg (January 10-14) will focus on practicing shipboard procedures, testing the submersibles and their equipment, conducting pilot checkout

dives, and conducting dives for education and outreach purposes. The second leg (January 15-19) will focus on conducting a discrete set of reconnaissance tasks at as many as ten locations within the sanctuary, all located in the waters between Maui, Moloka`i Lana`i, and Kaho`olawe.

The numbers above represent potential dive locations for the Sustainable Seas team. Sea state, technical challenges, and project priorities will determine if and when these target sites get visited. The expedition team will be conducting site characterizations at most locations. Several bottom features are worth noting: 6 - Molokini crater, 7 - North-South ridge, 8 - Rocky headlands, 10 - suspected fossil reefs, and 11 - Pinnacle 88. The Ka'imimoana will rendezvous with the Atlantis submarine at target site 12.

10 Dive Location: Lahaina
Number of Dives: 2

11 Dive Location: Lahaina
Number of Dives: 2

Education Event
KidScience Broadcast to classrooms across Hawai`i
10:30 - 11:00 am Hawai`i Time

12 Dive Location: Lahaina
Number of Dives: 2

Education Event
Students at Sea
1:00 - 5:00 pm Hawai`i Time
Students participate in marine research with hands-on experience aboard the Trilogy

13 Dive Location: Lahaina
Number of Dives: 2

Education Event
Students at Sea
1:00 - 5:00 pm Hawai`i Time
Students interact with DeepWorker and pilots aboard the Ka'imimoana

Outreach Event
Evening VIP Reception
Waikiki Aquarium

14 Dive Location: Lahaina
Number of Dives: 3

Outreach Event
Media Day

15 Dive Location: Target 1
Number of Dives: 2

Outreach Event
Maui Open House
Hawaiian Islands Humpback Whale National Marine Sanctuary Headquarters
9:00 am - 3:00 pm

16 Dive Location: Target 5
Number of Dives: 4

Transit to Target 4 Location

17 Dive Location: Target 4
Number of Dives: 2

Transit to Target 3 Location

Dive Location: Target 3
Number of Dives: 1

Transit to Target 7

18 Dive Location: Target 7
Number of Dives: 4

Transit to additional site, to be determined during mission

19 Dive Location: To be determined
Number of Dives: 1

22 *Outreach Event*
Oahu Open House
Waikiki Aquarium

23 *Outreach Event*
Kona Open House

25 *Education Event*
KidScience Broadcast Nationwide
9:00 - 10:00 Hawai`i Time

Education Event
Student Summit
1:00 pm Hawai`i Time
Oahu Studio with links to Maui, Kaua`i, Big Island and American Samoa

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(top)

JUNE 2000

June 5 - 24/July 14 - 19 Sustainable Seas Expedition to Channel Islands National Marine Sanctuary

The goals and objectives of the Sustainable Seas Expeditions mission to the Channel Islands focus on research, exploration, and education and outreach.

Research - Use the DeepWorker submersible and ROV to conduct transects and roving surveys to collect video footage, still photographs, and water quality data. Research dives will support two projects designed to collect data on geology, benthic habitats, and fish species.

Exploration - Use the DeepWorker submersible and ROV to opportunistically explore areas that blue whales and other whale species are feeding on krill.

Education and Outreach - Use the DeepWorker submersible and ROV to conduct transects and roving surveys to collect video footage, still photographs, and water quality data. Education dives will complement the research dives noted above, and have been designed to collect data on deep water benthic habitats adjacent to well surveyed shallow water areas, as well as specific species of fish.

The SSE mission will consist of three legs. The first leg is scheduled for June 5-11, and will focus on practicing shipboard procedures, testing the submersibles and their equipment, conducting emergency drills, and conducting pilot checkout dives. The second leg is scheduled for June 12-18, and will focus on conducting fish assessment and geologic characterization transects. The third leg of the cruise is scheduled for June 19-23 and will focus on fish species assessments and exploration dives.

Nighttime operations during the first leg will focus on characterizing the eddy in the Santa Barbara Channel using ADCP and TOWYO. Nighttime operations during both the second and third leg of the cruise will involve running side-scan sonar transects.

The missions planned for the 2000 expeditions (indicated by yellow lines) are focused along the southern shores of the islands of Santa Rosa, Santa Cruz, and Anacapa. Additional dives are planned for the north side of Anacapa.

5 *Training Dives*
Dive Location: Anacapa Island

6 *Training Dives*
Dive Location: Anacapa Island

7 *Training Dives*
Dive Location: Landing Cove, Anacapa Island

8 *Training Dives*
Dive Location: Landing Cove, Anacapa Island

Education Event
LIVE Uplink/Webcast from Anacapa Island

9 *Training Dives*
Dive Location: Anacapa Island

10 *Training Dives*
Dive Location: Anacapa Island

Education Event
Students at Sea

11 *Training Dives*
Dive Location: Anacapa Island

Education Event
Students at Sea

12 *Research Dives*
Dive Location: Footprint off Anacapa Island
Number of Dives: 2

13 *Research Dives*
Dive Location: Footprint off Anacapa Island
Number of Dives: 2

14 *Research Dives*
Dive Location: Anacapa Island
Number of Dives: 2

15 *Research Dives*
Dive Location: Anacapa Island
Number of Dives: 2

16 *Research Dives*
Dive Location: Santa Rosa Island
Number of Dives: 2

17 *Research/Exploration Dives*
Dive Location: Santa Rosa Island
Number of Dives: 2

18 *Exploration Dives*
Dive Location: Santa Rosa Island
Number of Dives: 4

19 *Exploration Dives*
Dive Location: Santa Rosa Island
Number of Dives: 2

20 *Exploration Dives*
Dive Location: Santa Rosa Island
Number of Dives: 4

21 *Research Dives*
Dive Location: Anacapa Island
Number of Dives: 4

22 *Research Dives*
Dive Location: Footprint off Anacapa Island
Number of Dives: 2

23 *Research Dives*
Dive Location: Platform Gail
Number of Dives: 2

24 *Education Event*
Student Summit

Outreach Event
Open House at Sterns Wharf, Santa Barbara

25 In Port
Unload Channel Islands National Marine Sanctuary personnel and equipment. Load Monterey Bay National Marine Sanctuary personnel and equipment

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(top)

June 26 - July 12 Sustainable Seas Expedition to Monterey Bay National Marine Sanctuary

The goals and objectives of the Sustainable Seas Expeditions mission to the Channel Islands focus on research, exploration, and education and outreach.

Research - Use the DeepWorker submersible and ROV to conduct transects and roving surveys to collect video footage, still photographs, and water quality data. Research dives will support two projects designed to collect data on geology, benthic habitats, and fish species.

Exploration - Use the DeepWorker submersible and ROV to opportunistically explore areas that blue whales and other whale species are feeding on krill.

Education and Outreach - Use the DeepWorker submersible and ROV to conduct transects and roving surveys to collect video footage, still photographs, and water quality data. Education dives will complement the research dives noted above, and have been designed to collect data on deep water benthic habitats adjacent to well surveyed shallow water areas, as well as specific species of fish.

26 *Outreach Event*
Reception with Dr. Sylvia Earle
Benefit for Monterey Bay Sanctuary Foundation
Hearst Castle Visitor Center, San Simeon California
6:30 - 9:30 pm

27 *Research Dives*
Dive Location: Sur Canyon or Big Creek
Number of Dives: 2

Education Event
Teacher-at-Sea Educational Research Dives

28 *Research Dives*
Dive Location: Sur Canyon or Big Creek
Number of Dives: 2

Education Event
Teacher-at-Sea Educational Research Dives
Student-at-Sea Education Days

29 *Research Dives*
Dive Location: Pt. Lobos
Number of Dives: 2

Education Event
Teacher-at-Sea Educational Research Dives
Student-at-Sea Education Days

30 *Research Dives*
Dive Location: Pt. Lobos
Number of Dives: 2

Education Event
Teacher-at-Sea Educational Research Dives

Education and Outreach Event
Live Interactive Web Cast at Monterey Coast Guard Pier

JULY 2000

1

Research Dives
Dive Location: Pt. Lobos
Number of Dives: 2

Education Event
Teacher-at-Sea Educational Research Dives

2

Research Dives
Dive Location: Mid-water monitoring for Blue Whales or Sur Canyon
Number of Dives: 2

3

Research Dives
Dive Location: Mid-water monitoring for Blue Whales or Sur Canyon
Number of Dives: 2

4

Research Dives
Dive Location: Mid-water monitoring for Blue Whales or Sur Canyon
Number of Dives: 2

5

Research Dives
Dive Location: Mid-water monitoring for Blue Whales or Sur Canyon
Number of Dives: 2

6

Research Dives
Dive Location: Mid-water monitoring for Blue Whales or Sur Canyon
Number of Dives: 2

7

Research Dives
Dive Location: Big Creek, Soquel Canyon or Sur Canyon
Number of Dives: 2

8

Research Dives
Dive Location: Big Creek, Soquel Canyon or Sur Canyon
Number of Dives: 2

9 *Research Dives*
Dive Location: Big Creek, Soquel Canyon or Sur Canyon
Number of Dives: 2

10 *Research Dives*
Dive Location: Big Creek, Soquel Canyon or Sur Canyon
Number of Dives: 2

11 *Research Dives*
Dive Location: Big Creek, Soquel Canyon or Sur Canyon
Number of Dives: 2

12 *Research Dives*
Dive Location: Big Creek, Soquel Canyon or Sur Canyon
Number of Dives: 2

Outreach Event
McArthur Open House in Santa Cruz

13 *McArthur* returns to the Channel Islands National Marine Sanctuary

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(top)

July 27 - August 31 Sustainable Seas Expedition to West Florida Shelf

The goals and objectives of the Sustainable Seas Expeditions mission to the West Florida Shelf focus on research, exploration, and education and outreach.

Research and Exploration - Five major projects will be underway during the West Florida mission.

- Archaeological Surveys - investigate evidence of paleohuman occupation of the continental shelf.
- Biological Survey - conduct midwater and benthic video transects to characterize the Middleground and Big Bend regions
- Survey of Paleoshorelines - video transects and exploratory dives on paleoshoreline/reef features, emphasizing Pulley's Ridge
- Survey of Jewfish and Jewfish Habitat
- Macroalgal and Seagrass Survey - document the diversity, community structure and distribution patterns

27 *Gunter* arrives in Pascagoula, Mississippi

28 - 31 Mobilization, loading of gear and testing of launch and recovery equipment in Pascagoula, Mississippi

August 2000

1 - 3 Mobilization, loading of gear and testing of launch and recovery equipment in Pascagoula, Mississippi

4 Evening departure for Panama City, Florida

5 - 7 *Training Dives*
Dive Location: Offshore, Panama City, Florida

8 - 13 *Research Dives*
Dive Location: Florida Middleground

14 *Research Dives*
Dive Location: Florida Middleground

Arrive in Tampa Bay for personnel transfer

15 - 18 *Research Dives*
Dive Location: Big Bend

19 *Research Dives*
Dive Location: Big Bend

Return to Tampa Bay

20 - 22 In port of Tampa Bay. Sub maintenance, Open House, Media Events

23 Evening departure for Pulley's Ridge

24 - 30 *Research Dives*
Dive Location: Pulley's Ridge

31 *Research Dives*
Dive Location: Pulley's Ridge

Transit to Key West, Florida

(top)

September 1 - September 23 Sustainable Seas Expedition to Florida Keys National Marine Sanctuary

The goals and objectives of the Sustainable Seas Expeditions mission to the Florida Keys focus on research, exploration, and education and outreach.

Research and Exploration - Three major projects will be underway during the West Florida mission.

- Dry Tortugas Habitat Characterization - special emphasis on benthic assessment, fish counts, behavior.
- Assessment of Fish and Benthic Organisms - conduct video transects to determine the distribution, abundance and size of key species of fish and invertebrates
- Queen Conch Assessment - document presence, abundance, distribution and size of queen conchs in Upper Keys

September 2000

1 - 2 *Gunter* arrives in Key West

Submersible maintenance, personnel transfer, media events

3 Depart for Dry Tortugas

4 - 14 *Research Dives*
Dive Location: Dry Tortugas

15 *Research Dives*
Dive Location: Dry Tortugas

Depart for Key West

16 *Gunter Open House*
Location: Key West, Mallory Square

17 Depart for Molasses Key/Upper Keys

18-20 *Research Dives*
Dive Location: Molasses Key/Upper Keys

21 *Research Dives*
Dive Location: Molasses Key/Upper Keys

Return to Key West

22 *Media Day*
Location: Key West

23 *Gunter* departs for home port of Pascagoula, Mississippi

(top)

SUSTAINABLE SEAS EXPEDITIONS

SCHEDULE OF EVENTS

SITE INDEX

1999 Missions

- Gulf of the Farallones National Marine Sanctuary (April 13 to April 26)
- Cordell Bank National Marine Sanctuary (April 27 to May 8)
- Monterey Bay National Marine Sanctuary (May 9 to May 22)
- Channel Islands National Marine Sanctuary (May 24 to June 5)
- Olympic Coast National Marine Sanctuary (June 16 to June 30)
- Stellwagen Bank National Marine Sanctuary (July 9 to July 15)
- Gray's Reef National Marine Sanctuary (July 26 to August 6)
- Florida Keys National Marine Sanctuary (August 16 to August 29)
- Flower Garden Banks National Marine Sanctuary (September 1 to September 13)

[NOTE: This calendar was derived from mission schedules. These are a guide as to how the research projects are expected to progress. Unforeseeable events such as weather, operational problems and equipment failures can change the schedule at any time.]

1999

APR | MAY | JUN | JUL | AUG | SEP

APRIL 1999

April 13 - 26 Sustainable Seas Expedition to the Gulf of the Farallones National Marine Sanctuary [click **here** for the Mission Log]

An ecosystem dynamics study will be conducted at night during the Gulf of the Farallones expedition. Water samples will be taken at various depths to examine the relationship between water masses and the distribution and abundance of organisms.

Map shows four possible dive locations: 1) Rittenburg Bank, 2) North Farallon Islands,3) Southeast Farallon Islands Islands, and 4) Drakes Bay

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13 *(Travel)*
NOAA Ship McArthur arrives in San Francisco.

14 *(Equipment Preparation)*
Scientists arrive and begin loading equipment

15 *(Equipment Preparation, Outreach)*
Scientists finish loading equipment
VIP kickoff gathering on NOAA Ship McArthur

16 *(Equipment Preparation, Outreach)*
McArthur departs San Francisco, heads to Southeast Farallon Island
New DeepWorker pilots begin launch and recovery exercise

17 *(Exploration)*
Dive Location: East Landing, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography. Number of Dives: 3

18 *(Exploration)*
Dive Location: Shubrick Point, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 3

19 *(Exploration, Investigation)*
Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To create species list for subtidal algae at Southeast Farallon Island by conducting video and visual transects to identify algae and document depth distribution.
Number of Dives: 1

Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To document sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

Dive Location: East Landing, Southeast Farallon Island
Objective: To assess red abalone abundance in subtidal habitats of Southeast Farallon Island through video and still photographs taken along predetermined transects.
Number of Dives: 1

20 *(Exploration, Travel)*
Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To assess red abalone abundance in subtidal habitats of Southeast Farallon Island through video and still photographs taken along predetermined transects.
Number of Dives: 1

McArthur proceeds back to San Francisco for Earth Day Events

21 *(Exploration, Outreach)*
Location: San Francisco
In celebration of Earth Day (April 22), Sustainable Seas Expeditions will invite members of the media onboard the McArthur to demonstrate DeepWorker in action. Dr. Sylvia Earle will make a demonstration dive, and answer questions about the expeditions.

After returning the media expedition to the dock, McArthur departs for Farallon Islands.

22 *(Exploration)*
Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 3

23 *(Exploration)*
Dive Location: Mirounga Bay, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 3

24 *(Exploration)*
Dive Location: Mirounga Bay, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

Dive Location: North Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

25 *(Exploration)*
Dive Location: Fisherman's Bay, Southeast Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

Dive Location: North Farallon Island
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 2

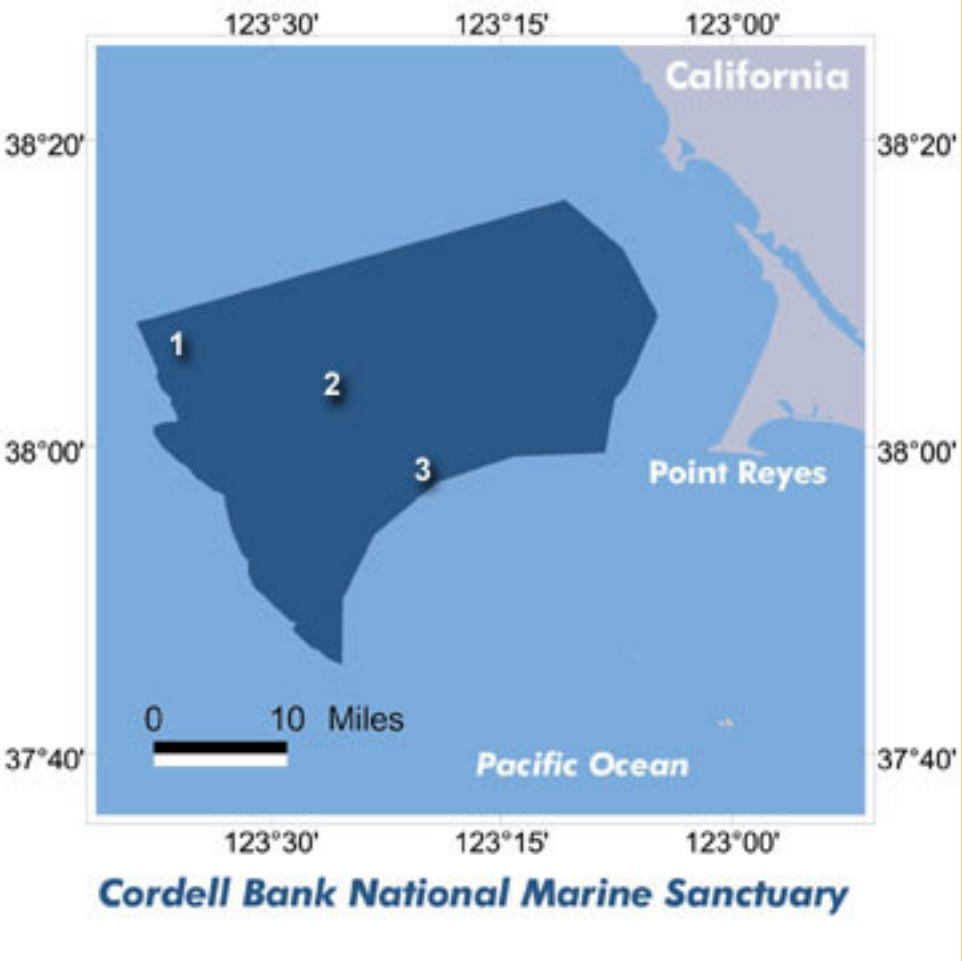
26 *(Education, Travel)*
McArthur heads to Bodega Harbor for Student Summit.
Student Summit held at Bodega Marine Laboratory.
McArthur departs Bodega Bay

Live On-Line Chat Entitled "Meet Sylvia Earle, Chief Scientist of Sustainable Seas Expeditions" .
Time: 10:30 a.m. to 11:30 a.m. Pacific Time

(top)

April 27 - May 8 Sustainable Seas Expedition to Cordell Bank National Marine Sanctuary

In addition, an ecosystem dynamics study will be conducted at night during the Cordell Bank expedition. Water samples will be taken at various depths to examine the relationship between water masses and the distribution and abundance of organisms.



Proposed dive sites for the Cordell Bank expedition are: 1) in the northwest area of the sanctuary, there will be an estimated five to six dives, 2) in the middle grounds of the sanctuary, there will be an estimated six dives, and 3) in the southeast, the DeepWorker will be making an additional two to three dives.

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27 *(Exploration)*
Location: Middle Ground, Cordell Bank
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

28 *(Exploration)*
Location: Middle Ground, Cordell Bank
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

29 *(Exploration, Investigation)*
Location: Middle Ground, Cordell Bank
Objective: To document flora and initiate species list for algae. Unidentifiable algae will be collected.
Number of Dives: 1

Location: Northwest portion of Cordell Bank
Objective: To investigate fishing effects on hard bottom substrates.
Number of Dives: 2

30 *(Exploration, Investigation)*
Location: Northwest portion of Cordell Bank
Objective: To investigate fishing effects on hard bottom substrates.
Number of Dives: 1

Location: Middle Ground, Cordell Bank
Objective: To document flora and initiate species list for algae. Unidentifiable algae will be collected.
Number of Dives: 1

Location: Southeast Corner, Cordell Bank
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

(top)

MAY 1999

[continuation of Cordell Bank National Marine Sanctuary Expedition]

1 *(Rest)*
All day in port.

2 *(Exploration)*
Location: Middle Ground, Cordell Bank
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 2

3 *(Exploration, Investigation)*
Location: Southeast Corner, Cordell Bank
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

Location: Middle Ground, Cordell Bank
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 1

Location: Middle Ground, Cordell Bank
Objective: To document flora and initiate species list for algae. Unidentifiable algae will be collected.
Number of Dives: 1

4 *(Exploration)*
Location: Western Edge of Cordell Bank
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography. On this dive, Sylvia Earle will be searching specifically for an anchor lost by Edward Cordell on his first survey visit to the Bank in 1869.
Number of Dives: 1

Location: Middle Ground, Cordell Bank
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.

Number of Dives: 1

5 *(Exploration)*
Location: Middle Ground, Cordell Bank
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

Location: Northwest Portion, Cordell Bank
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

6 *(Rest)*
Location: San Francisco
In Port All Day
Live On-Line Chat Entitled "Exploring the Cordell Bank National Marine Sanctuary" featuring Dan Howard, sanctuary manager.
Time: 10:00 a.m. to 11:000 a.m. Pacific Time

7 *(Rest)*
Location: San Francisco
In Port All Day

8 *(Outreach, Travel)*
McArthur Open House - Ship open from noon to 4 p.m.
McArthur sails for Monterey

(top)

May 9 - May 22 Sustainable Seas Expedition to Monterey Bay National Marine Sanctuary

Map shows four possible dive locations: 1) The head of Monterey Canyon, 2) Shelf of the Monterey Canyon, 3) Point Lobos Ecological Reserve, and 4) Big Creek Marine Ecological Reserve

9 *(Training)*
Location: Hopkins Reserve
Training dives for Monterey Bay DeepWorker pilots

10 *(Training)*
Location: Hopkins Reserve
Training dives for Monterey Bay DeepWorker pilots

11 *(Investigation)*
Location: Monterey Bay Canyon
Objective: To investigate day and night activity patterns of invertebrates.
Number of Dives: 2

Location: Monterey Bay Canyon
Objective: To investigate day and night activity patterns of fish.
Number of Dives: 1

12 *(Outreach, Investigation)*
Location: Monterey Harbor
Open house for public aboard McArthur

Location: Monterey Bay Canyon
Objective: To investigate day and night activity patterns of invertebrates.
Number of Dives: 2

Location: Monterey Bay Canyon
Objective: To investigate day and night activity patterns of fish.
Number of Dives: 1

13 *(Exploration)*
Location: To be determined
Dr. Sylvia Earle to dive

(Exploration)
Location: BlueFish Cove, Pt. Lobos Reserve
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 3

14 *(Exploration, Education)*
Location: To be determined
Dr. Sylvia Earle to dive

(Exploration,)
Location: BlueFish Cove, Pt. Lobos Reserve
Objective: To characterize habitat and assess algae, invertebrate and fish assemblages along predetermined transects with video and still photography.
Number of Dives: 3

Live On-Line Chat Entitled "Amazing Ocean Research Technologies" featuring Francesca Cava, project manager for the Sustainable Seas Expeditions.
Time: 10:00 a.m. to 11:000 a.m. Pacific Time

15 *(Investigation)*
Location: Big Creek Reserve
Objective: To assess fish in the No-take area of Big Creek Reserve
Number of Dives: 3

16 *(Investigation)*
Location: Big Creek Reserve
Objective: To assess fish in the No-take area of Big Creek Reserve
Number of Dives: 3

17 *(Investigation)*
Location: Big Creek Reserve
Objective: To assess fish in the No-take area of Big Creek Reserve
Number of Dives: 3

Live On-Line Chat Entitled "Monterey Bay National Marine Sanctuary/Prickly Shark Ecology: The Process of Observation and Analysis" featuring Bill Douros, Sanctuary Manager, Sylvia Earle, Chief Scientist and Francesca Cava, project manager for the Sustainable Seas Expeditions.
Time: 10:00 a.m. to 11:00 a.m. Pacific Time

18 *(Investigation, Education)*

Location: Monterey, Naval PostGraduate School
Sanctuary Summit featuring Dr. Sylvia Earle. Local students and teachers will discuss ocean issues such as marine reserves.

19

20 *(Investigation, Education)*
Location: Monterey Bay Canyon
Objective: To study the ecology of prickly sharks. The area will be surveyed using sonar to track and observe previously tagged individuals.
Number of Dives: 3

Location: Monterey Bay Canyon
Objective: To observe the pattern of dispersion of dredge spoils at the mouth of the Canyon, in conjunction with one of the shark dives.
Number of Dives: 1

21 *(Investigation)*
Location: Monterey Bay Canyon
Objective: To study the ecology of prickly sharks. The area will be surveyed using sonar to track and observe previously tagged individuals.
Number of Dives: 3

Location: Monterey Bay Canyon
Objective: To observe the pattern of dispersion of dredge spoils at the mouth of the Canyon, in conjunction with one of the shark dives.
Number of Dives: 1

22 *(Contingency Day)*

23 *(Rest)*

(top)

May 24 - June 5 Sustainable Seas Expedition to Channel Islands National Marine Sanctuary

Map shows five locations in the sanctuary: 1) San Miguel, 2) Santa Rosa, 3) Santa Cruz, 4) Anacapa and 5) Santa Barbara. Most expeditions will take place adjacent to Anacapa.

24 *(Rest, Education)*
Location: Port Hueneme
Scientists load McArthur

Channel Islands National Marine Sanctuary Summit
7:00pm to 9:00pm
Santa Barbara County Hearing Chambers

Live On-Line Chat Entitled "Teacher in the Sea" featuring Mike Guardino, a teacher from Monterey Bay.
Time: 10:00 a.m. to 11:00 a.m. Pacific Time

25 *(Training)*
Location: Anacapa Island
Pilot Checkout Dives

26 *(Training)*
Location: Anacapa Island
Pilot Checkout Dives

27 *(Outreach, Exploration, Education)*
Media/Outreach Day
NASA live uplink of dive
Student Summit Team field trip aboard the Island Packer's vessel Sundown

Location: Anacapa Island
Objective: To investigate benthic habitats previously mapped with sidescan sonar in order to groundtruth data
Number of Dives: 2

Live On-Line Chat Entitled "Channel Islands National Marine Sanctuary/Great American Fish Count" featuring Ed Cassano, Sanctuary Manager.
Time: 11:00 a.m. to 12:00 p.m. Pacific Time

28 *(Exploration)*
Location: Anacapa Island
Objective: To investigate benthic habitats previously mapped with sidescan sonar in order to groundtruth data
Number of Dives: 2

29 *(Exploration)*
Location: Wycoff Ledge
Objective:
Number of Dives: 2

30 (Contingency Day)

31 *(Exploration)*
Location: Anacapa Island
Objective: To investigate benthic habitats previously mapped with sidescan sonar in order to groundtruth data
Number of Dives: 2

(top)

JUNE 1999

(*continuation of Channel Islands National Marine Sanctuary Expedition)*

1 *(Exploration)*
Location: Anacapa Island
Objective: To investigate benthic habitats previously mapped with sidescan sonar in order to groundtruth data
Number of Dives: 2

2 *(Research)*
Location: Anacapa Island
Objective: To collect data on spawning habitat of market squid *(Loligo opalescens)*
Number of Dives: 2

3 *(Exploration, Education)*
Location: Anacapa Island
Objective: To investigate benthic habitats previously mapped with sidescan sonar in order to groundtruth data
Number of Dives: 3

Live On-Line Chat Entitled "Understanding the Living Resources"
Time: 11:00 a.m. to 12:00 p.m. Pacific Time

4 *(Travel)*

(Outreach)
5 Location: Santa Barbara
Open House aboard McArthur

(top)

June 16 - June 30 Sustainable Seas Expedition to Olympic Coast National Marine Sanctuary

The Olympic Coast team has an ambitious dive schedule. The numbers indicate sites for: 1) an education project to study underwater marine habitats, 2) exploration transects within deep ocean canyons, 3) a research effort to study the affects of fish trawling, 4) a cross-shelf characterization of seafloor and benthic communities, 5) night operations and bottom grabs from the YTT

Discovery, and 6) an exploration of cold seep areas and other tectonic features.

16 *(Outreach, Equipment Preparation)*
Location: Keyport/Bangor, then Seattle
Discovery Bay loads at Keyport/Bangor dock
Leaves Keyport for Seattle
Discovery Bay Open House in Seattle

17 *(Training, Travel)*
Location: Seattle
Pilot training, travel to Cape Alava

18 *(Training)*
Location: Cape Alava
Pilot evaluation dives

19 *(Investigation, Exploration)*
Location: Specific dive sites to be determined
Objective: To study groundfish and invertebrates in trawlable and untrawlable survey habitats. Habitat will be recorded on video and behavioral observations noted.
Number of Dives: 2

Location: Specific dive sites to be determined
Objective: To characterize seafloor habitat complexity and benthic invertebrate communities in lightly and heavily trawled study areas. Habitat will be recorded on video.
Number of Dives: 1

20 *(Investigation)*
Location: Specific dive sites to be determined
Objective: To study groundfish and invertebrates in trawlable and untrawlable survey habitats. Habitat will be recorded on video and behavioral observations noted.
Number of Dives: 2

Location: Specific dive sites to be determined
Objective: To characterize seafloor habitat complexity and benthic invertebrate communities in lightly and heavily trawled study areas. Habitat will be recorded on video.
Number of Dives: 1

21 *(Investigation)*
Location: Specific dive sites to be determined within Juan de Fuca Canyon and/or Nitinat Canyon.
Objective: To conduct first visual and video exploration of the deep sea canyons within the Olympic Coast National Marine Sanctuary
Number of Dives: 2

Location: Specific dive sites to be determined
Objective: To study groundfish and invertebrates in trawlable and untrawlable survey habitats. Habitat will be recorded on video and behavioral observations noted.
Number of Dives: 1

22 *(Investigation, Education)*
Location: Specific dive sites to be determined
Objective: To characterize seafloor habitat complexity and benthic invertebrate communities in lightly and heavily trawled study areas. Habitat will be recorded on video.
Number of Dives: 2

Location: Specific dive sites to be determined
Objective: To conduct video and narrative programs during dives as an educational outreach to portray underwater marine wildlife and habitats to students and lay people.
Number of Dives: 1

23 *(Rest)*
Location: port
Discovery in port for refueling

24 *(Education, Investigation)*
Location: Specific dive sites to be determined
Objective: To conduct video and narrative programs during dives as an educational outreach to portray underwater marine wildlife and habitats to students and lay people.
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To study groundfish and invertebrates in trawlable and untrawlable survey habitats. Habitat will be recorded on video and behavioral observations noted.
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To characterize seafloor habitat complexity and benthic

invertebrate communities in lightly and heavily trawled study areas. Habitat will be recorded on video.
Number of Dives: 1

25 *(Investigation, Exploration)*
Location: Specific dive sites to be determined
Objective: To characterize seafloor habitat complexity and benthic invertebrate communities in lightly and heavily trawled study areas. Habitat will be recorded on video.
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To characterize the seafloor and benthic communities across the shelf along a transect from the shelf break to nearshore waters with video.
Number of Dives: 2

26 *(Exploration)*
Location: Specific dive sites to be determined
Objective: To explore the biology and geology of cold seep areas and other tectonic features.
Number of Dives: 3

27 *(Exploration)*
Location: Specific dive sites to be determined within Juan de Fuca Canyon and/or Nitinat Canyon.
Objective: To conduct first visual and video exploration of the deep sea canyons within the Olympic Coast National Marine Sanctuary
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To obtain high quality video images for the Sustainable Seas Expeditions Project
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To characterize seafloor habitat complexity and benthic invertebrate communities in lightly and heavily trawled study areas. Habitat will be recorded on video.
Number of Dives: 1

28 *(Exploration, Education)*
Location: Specific dive sites to be determined within Juan de Fuca Canyon and/or Nitinat Canyon.
Objective: To conduct first visual and video exploration of the deep sea canyons within the Olympic Coast National Marine Sanctuary
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To characterize the seafloor and benthic communities across the shelf along a transect from the shelf break to nearshore waters with video.
Number of Dives: 1

Location: Specific dive sites to be determined
Objective: To conduct video and narrative programs during dives as an educational outreach to portray underwater marine wildlife and habitats to students and lay people.
Number of Dives: 1

29 *(Education)*
Location: Specific dive sites to be determined within Juan de Fuca Canyon and/or Nitinat Canyon.
Objective: To conduct first visual and video exploration of the deep sea canyons within the Olympic Coast National Marine Sanctuary
Number of Dives: 2

30 *(Rest)*
Location: Port Angeles Pier

(top)

JULY 1999

1 *(Education)*
Live On-Line Chat Entitled "Charting the Sea Floor" featuring Ed Bowlby from the Olympic Coast National Marine Sanctuary
Time: 10:00 a.m. to 11:00 p.m. Pacific Time

2 *(Travel)*
NOAA Ship Ferrel arrives at U.S. Coast Guard Pier in Boston.

3 *(Equipment preparation)*
Submersibles and support equipment onloaded to Ferrel.

4 *(Outreach)*
Ferrel Open House in Boston.

5 *(Training)*
Location: U.S. Coast Guard Pier
Training dives for Stellwagen Bank DeepWorker pilots

6 *(Training)*
Location: U.S. Coast Guard Pier
Training dives for Stellwagen Bank DeepWorker pilots

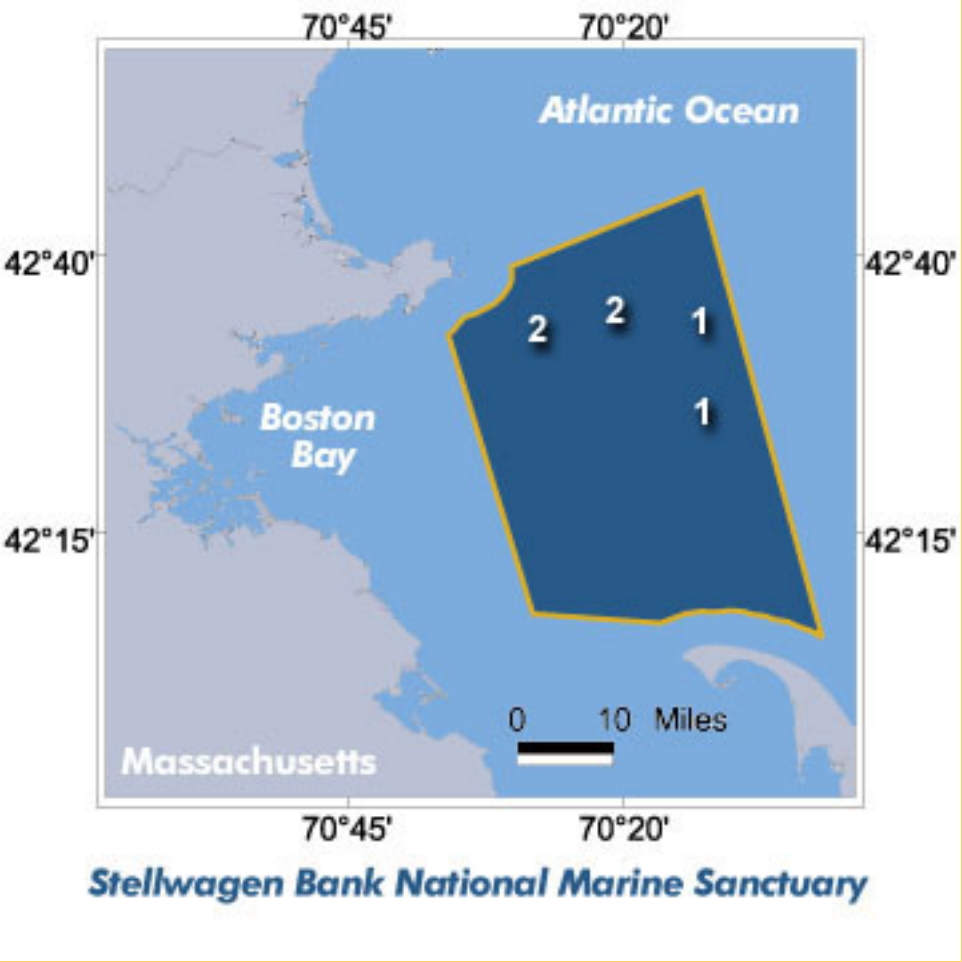
7 *(Training)*
Location: U.S. Coast Guard Pier
Training dives for Stellwagen Bank DeepWorker pilots

8 *(Training, Travel)*
Location: Underway to Stellwagen Bank
Training dives for Stellwagen Bank DeepWorker pilots

(top)

July 9 - July 15 Sustainable Seas Expedition to Stellwagen Bank National Marine Sanctuary

In addition, several other experiments will take place during the cruise, not involving dive operations. Sediment samples will be taken to examine patterns in microbial diversity along gradients from the deep boulder reef. The water column structure will be characterized at each dive site.



1.) The primary dive sites are deep boulder reefs within the Maine Cod Closure Area. 2.) Alternate dive sites provide a bit more shelter in case of rough seas and inclement weather. Here too, the study sites are boulder areas, in the Tillies Basin off Cape Ann.

9 *(Training, Travel)*
Location: Underway to Stellwagen Bank
Training dives for Stellwagen Bank DeepWorker pilots

10 *(Investigation)*
Dive Location: Station 2224
Objective: To investigate day and night activities of fishes in deep boulder reefs.
Number of Dives: 3

11 *(Investigation)*
Dive Location: Station 2224
Objective: To investigate day and night activities of fishes in deep boulder reefs.
Number of Dives: 3

12 *(Investigation)*
Dive Location: Station 38
Objective: To investigate day and night activities of fishes in deep boulder reefs.
Number of Dives: 3

13 *(Investigation, Education)*
Dive Location: Station 38
Objective: To investigate day and night activities of fishes in deep boulder reefs.
Number of Dives: 3

Live Webchat
10:00 am - 11:00 am Pacific time (1:00 pm - 2:00 pm eastern time)
Stellwagen Bank National Marine Sanctuary (SBNMS): Welcome to Stellwagen Bank

14 *(Investigation)*
Dive Location: Station 38
Objective: To investigate day and night activities of fishes in deep boulder reefs.
Number of Dives: 3

15 *(Exploration)*
Dive Location: Station 38
Objective: To characterize biodiversity of deep boulder reef epifauna along predetermined transects with video and still photography.
Number of Dives: 1

(Exploration)
Dive Location: Station 2224
Objective: To characterize biodiversity of deep boulder reef epifauna along predetermined transects with video and still photography.
Number of Dives: 1

(Travel)
Ferrel returns to U.S. Coast Guard Pier in Boston

(top)

July 26 - August 6 Sustainable Seas Expedition to Gray's Reef National Marine Sanctuary

1. The dive site is from the bottom of Gray's Reef and areas east out to the continental shelf. 2. Projects will span Gray's Reef and will include areas adjacent to the reef and along the inner, middle and outer edge reefs of the Georgia Bight.

26 *(Investigation)*
Dive Location: Gray's Reef
Objective: To characterize and compare the benthic fauna in three hard bottom shelf habitats along predetermined transects using video and still photography.
Number of Dives: 1

(Exploration)
Dive Location: Gray's Reef
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To search debris fields and outcroppings for any objects of historical or cultural importance from the era when Gray's Reef was exposed during the last Ice Age.
Number of Dives: 1

27 *(Investigation)*
Dive Location: Gray's Reef
Objective: To search debris fields and outcroppings for any objects of historical or cultural importance from the era when Gray's Reef was exposed during the last Ice Age.
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To assess habitat utilization and abundance of loggerhead sea turtles associated with natural ledges at Gray's Reef.
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To investigate and characterize day and night activities of vertebrates and invertebrates on Gray's Reef.
Number of Dives: 1

28 *(Education, Outreach)*
Dive Location: Gray's Reef
Objective: To document SSE activities at Gray's Reef as part of ongoing "Rivers To Reefs" Public Television Series
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To search debris fields and outcroppings for any objects of historical or cultural importance from the era when Gray's Reef was exposed during the last Ice Age.
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To investigate and characterize day and night activities of vertebrates and invertebrates on Gray's Reef.
Number of Dives: 1

29 *(Investigation)*
Dive Location: Gray's Reef
Objective: To assess habitat utilization and abundance of loggerhead sea turtles associated with natural ledges at Gray's Reef.
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To search debris fields and outcroppings for any objects of historical or cultural importance from the era when Gray's Reef was exposed during the last Ice Age.
Number of Dives: 1

(Investigation)
Dive Location: Gray's Reef
Objective: To characterize and compare the benthic fauna in three hard bottom shelf habitats along predetermined transects using video and still photography.
Number of Dives: 1

30 *(Investigation)*
Dive Location: Gray's Reef
Objective: To investigate and characterize day and night activities of vertebrates and invertebrates on Gray's Reef.
Number of Dives: 2

(Exploration)
Dive Location: Gray's Reef
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 1

31 *(Travel)*
Depart Gray's Reef for Savannah

(top)

AUGUST 1999

1 *(Outreach)*
Location: Savannah River Walk
Open House

2 *(Exploration)*
Dive Location: Gray's Reef
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 3

3 *(Exploration)*
Dive Location: Sapelo Scarp
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 2

(Investigation)
Dive Location: Sapelo Scarp
Objective: To characterize and compare the benthic fauna in three hard bottom shelf habitats along predetermined transects using video and still photography.
Number of Dives: 1

4 *(Exploration)*
Dive Location: Sapelo Scarp
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 2

(Investigation)
Dive Location: Sapelo Scarp
Objective: To characterize and compare the benthic fauna in three hard bottom shelf habitats along predetermined transects using video and still photography.
Number of Dives: 1

5 *(Exploration)*
Dive Location: Mid-Shelf Site
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 2

(Investigation)
Dive Location: Mid-Shelf Site
Objective: To characterize and compare the benthic fauna in three hard bottom shelf habitats along predetermined transects using video and still photography.
Number of Dives: 1

6 *(Investigation)*
Dive Location: Gray's Reef
Objective: To investigate and characterize day and night activities of vertebrates and invertebrates on Gray's Reef.
Number of Dives: 1

9 *(Education)*
Student Summit held at Gray's Reef National Marine Sanctuary Offices on Skidaway Island.

13 *(Travel)*
Ferrel arrives in Key West.

14 *(Equipment Preparation)*
Load submersibles and equipment onto Ferrel.

15 *(Training, Travel)*
Location: Offshore at Key West
Training dives for Florida Keys DeepWorker pilots.
Evening transit to Dry Tortugas.

(top)

August 16- August 29 Sustainable Seas Expedition to Florida Keys National Marine Sanctuary

The Florida Keys expedition team will travel to several locations within the sanctuary. The general activities they will be conducting are as follows: 1. Deep reef exploration and habitat characterization off of Tortugas Bank, Sherwood Forest, Black Coral Rocks, and Riley's Hump; 2. Deep reef and sponge habitat health assessment in Eastern Sambos; 3. High school education/research effort from fore to deep reef on Conch Reef / Molassas Reef; and, 4. Video transects and fish counts along Carysfort Reef.

16 *(Exploration)*
Dive Location: West of Dry Tortugas
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

(Investigation)
Dive Location: West of Dry Tortugas
Objective: To characterize biology and geology of Tortugas Bank and adjacent areas
Number of Dives: 1

17 *(Exploration)*
Dive Location: West of Dry Tortugas
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

(Investigation)
Dive Location: West of Dry Tortugas
Objective: To characterize biology and geology of Tortugas Bank and adjacent areas
Number of Dives: 1

18 *(Exploration)*
Dive Location: West of Dry Tortugas
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

(Investigation)
Dive Location: West of Dry Tortugas
Objective: To characterize biology and geology of Tortugas Bank and adjacent areas.
Number of Dives: 1

19 *(Investigation)*
Dive Location: West of Dry Tortugas
Objective: To determine the influence of Gulf of Mexico water on the deep reef tract near the Tortugas.
Number of Dives: 1

20 *(Exploration)*
Dive Location: Sherwood Forest
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 1

(Investigation)
Dive Location: West of Dry Tortugas
Objective: To determine the influence of Gulf of Mexico water on the deep reef tract near the Tortugas.
Number of Dives: 1

21 *(Investigation)*
Dive Location: West of Dry Tortugas
Objective: To determine the influence of Gulf of Mexico water on the deep reef tract near the Tortugas.
Number of Dives: 2

23 *(Training)*
Location: Key West
Training dives for Florida Keys DeepWorker pilots.

(Education, Outreach, Exploration)
Location: Key West
Objective: To collect imagery and make observations along transects from the fore reef environment to the deep reef environment, as outlined in proposals from local high school students.
Number of Dives: 1

24 *(Investigation)*
Dive Location: U.S.S. Wilkes-Barre (artificial reef near Key West)
Objective: To explore and document biota and cultural data on deep artificial reefs.
Number of Dives: 1

(Exploration)
Dive Location: Offshore Key West
Objective: To document Sanctuary resources and record Sustainable Seas Expedition activities through video and still photography.
Number of Dives: 1

25 *(Education, Outreach, Exploration)*
Location: Marathon
Objective: To collect imagery and make observations along transects from the fore reef environment to the deep reef environment, as outlined in proposals from local high school students.
Number of Dives: 1

(Exploration)
Dive Location: Carysfort Reef
Objective: To explore and document deep coral reef health.
Number of Dives: 1

26 *(Exploration)*
Dive Location: Carysfort Reef
Objective: To explore and document deep coral reef health.
Number of Dives: 1

(Exploration)
Dive Location: Carysfort Reef
Objective: To census and characterize deepwater fish assemblages.
Number of Dives: 1

27 *(Exploration)*
Dive Location: Carysfort Reef
Objective: To explore and document deep coral reef health.
Number of Dives: 1

(Investigation)
Dive Location: Ocean Freeze (artificial reef)
Objective: To explore and document biota and cultural data on deep artificial reefs.
Number of Dives: 1

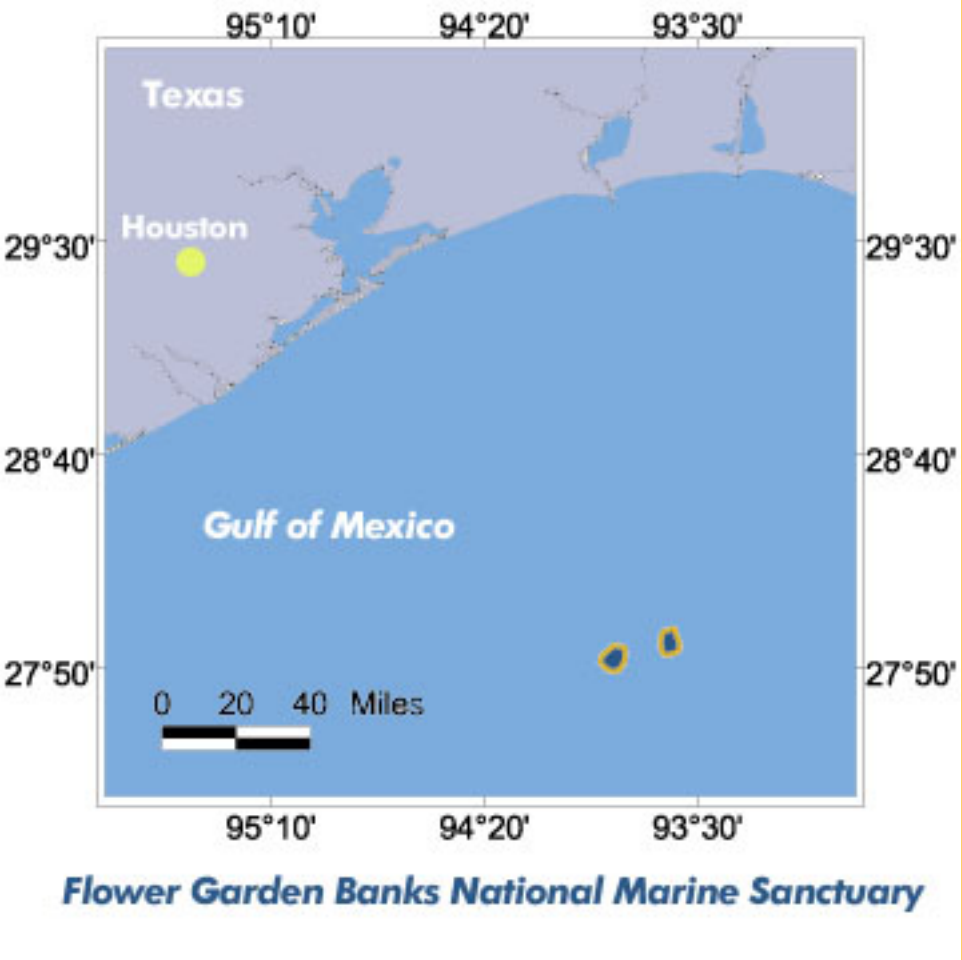
28 *(Exploration)*
Dive Location: Carysfort Reef
Objective: To explore and document deep coral reef health.
Number of Dives: 1

(top)

31 *(Travel)*
Scientists board FERREL at Pascagoula, Mississippi

SEPTEMBER 1999

September 1 - September 13 Sustainable Seas Expedition to Flower Garden Banks National Marine Sanctuary



(Mission map is forthcoming)

1 *(Training)*
Location: East Flower Garden Bank
Training dives for Flower Garden Bank DeepWorker pilots

2 *(Exploration)*
Dive Location: East Flower Garden Bank
Objective: To explore deep water habitats in the vicinity of a brine seep in the seabed.
Number of Dives: 1

3 *(Research)*
Dive Location: East Flower Garden Bank
Objective: To document the annual coral spawning at Flower Garden Banks.
Number of Dives: 1

(Exploration)
Dive Location: East Flower Garden Bank
Objective: To explore methods of underwater lighting during night dives that minimize the harmful effects of light on biota.
Number of Dives: 1

4 *(Exploration)*
Dive Location: East Flower Garden Bank
Objective: To explore deep water habitats in the vicinity of a brine seep in the seabed.
Number of Dives: 1

5 *(Research)*
Dive Location: East Flower Garden Bank
Objective: To document the annual coral spawning at Flower Garden Banks.
Number of Dives: 2

6 *(Travel)*
Transit to Galveston, Board Leg 2 scientists

7 *(Outreach)*
Location: Galveston
Open House Dockside

(Travel)
Depart Galveston, transit to Flower Garden Banks

8 *(Exploration)*
Dive Location: East Flower Garden Bank
Objective: To explore and document deep coral reef habitats.
Number of Dives: 1

9 *(Contingency Day)*

10 *(Exploration)*
Dive Location: East Flower Garden Bank
Objective: To explore and document deep coral reef habitats.
Number of Dives: 2

(Exploration)
Dive Location: East Flower Garden Bank
Objective: To explore and census deep-water fish assemblages.
Number of Dives: 1

11 *(Exploration)*
Dive Location: East Flower Garden Bank
Objective: To explore and census deep-water fish assemblages.
Number of Dives: 1

(Exploration)
Dive Location: East Flower Garden Bank
Objective: To explore and document deep coral reef habitats.
Number of Dives: 2

(Exploration)
Dive Location: East Flower Garden Bank
Objective: To explore and census deep-water fish assemblages.
Number of Dives: 1

12

(Exploration)
Dive Location: East Flower Garden Bank
Objective: To explore and document deep coral reef habitats.
Number of Dives: 2

13 *(Travel)*
Transit to Galveston

(top)

SUSTAINABLE SEAS EXPEDITIONS

MISSION LOG

GULF OF THE FARALLONES

SITE INDEX

BACKGROUND

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EXPEDITION UPDATE

April 13 - 26, 1999

After over a year of planning, the Sustainable Seas Expeditions are finally underway! The first mission in this grand adventure took us to the Gulf of the Farallones, just west of San Francisco. These waters, so enticingly close, have remained largely unexplored and mysterious due to the hazards of scuba diving here.

Within the safety of DeepWorker, the expedition is taking scientists and sanctuary staff where no one has gone before. So little is known about what's beneath the surface here that simply exploring, observing, and documenting the biological and geological makeup of the gulf will allow us to make valuable contributions to the scientific knowledge of this very special place.

The McARTHUR left port on April 17, with the first few days dedicated to checkout dives for the submersible pilots. We were back in port on April 22, Earth Day, to celebrate the official launch of the Sustainable Seas project and to host some special events on board the McARTHUR. Then we were off again, and getting some great dives in. On April 27, the expedition moved on to San Francisco's other National Marine Sanctuary, Cordell Bank. Things are really coming together, and the adventure is only just beginning!

Gale Mead, Expedition Log Editor

LOG

April 17, 1999

April 18, 1999

April 19, 1999

April 20, 1999

April 23, 1999

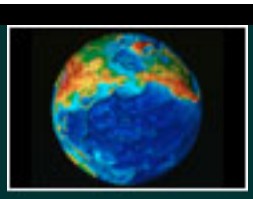
April 24, 1999

April 25, 1999

April 26, 1999

Summary of Education

Summary of Investigations



SEALERS

A LOOK BACK

HIGHLIGHTS
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EDUCATION

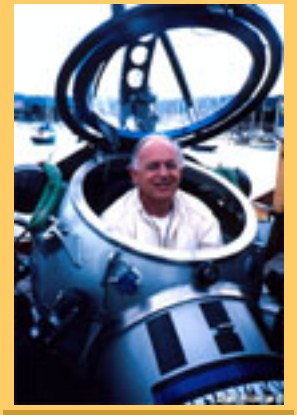
POEM

Interview

Interview with Ed Ueber, Manager
Gulf of the Farallones National Marine Sanctuary
On Location in the Farallon Islands
March 1999

What are the characteristics of the sanctuary?

Click here for audio response. (RealAudio), for help see About this Site



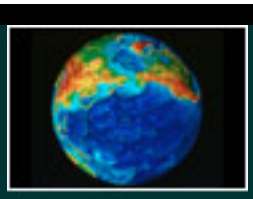
Ed Ueber

The Gulf of the Farallones National Marine Sanctuary is this wonderful expanse of ocean- roughly 1,000 square nautical miles. Right in the middle are the Farallon Islands. Where we are right now is home to the most important breeding colony of seabirds in the continental United States. We also have thousands of seals and sea lions here. The Gulf is the most heavily fished area in California, Oregon, and Washington. We have an incredible "soup" of nutrients coming from the deep via upwelling, which feeds the fish, the pinnipeds, and the whales.

As manager of this protected area, how do you stay in touch with the resources of the sanctuary?

Click here for audio response.

Keeping in touch with sanctuary resources is really an effort for a lot of people. We utilize our Beach-Watch Program, our Seals Program, and two other volunteer programs. We also get assistance

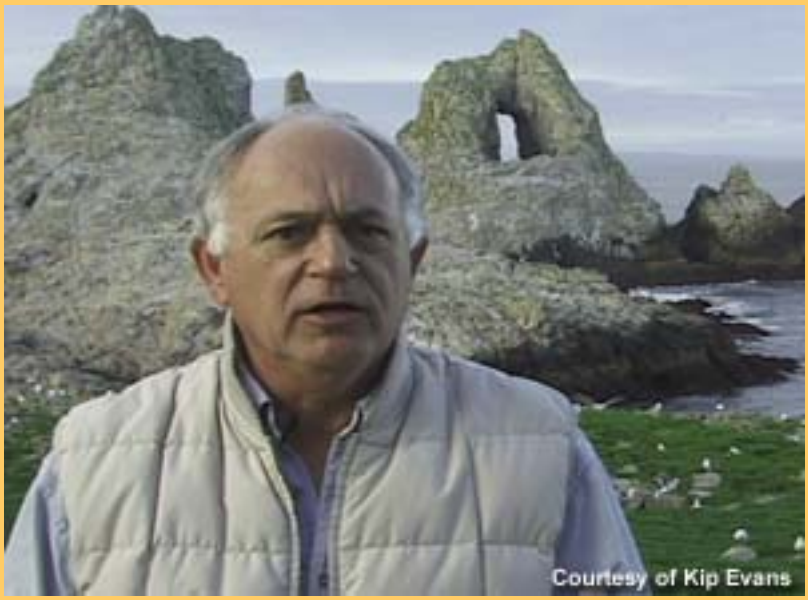


SEALERS

A LOOK BACK

from the California Fish and Game Department, the U.S. Coast Guard, and everyone else who is out on the ocean, including commercial fishermen.

(top)



Manager Ed Ueber shares his thoughts about the expeditions.

What are the major management challenges in the sanctuary?

Click here for audio response.

Some of the major challenges of managing the sanctuary are (1) how to allow people to interact with the animals, and (2) how to utilize the ocean without having detrimental effects on these animals. With the DeepWorker, we will be able to see how these animals live and where they live. We will be able to map the bottom of the habitats and observe the animals in the habitats. So, and if something needs to be done out here to help people, then we will know that it's better to "do it over there than it is to do it over here." So the DeepWorker will be very important in helping us to manage the sanctuary.

What is the role of the DeepWorker in the sanctuary?

Click here for audio response.

The DeepWorker's role around the Farallon Islands is very important for the Sanctuary. We are only able to get into the top couple of feet--the water is very cold, the currents are very treacherous, and there are white sharks that you don't want to swim with--so we can't use traditional diving methods. Without the DeepWorker, we wouldn't even be able to get into the top 60 feet of the water. The DeepWorker's range goes down to 2,000 feet, where we can see the creatures on the bottom and observe how the species change as we near the surface.

The DeepWorker offers us a window into the unknown, into the mysteries we can't see. Without this window, it's just like being inside of a house with the shades drawn. If you open the shades, you can see a beautiful vista, and that is what we hope to see--the beauty that is in the ocean.

(top)

The Sustainable Seas Expeditions will provide insight into all the splendor that lives beneath the waves.

What has changed in the last 50 years of ocean management?

Click here for audio response.

In the last 50 years, some major changes have occurred in the way people view the ocean. It was considered a dump--a bottomless pit to throw things in, and also a pit where you could draw up all the fish you wanted, whenever you wanted. Everything was unbounded--its ability to absorb pollution, its ability to produce protein and fish and food. We now know that this it not true. In fact, we know that we must set aside special areas to protect these wonderful things. The Gulf of the Farallones is one of 12 areas in the United States that has been set aside as a National Marine Sanctuary. This is a complete change from what occurred 50 years ago. In fact, the National Marine Sanctuary Program is only 26 years old.

(top) **RETURN**

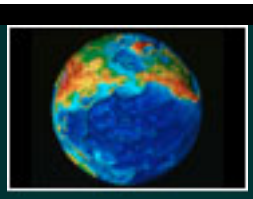
Natural Setting

GFNMS: The Water Behind the Acronym
by Karina Racz, Exhibit Designer and Educator
Farallones Marine Sanctuary Association

Inquisitive minds have wondered what is meant when one speaks of the "Gulf of the Farallones National Marine Sanctuary." What is it? Where does it lie? What specifies its boundaries? How would one characterize the region from a biological standpoint? This entry to the Sustainable Seas Expeditions Mission Log addresses these questions and focuses on revealing some of the hidden characteristics of this vast and beautiful region for our online readers.

Point Reyes is the furthest point west, and a prime site for land-based whalewatching in the sanctuary.

The Gulf of the Farallones National Marine Sanctuary encompasses a total area of 949 square nautical miles off the coast of northern California, an area that is larger than Yellowstone National Park. Within the reaches of this sanctuary is a complete spectrum of marine habitats. Sandy beaches, estuaries, lush rocky intertidal



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zones, and deep ocean environments are all included within the designation of this site. Bordered by Cordell Bank National Marine Sanctuary to the west, it begins at Bodega Head in the north and reaches inland to protect several large bodies of water including the Esteros Americano and de San Antonio, Tomales Bay, and Bolinas Lagoon. The sanctuary then extends seaward to embrace the oceanic environment surrounding and beyond the Farallon Islands. The sweep of the Gulf of the Farallones continues until it meets Monterey Bay National Marine Sanctuary, forming a continuous stretch of protection off California's coast.

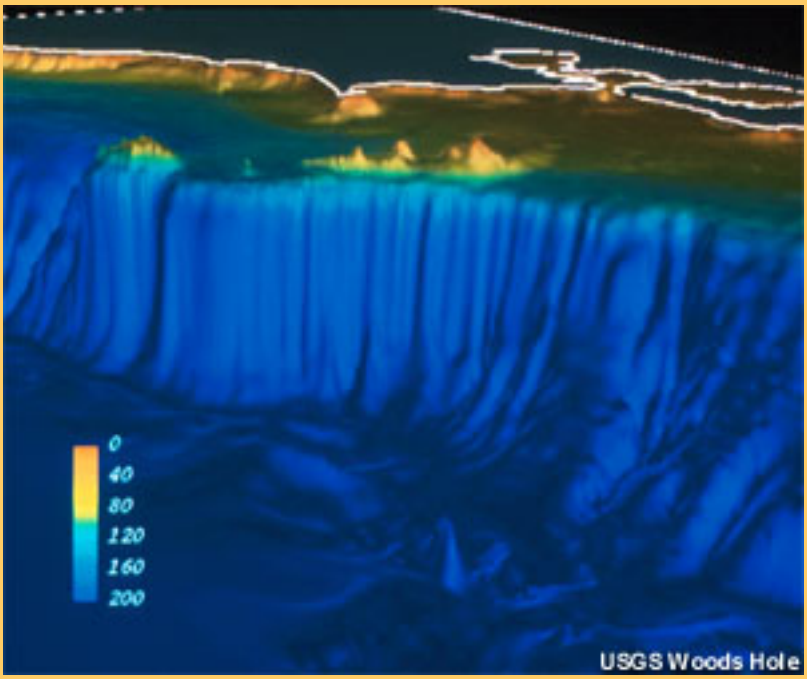
The Gulf of the Farallones National Marine Sanctuary extends inland to include several bodies of estuarine water, including the Estero de San Antonio.

(top)

Just beyond the churning waters of the Golden Gate swarms of krill cluster in the rich, deep waters where the great whales come to feed. Seals and sea lions congregate on the sandy beaches and rocky outcroppings which serve as the ideal settings for their rookeries, and where the greatest concentration of breeding seabirds nest in the continental United States. Schools of juvenile rockfish

hover midwater near forests of bull whip kelp that sway in the ebb and flow of the tide. Iridescent jellies and microscopic organisms, which form the base of the food web, drift with the currents. All of this biological activity occurs because of the larger system at work in this area, which cannot be fully appreciated by isolating specific factors. In a trickle-down effect, one event hinges on the next, combining the influences of physical characteristics, such as topography, currents, and climate, with biological interactions and dependencies. The balance of all of these parts constitutes the Gulf of the Farallones.

The Golden Gate of San Francisco



Computer imagery shows the topography of the seafloor of the Gulf of the Farallones National Marine Sanctuary and the steep drop-off of the continental slope past the Farallon Islands.

To understand some of the factors that contribute to this unique

system, we begin at the seafloor. The topographic structure of the Gulf of the Farallones is characterized by a wide continental shelf, with depths shallower than 600 feet. This gently sloping seafloor extends west for approximately 40 nautical miles, and is the widest shelf found anywhere along the California coast. South of the Gulf of the Farallones, the topography changes markedly to a narrower shelf followed by the deep submarine canyon found in Monterey Bay.

Satellite image of the San Francisco Bay Area and its proximity to the sanctuaries west of the Golden Gate.

From an aerial perspective, one can view the proximity of San Francisco Bay and how it affects the Gulf region. In the winter and early spring, less saline water from the Bay flows out the narrow funnel of the Golden Gate and creates a plume which moves offshore and joins the southeast-flowing California Current along the continental shelf. Seasonal upwelling of cold, nutrient-rich water occurs along the coast just north of Point Reyes during the same general time period as this outflow of San Francisco Bay water. Some of the upwelled water is carried southeastward past Point Reyes, bringing nutrients into the Gulf of the Farallones and creating a highly productive region. The combination of the underlying topography of the Gulf of the Farallones, its connection with the Bay, the prevalent wind patterns, and the rotation of the earth creates a current system in this Sanctuary that acts as a highly productive circulation unit. Because of the ideal habitats and rich food sources brought about by the physical factors described, there is an explosion of life in this Sanctuary that is astounding.

The Gulf of the Farallones is an area of incredible beauty and biological wealth that we are just beginning to understand. The Sustainable Seas Expeditions promises to enhance our understanding and shed more light on all that is a part of this intricate system. By appreciating our role within the natural processes of the area and by treating the region as a balanced and necessary whole, we make stewardship of the oceans a first priority and stand a better chance of preserving the diversity and wonder of

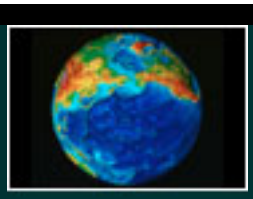
our natural heritage for future generations.

(top) **RETURN**

Maps

The Sanctuary

Just north and west of San Francisco Bay a large expanse of Pacific Ocean along with nearshore tidal flats, rocky intertidal areas, wetlands, subtidal reefs, and coastal beaches was designated in 1981 as the Gulf of the Farallones National Marine Sanctuary. This 1,255 square mile area (948 square nautical miles) is larger than the state of Rhode Island.



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The Farallon Islands, 30 miles (26 nautical miles) west of the Golden Gate Bridge in the south central part of the sanctuary, are a national wildlife refuge, offering resting and breeding sites for marine mammals and seabirds, lured by the undisturbed habitat found in the islands and the surrounding nutrient-rich waters. The sanctuary has thousands of seals and sea lions, and is home to the largest concentration of breeding seabirds in the continental U.S.

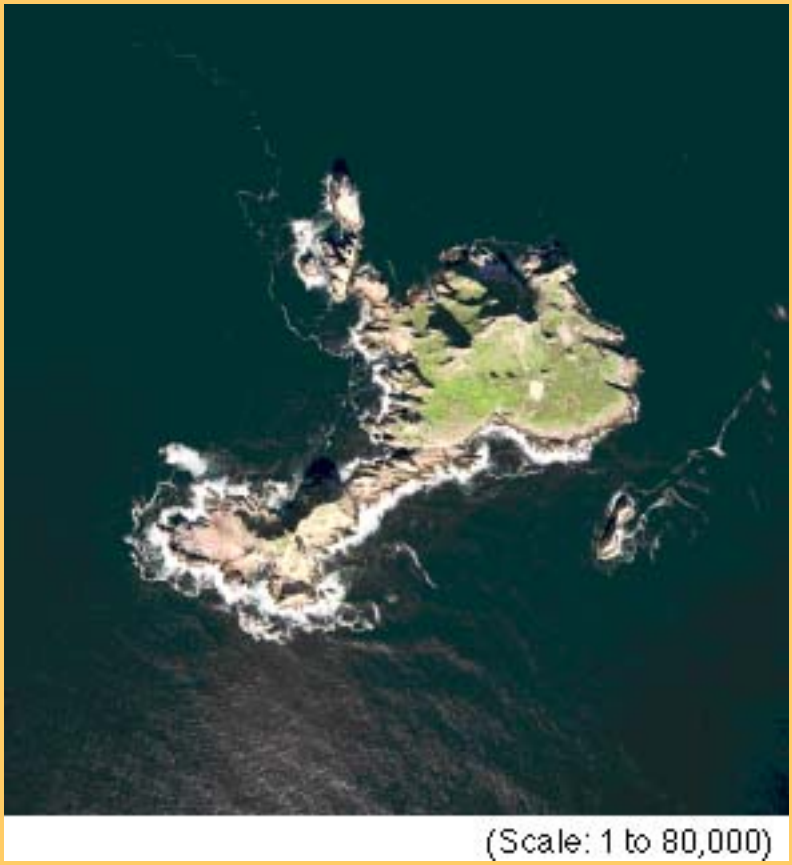
(top)

The Mission

Map shows four possible dive locations: 1) Rittenburg Bank, 2) North Farallon Islands, 3) Southeast Farallon Islands Islands, and 4) Drakes Bay.

(top)

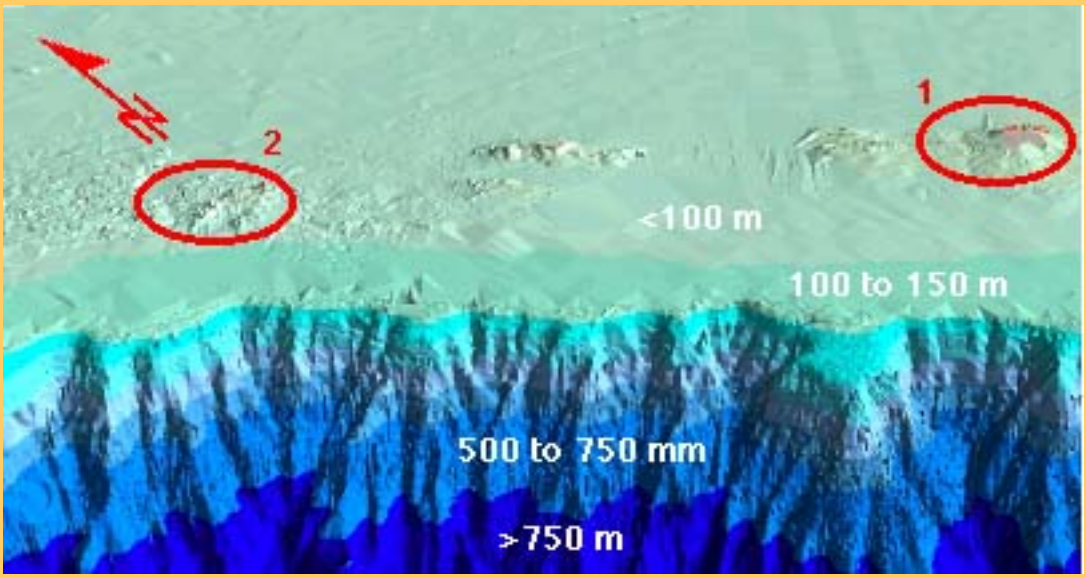
Aerial Photographs



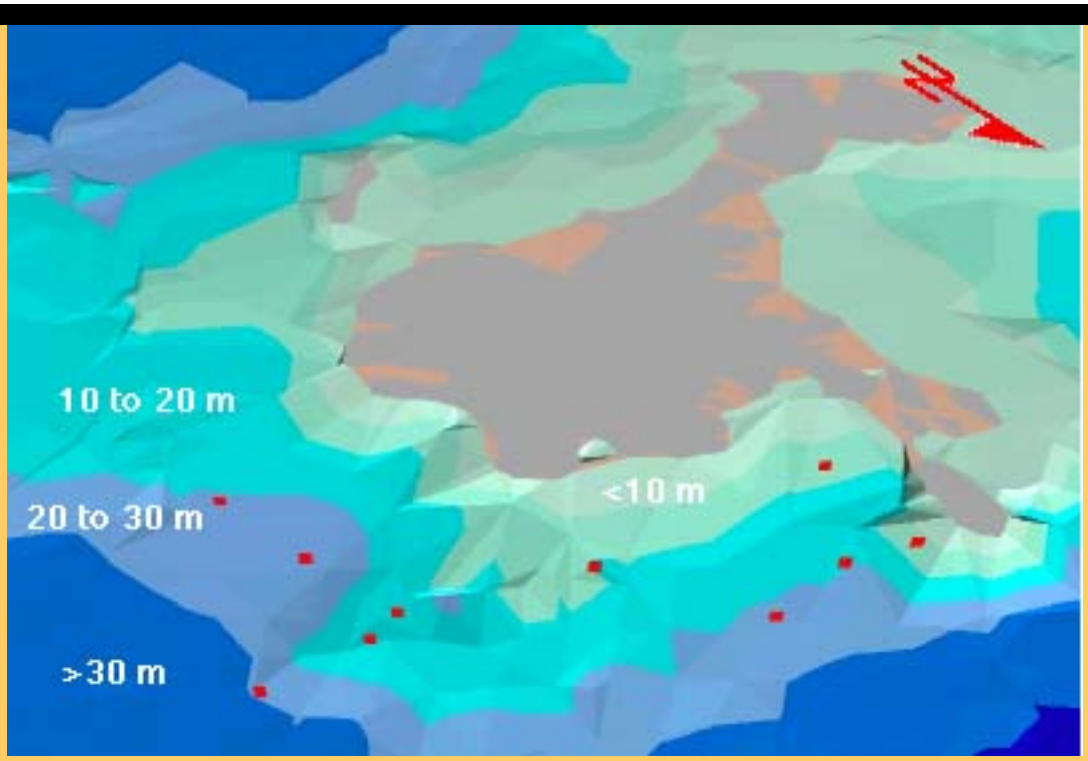
Aerial photographs of North Farallon Islands (top) and Southeast Farallon Islands (bottom). (Source: NOAA's National Geodetic Survey)

(top)

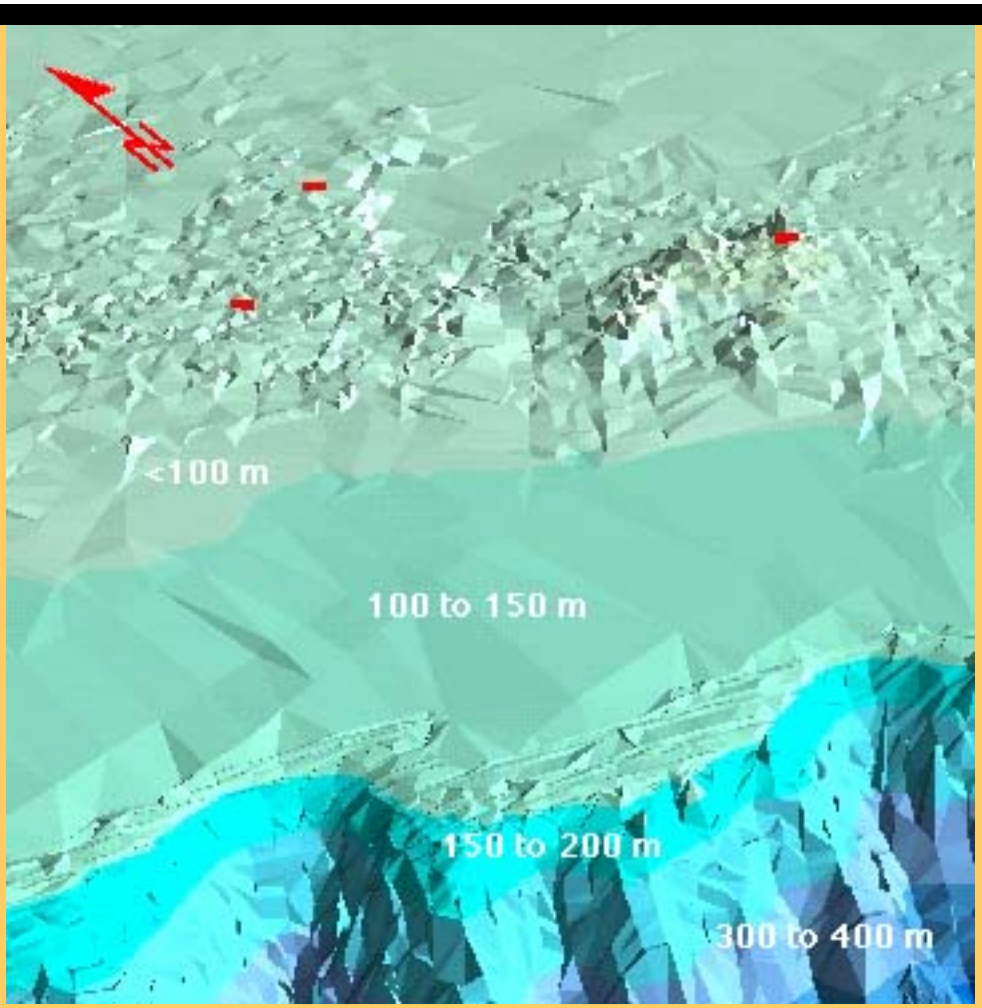
The Sea Floor



Map of sea floor around Farallon Islands looking towards the northeast. Red ovals show dive locations: 1) Southeast Farallon Islands and 2) in the northwest region of the sanctuary near the North Farallon Islands. (Rittenburg Bank not shown). (Source: based on NOAA's hydrographic survey data collections)



Map of proposed dive sites around Southeast Farallon Islands looking towards the southwest. Note that dive sites are in relatively shallow water. (Source: based on NOAA's hydrographic survey data collections)



Map of proposed dive sites off of the North Farallon Islands. Note that dive sites are in deeper water. (Source: based on NOAA's hydrographic survey data collections)

(top) RETURN

Research

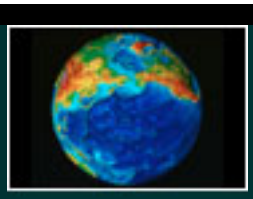
The DeepWorker 2000 as a Research Tool
by Jan Roletto, Research Coordinator
Gulf of the Farallones National Marine Sanctuary


Jan Roletto

DeepWorker provides our sanctuaries with a great opportunity to explore areas where we are not normally able to go. Areas of particular interest within the Gulf of the Farallones National Marine Sanctuary are also areas where white sharks frequent the waters, thus making diving hazardous. While the use of remote operating vessels (ROVs, unmanned submersibles) has occurred in the sanctuary, ROVs only give a spotlighted view of the benthos and make behavioral observations nearly impossible. Using DeepWorker will greatly increase our knowledge of the sanctuaries and will enable us to better provide information to our constituents-adults and children-on the wonders of the Sanctuaries.

(top)

During our first year of exploration, we will not only explore new places within the sanctuaries but we will also better understand how we may best use DeepWorker 2000 in future research. We hope to explore the subtidal areas around the Farallon Islands. These areas are rich and diverse; hundreds of thousands of seabirds depend on this area for food during the breeding season; commercial fisheries harvest urchins and fish from these waters; the pinnipeds and white sharks depend on these areas to forage and flourish. We hope to establish long-term monitoring sites around the Farallones and concentrate our efforts in areas where we know white shark attacks occur. We also know that nowhere else, along the California coast, do some of these species of invertebrates and algae exist. Why is this area so productive and diverse? We hope to answer this question by exploring the subtidal areas at the Farallones.



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Other possible uses for DeepWorker 2000 in the Gulf of the Farallones sanctuary may be to:

- Survey the continental shelf and slope to document the extent and area affected by the Farallon Radioactive Waste Dump. It may be possible to sample the dumpsite for contaminants.
- Locate and investigate the T/V PUERTO RICAN oil tanker that was full of oil when it sank in the Gulf. We would like to determine if this tanker is continuing to leak oil into the Sanctuaries.
- Combine visual observations with some of our current work aimed at estimating biomass and use the DeepWorker to observe feeding behavior of predators such as white sharks and blue whales. We would take a giant step in understanding the ecosystem of the Gulf of the Farallones National Marine Sanctuary.

We are just starting to ask the right questions and gather pertinent biological information. No matter which research projects actually are accomplished with DeepWorker 2000, the images provided by the submersible exploration of the sanctuaries will generate the awe in the public sector that now is reserved for birders, whale watchers, fisherfolk and biologists. The sanctuaries are our treasures waiting to be unlocked.

(top) RETURN

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Education

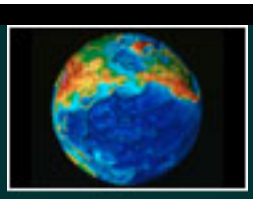
A Vision for Sanctuary Education in the San Francisco Bay Area
by Karina Racz, Exhibit Designer and Educator
Farallones Marine Sanctuary Association

Karina Racz

"The Gulf of the what?" is the typical question accompanied by a furrowed brow and a look of bewilderment when one mentions the Gulf of the Farallones National Marine Sanctuary off the coast of San Francisco. Except for the individuals who remember a TV documentary on the sharks of the Farallon Islands, many people in this major metropolitan area aren't aware that there are islands 26 miles off the coast, let alone that a protected body of water surrounds them. Fog keeps the Islands and the sanctuary shrouded in mystery many days of the year, and frigid, rough water deters most from venturing into the foreign realm beyond the Golden Gate. So do regulations since the Farallon Islands are a National Wildlife Refuge and only a restricted number of biologists are allowed to set foot on them in order to maintain a safe haven for the resident animals.

"What is a National Marine Sanctuary...?" is usually the next question and it is apparent that more public education and outreach are needed before the name of this Sanctuary becomes a household word in the Bay Area. With a severely limited sanctuary budget and staff, and so many physical challenges to the general public's access and experience of this body of water, widespread education on this sanctuary is no small undertaking.

How does one go about beginning to protect a body of water that is generally regarded as cold, dangerous, forbidding, and so, well, huge? At Ocean Beach in San Francisco, posted signs warn of the menacing power of the waves and the threats of rip currents, indicating that unwary swimmers have met their fate here. Point Reyes warns of white sharks, which have, on occasion, sampled a surfer or two. Winter storms create massive waves which hit the shoreline and cause devastating erosion, whole houses slipping into



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the sea. These are the ocean stories that make the headlines and stick in people's minds. Why would such a mighty, powerful, vast ocean need protection from us?

(top)

The Golden Gate of San Francisco

In the Bay Area, the general mindset is much more Bay-focused. It's calmer, more accessible, and a great source of recreation. On weekend afternoons the colorful sails of windsurfers slice through the vista from Russian Hill with Alcatraz, a prime destination for tourists, plainly within view. Ferries commute from Tiburon, Sausalito, and Angel Island on a regular basis, rarely encountering seasick-inducing conditions. But even as the tourists and locals enjoy the pleasures of the Bay, there is another world just to the west that remains unknown--wilder, more extreme, and yet still vulnerable to our ignorance. It's as if marine life and awareness stop at the Golden Gate save for the diehard surfer or hardy whale watcher who has ventured beyond. Though its wild beauty causes an endless stream of cars to wind their way along Highway One, few people are prompted to probe into what might exist in that immense expanse of western blue. Cold, dangerous, inaccessible, out of sight, and out of mind. Why should people care about the health of something so apparently removed from their everyday lives? These are some of the challenges facing the management of the Gulf of the Farallones.

But what if one had a tool, a hook for bringing people's attention to what lies beneath the waves? A means of getting there and bringing the sanctuary to the people? This is what the DeepWorker 2000 and the Sustainable Seas Expeditions will do for this sanctuary. New submersible pilots from diverse backgrounds and areas of expertise will dive in the sanctuary, going where we have yet to go. Like astronauts in outer space, they will expand the reaches of our

minds and increase awareness of the vast resources that lie waiting to be discovered. They will bring back what they see, through video and still footage, and communicate the experience of the wonder and beauty of this ocean realm to the public.

Though surrounded by water, few San Franciscans are aware of the neighboring sanctuaries, or of the wonders they contain.

(top)

A Marine Sanctuaries Fair for the general public will be held in San Francisco upon the return of the NOAA ship McARTHUR from the expedition. The DeepWorker submersible will be on board for the public to view, as well as other scientific equipment used in sanctuary research. The pilots will be available to answer questions and to encourage public discussion about the health of the sanctuary. Bay Area marine organizations will participate and host interactive exhibit booths, encouraging the theme of how citizens can become more involved in ocean conservation efforts and make a difference in their everyday lives.

Rough, cold water and storms characterize this stretch of the Pacific, making public access and enjoyment a challenge.

Educational materials will be created as a result of these expeditions. Slide shows, videos, and curricula will be tailored to high school students in the Bay Area. There is a gaping hole in marine education both locally and nationally. Though ideal for integrating concepts in such areas as biology, math, physics, chemistry, and geography, our coasts and oceans remain largely untapped as environmental classrooms for experiential learning. Sustainable Seas is the spark that will ignite a fire of interest in the local and national marine environment. Teachers will be provided the materials to integrate marine topics and sanctuary education into their school year planning. As ambassadors for the ocean and role models for students, the DeepWorker pilots will make guest presentations at local schools. Thoughtful discussions among the students, the decision makers of tomorrow, will be initiated and their active participation in caring for the sanctuary will be encouraged.

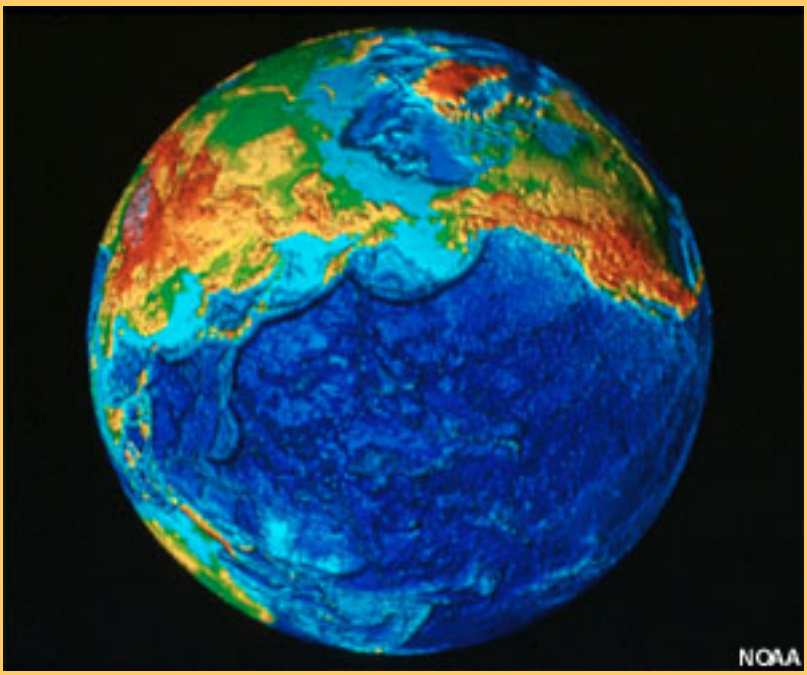
What the pilots of the DeepWorker see in these expeditions will be made real to a widespread audience through the vehicles of exhibits, publications, movies, and presentations. These reflections will bring the sanctuary to the lives of the people whose activities on land affect its health every day. Compelling imagery and knowledgeable accounts will stimulate care and concern for what was once too abstract. An ethic of ocean conservation will be inspired and the Gulf of the Farallones National Marine Sanctuary will no longer be a mystery.

(top) **RETURN**

A Look at Planet Water

by Ed Ueber, Manager
Gulf of the Farallones National Marine Sanctuary

Our planet's name is incorrect
For dirt is out of order
Our planet is the liquid one
And we should call it Water

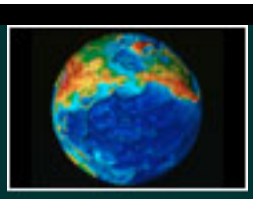


Earth is a water planet.

As we rocket into space
The space between our ears
Lacks the facts of inner space
To help us solve our fears

The ocean rules this third sphere out
With message loud and clear
And when you heed the forces about
It's El Niño that you hear

(top)



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Marine Sanctuaries there are twelve
And all in NOAA's realm
With Cordell and the Farallones
The first to guide the helm

The Sustainable Seas Expedition
Will start in ninety-nine
To usher in the millennium
We hope to dive on time

DeepWorker is our window
Through which all can see
Why the good Doctor Earle
Has called us eight to sea

To explore the ocean deep
With sub by Mr. Nuytten
Which will sink two thousand feet
And raise again we're certain

Sylvia has asked a few
To toil with her below
And there to unlock mysteries
Beneath the marine snow

(top)

The eight pilots for the GFNMS and CBNMS are: Tom Laidig, Karina Racz, Dan Howard, Natalie Cosentino. Top row: Amber Mace, Maria Brown, Ed Ueber, Jan Roletto

Now the good and noble few
Who dance within the seas
Will try and raise awareness
And gain knowledge sure to please

With Goldman's and National Geo's help
To provide the way
Dan and Ed and Amber
Will all submerge to play

Then Jan shall test her skills
To make the science right
She hopes to dive in sunlight
And surface in the night

(top)

We'll dive with mighty cetaceans
As large as houses be
We'll look at tiny ctenophores
And wonder at what we see

Nat will search for algae
And find red and brown and green
To tell us where they're living
And ways to evaluate the scene

Laidig's looking for some fish
To see where they abide
He doesn't plan to eat them
And hopes they do not hide

Although the cameras are all set
Karina's going to be
The person who draws what's wet
And shows their beauty to me

Maria wants a shark to swim
Within her range of sight
But prays the mighty denizen
Does not give DeepWorker a big bite

And so we eight have entered
A realm of alien vent
To look out of a window
And see where none have went

(top) RETURN

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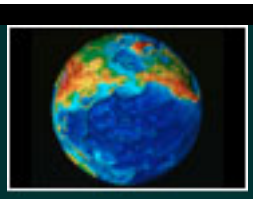
A Trip to the Farallones

by Daniel F. Murley, California State Park Ranger
Fort Ross State Historic Park

With grim, dogged determination and no lack of trepidation, the men strained at their oars. Each dip and drag propelled the crew toward their destination, the islands some thirty miles Southwest of the Russian colony at Ross. The one ragged Russian overseer and his eight-man, Native American crew, were headed for the Farallon Islands to retrieve sea lion meat, fur seal pelts, seabirds and bird eggs. Some of the men on board would replace those who had been hunting on the desolate islets for the last six months. Their craft was a large, open, skin-covered boat called a "baidar" by the Russians and "anyaq" by the Kodiak Island hunters. This keeless craft had been fashioned by the Alaska Natives according to centuries old tradition. In the 1800's at Colony Ross, the main food for both Russians and Alaskans was sea lion meat. Most of that, some four tons annually, was secured, prepared and dried by the small work crew of eight to ten on the Farallones.

A rendering of a typical scene of sealers clubbing for animals for their pelts.

Now, almost 200 years hence, I am fortunate to revisit the site of the hunting party's habitation site on Southeast Farallon Island. I will accompany two archaeological researchers from UCLA, and we



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will spend two weeks on the islands surveying, excavating and analyzing data. The Islands are surrounded by the Gulf of the Farallones National Marine Sanctuary and are part of the US Fish and Wildlife Refuge system. Due to the extensive bird and marine mammal populations, visitation to the islands is highly restricted, and we consider ourselves very lucky to have had all the right permits and permissions approved.

(top)

Our skipper, Captain Rick, is a cordial, capable, knowledgeable man of the sea. Also on board were three crew-persons, our team of three archaeologists and an interesting young man headed to spend three months on Southeast Farallon. He was part of a team of bird researchers who rotate through the Point Reyes Bird Observatory's research station. Since 1967, biologists and volunteers from PRBO have been the caretakers of the island's diverse and unique wildlife. Along with monitoring bird populations and migrations, their studies include long-term studies of marine mammals and great white sharks.

As the numbers of frolicking sea lions seen from the boat increased, it was a sure sign we were nearing our destination. Suddenly, through the mist appeared the jagged granite peaks of Southeast Farallon Island, poking out of the sea. After the sighting of the craggy islets imprinted on our brains, other senses were then assaulted. An attack on the auditory came from the cries of thousands of seabirds, perched on every rock, crag and cranny, and the bellowing, braying and barking of sea lions lodged upon the rugged, rocky shores. Next, wafting over the surface of the water, the pungent acrid odor of guano mixed with the briny smell of tidepools filled our olfactory. This odor was pervasive and hung heavily over and around the island. We would soon touch the roughly granulated rock that would be our home for the next two weeks.

We were safely transferred from the boat to the landing and cordially greeted by the Point Reyes Bird Observatory staff. The arrival of our three-person archaeology crew doubled the island's human population, and with all our equipment, screens, cameras, tripods, computers and surveying stuff, it might have appeared that we were moving out here for good. We loaded all our junk onto a handrail car, which we then pushed up a slight grade to our place of residence. We were to be housed in an old Coast Guard light keeper's residence. The Farallon light has been automatic for many years.

(top)

After we unloaded our gear and chose our bunks, we were taken on a tour of the 125-acre rock by the Birdman of Southeast Farallon Island (SEFI), Peter Pyle. Having spent 18 years working on the island for months at a stretch, he was a guide who knew every nook, cranny, cave and crag. One soon noticed that Peter and his colleagues went nowhere without binocular around their necks, and oftentimes in mid-sentence, the trusty little Leitz binos would be snatched and snapped to his eager intense eyes. No bird movement, on land or in the air, missed his scrutiny. I soon adopted the permanent binocular necklace, for there were plenty of amazing avian visitors to see. (More about that later.) Our mission now, after walking around the island viewing the stark yet beautiful landscape, was to select sights for surface collection units, make a plan for subsurface excavation an map in all the historical features left behind by former inhabitants.

The next day we began in earnest with a laser transit and stadia rod topped with a reflective prism, to precisely pinpoint the features left by the Russians, the U.S. Lighthouse Service, the Navy and the Coast Guard, all of whom had lived on the island and used it for various purposes. We also searched for remnants of a unique band of island visitors, the egg-gatherers from the 1840's through the 1870's.

The eggs of the common murre were gathered and sold in San Francisco by, among others, the Pacific Egg Company. Murre eggs are twice the size of a chicken egg, and have a uniquely conical shape so that if bumped or knocked while on its lofty cliff-side rookery; it will roll in a circle rather than roll off the edge. During the egg raid reign of terror, 300,000 eggs per year were removed. A barbaric practice of destroying all the eggs in the nests early in the gathering season would ensure fresh eggs for the greedy pickers.

We didn't eat any murre eggs; in fact, all the birds had fledged and flown by the time we arrived, but we did see remains of egg company dwellings.

(top)

Our archaeological investigation shed new light on the history of human habitation on Southeast Farallon Island. Our particular area of interest was the Russian period in the 1800's, during which time a small group of individuals lived here. We know from some archival information that in the 1820's, Kodiak Island native hunters who had been brought to Ross by the Russians, were also taken to the Farallones. There were also local natives, some who were sent to

the island to work as punishment for "crimes" against the Russians.

In our excavations we found a few glass trade beads which probably belonged to one of these native people. The round red glass beads were found in an excavation unit that also contained the bones of many marine mammals, mostly sea lion, and numerous bones of common murres.

We know these workers were sent here to process food for the Ross colony. The most populous group at Ross was Alaska natives, and sea lions and sea birds were a major part of their diet. So my thought was, that while butchering and preparing these animals, the worker might have broken a necklace or bracelet of trade beads, and in retrieving them for restringing, might have lost the couple which we found. A similar red bead was found during our excavations, with Dr. Kent Lightfoot, of the Native Alaskan Village Site at Fort Ross in the early 1990's.

In another unit on Southeast Farallon, we turned up an abalone shell ornament and a clamshell disc bead, which are traditional adornments for California native people. These might have belonged to Vayamin or Yayumen and were lost while working in this other location.

We'll never know exactly what happened in detail. However, by looking at artifactual materials we excavated and archival information gleaned from historical records, we can get a better picture of what life might have been like for those misplaced individuals on these barren isles. And the more closely we look into the past, the more clearly we can see into the future.

As we waved good-bye from the afterdeck of our San Francisco-bound transport and motored away from the rock which had been home for 15 days, I felt that someday I would return. I had learned a great deal about the island and its history, but now, I was anxious to return home to my family and share with them this unique experience in natural history, archaeology and adventure.

"Such a long, long time to be gone, but a short time to be there."

(top) **RETURN**

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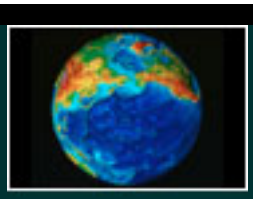
The Submerged Cultural Resources of the Gulf of Farallones National Marine Sanctuary

by Bruce G. Terrell, Marine Archaeologist
NOAA, National Marine Sanctuary Program

During the last Pleistocene ice age, between 10,000 and 20,000 years ago, the Earth's sea level was at its lowest. During this period, humans migrated between Asia and North America and inhabited the farthest reaches of the Americas. In the region of the Gulf of Farallones National Marine Sanctuary, prehistoric people settled within the coastal zone. This zone extended more than a mile beyond the present shoreline. As the climate warmed, the inhabitants were forced to retreat to successively higher elevations, often leaving behind evidence of their culture and lives.

The California coastal region surrounding the Gulf of the Farallones National Marine Sanctuary.

There is an excellent probability that components of these previous habitations may remain covered, by sediment and the sea, and may be identifiable by archaeologists. The technology which could be used to search for and study archaeological sites is evolving. The archaeological remains of these cultures are some of the submerged cultural resources which are protected by the Gulf of Farallones National Marine Sanctuary.



SEALERS

A LOOK BACK

Other sanctuary cultural resources include historic shipwrecks. Known shipwrecks span a 400-year timeframe, from the earliest Spanish ship (1595) to the 20th century. The sanctuary is mandated to protect historic shipwrecks and cultural archaeological sites. The Marine Protection and Sanctuary Act defines "historical" material as being fifty years or older, or of "special national significance."

The earliest documented historic shipwreck on the West Coast is the *San Augustin*, within the sanctuary. This Spanish Manila galleon was destroyed in a storm in 1595. Several private groups have searched the waters of Drake's Bay unsuccessfully attempting to find the ship's remains. The sanctuary, Point Reyes National Seashore, California State Lands, and Drake's Navigators Guild are currently engaged in a multiyear exploration endeavor for the ship.

(top)

The waters of the Gulf of Farallones National Marine Sanctuary have witnessed a rich diversity of watercraft. Most of this activity in the last 400 years has been focused on trade. The Spanish built missions around the Bay after 1776, which brought supply ships and foreign fur traders.

Following Mexico's independence from Spain in 1821, the port of Yerba Buena (later named San Francisco) gradually expanded into a regional trading center. New England's "Yankee Traders," and ships of European nations, traded, whaled, and gathered furs and hides while using San Francisco as a base to resupply their vessels.

Maritime activities also occurred in the waters of the sanctuary. The Russian-American Fur Company established an outpost at Bodega Bay in the early 1800s and imported Aleut Indians from Alaska to hunt seals on the Farallon Islands. The coastal regions saw many foreign ships involved in the Mexican hide and tallow trade. In this trade (described in the book *Two Years Before the Mast* by Richard Henry Dana) ships anchored offshore from ranches, and hides and tallow barrels were rowed to the ships by boat.

During the 1840s the United States government took a great interest in the region for economic and political reasons. So many Americans settled in California that they declared their independence from Mexico in 1846 and became a U.S. territory the following year.

The 1848 gold strike at Sutter's Mill was a defining moment in California and U.S. history. San Francisco became the Gold Rush

port of supply and trade, and the number of ships arriving exploded overnight. Many ships that came to San Francisco with passengers and supplies were abandoned by entire crews seduced with tales of instant riches. Entrepreneurs made fortunes attending to the multitude of needs of the growing population. Everything needed to sustain life was imported by ship including lumber, coal, foodstuffs, tools, liquor, prostitutes, and mail-order-brides.

(top)

During the second half of the 19th century, as the economy and society became more stable and growth slowed, San Francisco became America's Pacific economic hub, and thrived on maritime commerce. International maritime trade developed between San Francisco and many ports in the Pacific basin including South America, the Orient, and Australia. Passenger and mail steamers regularly transited the region. A thriving coastal commerce evolved along the Pacific coast and its inland waters in which small coastal schooners and brigs supplied small communities and carried their commerce to the larger ports in San Francisco Bay.

"Sampans" were used inshore and in estuarine waters by Chinese fishermen.

Several ethnic groups were responsible for developing and expanding the 19th century fisheries industry in the sanctuary region. Fishermen from the Mediterranean, including Italy and the Balkans, injected elements of their cultures into central California as well as introducing their distinctive watercraft designs. The Chinese were the major force in the shrimp, sea cucumber, and abalone industries, using their unique junks and sampans to harvest the resources.

The growing 19th and 20th century regional economy was accompanied by corresponding growth in the numbers and types of watercraft. A natural by-product of this was an increase in the number of shipwrecks. Although the greatest number of ship losses usually occurred in nearshore areas, the large volume of traffic made more ships and boats vulnerable to collisions and foundering in Pacific storms.

There are at least 151 documented historical shipwrecks within the sanctuary. Each historic shipwreck is a potential time capsule into a period of history. These wrecks sometimes constitute the sole remaining record of an economy, culture, and existence that often went undocumented. Through the study of shipwrecks we can learn about maritime economic and cultural exchange, historic lifestyles, foods, and important information about elements of historic ship construction.

The Gulf of the Farallones National Marine Sanctuary, as are all sanctuaries, is directed to preserve and protect the underwater cultural and natural resources of the area for the education and enjoyment of the public. Due in part to the harsh underwater environment and the regional shark populations, NOAA has been limited in its efforts to inventory the sanctuary's historic shipwrecks. It is hoped that initiatives like the Sustainable Seas Expeditions may help the sanctuary to identify these significant remnants of our common cultural heritage so that we may begin to make them known to the public.

(top) **RETURN**

April 17, 1999

Gale Mead, Expedition Log Editor

Weather: Foggy, temperatures in the 60's.

We're finally here!

It's been a long road to get here, but the Sustainable Seas Expeditions have finally begun! What started as the germ of an idea to explore the National Marine Sanctuaries has blossomed into an unprecedented partnership between NOAA, National Geographic, and a host of other partners. Over the past year, an incredible amount of hard work on all sides has brought us to where we are now, day one of an expedition that will span five years, and, we hope, will continue on even after that.

NOAA's investment in SSE has been enormous. The human resources alone have made things possible that we could hardly have even hoped for when the project was first conceptualized. Too many energetic and devoted individuals have made valuable contributions to possibly list them all. They include ship's personnel, folks at the Pacific Marine Command, and the staff at NOAA headquarters who, among many other huge contributions to SSE, took on the awesome task of making this website happen.

NOAA went to great lengths (and no small expense) retrofitting its research ship McARTHUR to make it capable of launching and recovering the submersibles. A deck along the port side was remodeled, and a new crane installed. These modifications, while made with SSE in mind, will enhance the McARTHUR's ability to carry out its other missions as well.

(top)

The McARTHUR's Commanding Officer, Bill Sites, describes how Sylvia first approached him about the possibility of bringing SSE operations to the McARTHUR. "She was on board for the Jason project, in March of 1998, and she asked me what I thought of the idea of launching subs off the McARTHUR. I told her that if she were involved, we'd love to have the chance to work with her again." The preparations to get the ship ready "were incredible. I was fried. We were task saturated for eight weeks, installing new equipment, and working through a three-page list of repairs. We were scrambling. Now that we're finally here, it's a big relief.

The ship has been excited about doing this for almost a year now."

At 6:00 this morning, we slipped away from pier 32 in San Francisco with a quiet, fanfare-free departure. We've just now dropped anchor about a tenth of a mile off the Farallon Islands, and the first test-launch of the sub is planned for after lunch.

Dan Howard, Assistant Manager of Gulf of the Farallones National Marine Sanctuary and Mission Coordinator for this leg of the expedition, describes his perspective on the launch of this expedition into his sanctuary:

Clouds and high seas surround the Southeast Farallon Islands.

> As the Mission Coordinator for this first Sustainable Seas Expedition, my hope is that we are setting the foundation for future exploration and research in our nation's marine sanctuaries. I hope, too, that the DeepWorker submersibles will be the key to unlocking mysteries and making new discoveries in a way that promotes interest in, and appreciation for, our nation's marine resources. And finally, by sending educators down into this new world, we can use their special skills to foster excitement for this incredible blue realm that is in such need of our attention and protection.

(top)

Work at sea often refuses to adhere to our carefully laid schedules and plans, and the SSE project is not exempt from that rule. But on the McARTHUR, as everyone on the crew proudly attests, three things you can always count on being on time are breakfast, lunch, and dinner. The galley staff on the McARTHUR has a flawless reputation for having things ready on schedule, no matter what, and the food is excellent. I was still stuffed from this morning's French toast when the fresh, hot cinnamon rolls were served for coffee break. And lunch will be served just a few minutes from now. As Maria Brown said, "If I'm not careful, I'll be too big to fit into the sub before too long."

We have the two training subs with us on this mission: DeepWorker 3 and 4. Both are only rated to 350 feet, but for this mission, that's OK. None of the dives we have

planned were for deeper than that here anyway. By the time SSE gets to Monterey, we'll have one or both of the 2000 foot subs.

As for these subs, well, it seems every time I blink, there's more and different equipment. The unwieldy laptop computer we were using for the sonar system has been replaced by a more streamlined display and mouse. The backup sub is equipped with a manipulator arm, while the main sub is bristling with cameras and lights.

Meanwhile, there are the islands, enticingly close. We've been watching the island's resident seabirds: cormorants, common murres, and seagulls, primarily. I've read so much about these islands, these amazing ecological gems so close to the metropolis of San Francisco, and it's a thrill to finally see them up close. Right in our own back yard, we have this treasure trove of biological diversity, yet so few people even know they're here, or what they represent. The islands are a last stronghold for seabirds whose nesting sites used to festoon many areas of our coastline, areas which have since been taken over by development for human use. I'm eager to get in the water with the sub to get a fish's eye view of the islands as well.

(top)

6:15 p.m.

Expeditions Director Sylvia Earle prepares for her inital dive in DeepWorker. Francesca Cava (right), Project Manager, views Sylvia's camera.

This afternoon was spent on pre-dive checks with Sylvia and Francesca, which included identifying and eliminating minor glitches with the subs. This is a brand new sub design, and in fact, these particular subs, officially known as DeepWorker 3 & 4, are actually the first two of this design ever made (DeepWorker 1 & 2 were prototypes of a very different design). Everything on these subs is new, and we're still testing as we go along. We are explorers not only geographically, but technologically. If it seems there are a lot of times that something needs fixing, adjusting, rewiring, or replacement; if the hazards of actually diving in such a touchy sub seem a bit much; well, welcome to the cutting edge! It's a little nerve wracking out here, but it's also where the most rewarding experiences can be found.

We were finally able to get the sub in the water about an hour ago, with one of the

Nuytco team, Steve Drover, piloting. But what I said about life on the cutting edge still applies. Steve had been in the water about 20 minutes when one of the system's water alarms informed him of water seeping into the sub's electrical junction box. Now, the Nuytco team will have to find out why it leaked, and fix whatever damage the water may have caused.

A few words about the team of technical wizards who are responsible for the sub: Ian Griffith is Operations Manager for DOER Marine Operations, a company working under contract with Nuytco to maintain the subs, and handle all onsite operations. Phil Otalora works for DOER, while Steve Drover works for Nuytco. I think these guys are some of the hardest workers I've ever met. They've been putting in long, long hours for the past few days (and nights) as we've been getting ready to go, operating on only a few hours of sleep a night. Last night, they were joined by Mike Cole, a camera whiz from National Geographic who flew out to help install a new high tech camera system. The subs, and the safety of the people piloting and launching them, are their top priority. And when the ship's crew has called it a day, and the rest of the scientific party are cozy and warm in the wardroom, or snuggled down into our bunks, the sub crew will continue to do whatever has to be done, so the sub can dive in the morning.

(top)

The lifestyle these guys are forced to live isn't easy. Phil has to leave behind his wife and 19-month-old daughter, sometimes for months at a time. And Ian's wife Elizabeth was due to deliver her second child April 9. Now over a week late, Ian's on pins and needles waiting for the news that our little friend is finally ready to make his grand entrance. But in the mean time, Ian's dedication to his work remains constant. The success of the mission, and the safety of the pilots, remain at the forefront.

Of course, many of us have to leave loved ones at home. It's part and parcel of working on the ocean. Harry Guice, a member of the McARTHUR's crew, shared with me the sadness he feels every time he has to say goodbye to his two daughters, who are only seven months and 16 months old. "I began this day e-mailing my wife to say 'good morning' to her and my two little girls. These three ladies are so dear to me. Let the show start so that we may get home to the ones we love."

Our Mission Coordinator, Dan Howard, showed me a poem his 15 year old daughter, Alicia, gave him before he left. The paper is already rumpled and worn from riding around in his pocket, and from frequent re-readings. She writes:

(top)

Think of me
When you are away
I am the wind,
Soft and gentle
Bringing you happy thoughts
And fond memories
I am the wind

Racing along the surface of the water,
Never stopping
But pausing a moment to say hello.

Think of me
While you are away.

I am the water,
Deep blue and glistening in the sunlight
Surrounding you with hugs and kisses, (and maybe a few punches)
I am the water
Reaching from every corner in sight
Providing adventure, fun and learning.

Think of me,
During the time you are away.

I am the sun,
Shining warm and bright,
Showering you with love and laughter
I glisten and gleam,
Forever showing signs of new life.

Think of me
When you are away,
And remember that I will be waiting for you
When you return.

(Alicia Howard, Age 15)

(top) **RETURN**

April 18, 1999

Kathy Soave, Teacher at Sea

Time: 3:00 pm
Weather: Breezy, cool but mostly sunny. Winds are approximately 10-15 knots NW and picking up.

Kathy Soave, Teacher at Sea

I am here on the McARTHUR, a NOAA ship, for the Sustainable Seas Expeditions, as the fortunate teacher chosen to be a part of this exciting mission. The scale and significance of this joint mission between the scientific community, the private sector, the government, education and the public is as extraordinary as it is complex.

I am struck by the amazing array of different backgrounds all of the people involved bring to the equation. But more than that, I am impressed with the spirit of cooperation and dedication displayed by all involved -- it is truly an experience where everyone brings something unique and important to the whole.

Arriving at the Farallon Islands, an incredible collection of rocks that seem to come right up out of the ocean floor about 25 miles west of the Golden Gate Bridge, seabirds of many varieties can be seen and heard. Common murres are everywhere, looking like comical flying white footballs, along with Brandt's cormorants bringing seaweed nesting materials to shore. And there are whales!! Gray whales can be seen spouting in the distance, accompanying us as the subs are worked on and made ready for launch. We were even treated to a slow, leisurely swim-by this morning by a curious gray.

Since this is the first time these one person submersibles (DeepWorker 2000) have

been used by these pilots in these particular conditions, there is a fair amount of tweaking to do before all is ready. But there is always something interesting to check out, from marine mammals and seabirds to submersible check-out procedures to discussing what is happening in various corners of the marine research world. This is definitely an amazing mission -- one my students (and hopefully people everywhere!) will learn much more about. Wow!! Sylvia Earle's sub is now in the water -- now we will begin to see the Marine Sanctuaries from their proper perspective - underwater. Time to go!!

(top) **RETURN**

SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

GULF OF THE FARALLONES

SITE INDEX

April 19, 1999

Gale Mead, Expedition Log Editor
Francesca Cava, SSE Project Manager
Steve Drover, Nuytco Submersible Ops Technician

Weather: Sunny, warm but windy (12 knots in the morning, increasing to 30 knots by 3:30 p.m.)
Location: Drake's Bay, near Point Reyes, CA

Things are starting to fall into place. During the past few days, it seemed like a slow start as we worked to get all the people and machines and different systems working together smoothly. But yesterday, Sylvia's dive went beautifully, as she piloted the sub in Drake's Bay.

Our photographer, Kip Evans dove with her using SCUBA equipment and captured some images of the dive. And today, we're finally seeing dive operations come together with pre-dive checks progressing quickly, launch and recovery ops going more and more smoothly, and technicians and scientists moving efficiently through post-dive procedures in preparation for the next dive. We are accomplishing what we had planned for the first few days of the mission: Get everyone more familiar with the subs, and with the launch and recovery procedures, and start getting the sub's pilots checked out in open water.

Kip Evans, Mission Photographer, prepares to film underwater footage of the DeepWorker.

I asked SSE Project Manager Francesca Cava to share her perspective on the Sustainable Seas Expeditions, and on her experiences today diving the sub for the first time since our training in Monterey and Seattle. She writes:

(top)

It isn't often you get to live a dream, or even attempt to be part of something that may be remembered long after it is complete. However, being the Project Manager of the Sustainable Seas Expeditions fulfills that vision and more. There has never been an expedition like this, with the goal to explore some of the most important areas of our ocean: the national marine sanctuaries, our national parks in the sea. It includes the public through the National Geographic Society's magazine, film, and web arms, and the public sector through our partnership with the federal government, which allows us to sail on their ships and tap their experts. It includes scientists, writers, conservationists, artists, poets, and explorers.

Francesca Cava aboard the McARTHUR in the Gulf of the Farallones National Marine Sanctuary.

On a personal level, it allows me to work with one of my heroes, Sylvia Earle, a woman who embodies the spirit of a true ocean explorer who always seeks to discover new underwater vistas, experience everything there is to experience.

Beyond dreams, however, this is a time when great things can be accomplished. We are starting to explore the ocean with the same determination and sense of wonder that others have had in exploring space. And not just once, or for a small handful of people. The new submersibles are more accessible than ever, and we hope to help open up the experience of first hand exploration of the ocean to as many people as we can. By using manned submersibles instead of robotic vehicles, we gain first hand experience of what it's like to really be there, and see with our own eyes what's there, and what isn't, and to attain a better appreciation for the changes that are taking place. Just as a picture is worth a thousand words, a first hand experience can take the place of a thousand pictures in really making a life-changing impression on our psyches. Robotic submersibles are valuable tools, but they cannot entirely replace the experience of being there.

(top)

Although there are only 60 or so pilots beginning this odyssey, we will not be the only ones. Perhaps, just like cars, these small submarines will someday grow from being accessible to only a handful of people to being within everyone's reach. Perhaps just like airplanes, these subs can take us to new places to see and discover. And once more of us have seen what is really happening in the ocean, perhaps more people will find places and animals to care about as much as we care about critters in our own back yard. It's all there waiting for us to discover!

Today, I had my first dive in the ocean water. This wasn't my first dive, as we trained first in a tank at the Monterey Bay Aquarium Research Institute, then a quick dunk in Monterey Bay, and later another in Lake Washington in Seattle. But this was as different as swimming in a pool vs. your first dunk in the ocean. Today, we are north of San Francisco Bay in a small natural harbor called Drake's Bay. This is where I did my first dive launched off the NOAA ship McARTHUR.

In some ways, it wasn't as dramatic as I'd expected; in others, it was more eventful than I could have imagined. The wind was gusting to 25 knots with a current of a knot or so. All of a sudden, like a piece of driftwood caught on an outgoing tide, my sub seemed to have a mind of its own. The McARTHUR, a 175 foot research vessel, looked huge from my vantage point at water level. The people on the fantail looked tiny. Whether I used my thrusters or not, I was going faster than I wanted, and not always in the direction I wanted to go. But for the first time, I could also go further than ever before, and I could also spend more time submerged below the surface. This was only a checkout dive, though, so I couldn't go too far. Only 27 feet down to a sandy bottom with surprisingly little action -- just a few starfish, some sea grass, and worm holes hinting of life going deeper yet. But it gave me a taste of what is yet to come, and like my first bite of a tasty meal, I can hardly wait for more!

I asked one of the Nuytco technicians, Steve Drover, to share his thoughts about Sustainable Seas, and about how things are going so far in this mission. He writes:

When I was first approached about being involved in this project, I have to admit, I was a little apprehensive about it. My worry came partly from my misguided fears about working on scientific projects, and working with scientists themselves. But after meeting with some of the people and seeing first hand what was going on, my feelings on the matter have changed considerably.

Almost all of my experience with diving and submersible operations comes from work in the commercial diving world. In that world, you have one purpose in life, and that is to complete the job at all costs.

Sometimes, safety is compromised, because the priority is always to complete the project, and keep the client happy. You have schedules to meet, and if you don't, you have the company man at your throat. It can be fun, but it can also be a total nightmare.

The Sustainable Seas Expeditions project, on the other hand, is a totally different kind of job, with other goals, a different attitude, and a higher purpose than just making money. We're out here to explore for the sake of discovery, and to promote science, conservation, and education, and the whole job feels different, because there's a totally different philosophy behind it.

I came from a place in Canada which has had its heart ripped out of it because of the damage that humans have done to the sea. My ancestors were all fishermen, so in a way, I feel somewhat responsible about what has gone on. Their livelihood, and their way of life, fishing off the coast of Newfoundland, was not sustainable. When too much was taken out of the ocean, the fish populations couldn't keep up, and the result has been devastation both for the marine ecosystem, and the communities they used to support. The main reason I chose to be involved in this project is so I can give back, in my own way, to the sea which has given so much to my family.

The subs are working well now, after many late nights. The pilots are also progressing along to a point where I feel they will be able to accomplish some good scientific work as soon as we can get a break in the weather to go back out to the islands. Practice, practice, practice, and don't get angry at the dive supervisor if he nags you about the little things. It's those little things that could make the difference between a successful dive and a disaster!

Today ended with some frustration, as winds kicked up to gale force intensity, causing us to abort launch of Ed Ueber's sub just moments before he would have made it into the water. But safety always must come first, and such high winds make it very difficult to control the sub while being lifted off the deck and into the water, and even while piloting the sub in the water. Tomorrow is another day, one we hope will come with better weather conditions, and more opportunities to dive!

(top) **RETURN**

April 20, 1999

Ed Ueber, Manager
Gulf of the Farallones National Marine Sanctuary

Predive the sub. Postdive the sub.
Predive the sub. Postdive the sub.
Predive the sub. Postdive --- No, wait, we ARE going to dive the sub! As one human began his exploration of the Gulf of the Farallones National Marine Sanctuary, the forces of Coriolis, barometric pressure, and advection delayed and then canceled my first two attempts to dive the sub.

The spinning Earth (Corriolis force) moved a high pressure system east and south. The steep gradient within this very high pressure system (1030 milibars) caused the atmosphere to slide down the gradient and gather speed. This ended the first dive before it ever started. The second dive was aborted because the cool ocean water was advected along the coast, meeting the warm land air mass, resulting in densely condensed water vapor.

Ed Ueber aboard the McARTHUR.

Or as a sailor might say, the first dive was blown out, and the second dive was fogged in!

Finally, with moderate visibility (six nautical miles) and decreasing 25 knot winds, it was finally safe enough for me to make my first dive in the Gulf of the Farallones National Marine Sanctuary in the DeepWorker.

"Like sailors lost in an unknown ocean" is how Alexander Graham Bell stated it, describing another great quest. I didn't feel that way about this adventure. I was worried about Matt, our swimmer, because of currents, thruster blades, and denizens of the deep. I was thinking about Maria Brown and her monumental task of taking what she and all the pilots from this sanctuary learn and translating this knowledge to others who cannot go. I know, as director of the Farallones Marine

Sanctuary Association, Maria is uniquely gifted and able to accomplish this, but what a task!

My other predive mates were Dan Howard, assistant manager of the sanctuary, Jan Roletto, research coordinator for the areas we manage, Kathy Soave, our Teacher at Sea from Branson High School, and Gale Mead, the editor of the SSE Expedition log. Yes, everyone shines the plastic dome, checks the thruster fluid, scrapes their knuckles trying to reach the drop weight release lever, and memorizes the lost-comms procedures of the exalted troika from Nuytco -- Steve Drover, the "interior designer," Phil Otalora, the "dome holder of wisdom," and Ian Griffith, the father-to-be of babe and pilots.

Once off the deck, the E-Ticket ride on the crane commences. For the sea conditions, the able deck crew of the NOAA ship McARTHUR was superb. Then a splash in the water and a speeding RHIB (Rigid Hull Inflatable Boat, pronounced "rib"), coxswained by Steve, with Kaye as crew, photographer, and warm smile, come to retrieve Matt the swimmer.

(top)

After the lines were released, I was given permission from Phil to dive. I flooded the soft ballast tank, but still found myself bobbing on the surface. I was too light (that was good for my ego!). I started flooding my hard ballast, and in a matter of seconds I started the descent for the bottom. Only 36 feet down, but it's a start. I have already been down to 10,000 feet in the submersible *USS Sea Cliff*, but this time, I'm CAPTAIN! My first command, and I would make sure the crew were snappy and deferential. Too bad it's a one-person sub, so I'm Captain and crew in one!

Once on the bottom, I repeated the life support readings: O2 percentage, cabin pressure, high and low pressure readings for both O2 tanks, air pressure, CO2 percentage, CO2 scrubber fan operational (almost forgot to report that one, again!) no ground faults, no water alarms, battery voltage at 256.8, and I'll even throw in a report on my depth at no extra charge! We report these readings every 10-15 minutes, and are in communication every five minutes. I think Ian thinks we'll slip off for a cold one if he doesn't keep close tabs on us.

Phil then instructed me to run transect/navigation tracts using the compass and sonar. All went well, except I was told to reduce speed (I was going the sub's max: 3 knots) or face a speeding ticket. Slowing to a good transect speed, I was flabbergasted by the number of worm and clam holes I could see. I also saw a 15" flatfish (ID'd as a petrale sole, but outside the accepted 60 foot minimum depth where they usually live), a dead 3" rock crab *(Cancer productus)*, ID'd by its protruding eye bump on the carapace, a dead 1-1/2" red urchin *(Strongel centrodus fransisconis)*, a single 2" stipe of kelp, 10-20 sea stars, and a limited amount of red algae in float, all on this holy sandy bottom.

All too soon, 10 life support checks later, Phil told me to surface and come to the ship. Maneuvering the sub on the surface, after blowing the ballast tank, I was

pleased. The tracking system had worked, transects had been run, algae and critters seen, and no mutiny by the crew. Now a safe retrieval, and back on ship. Matt was great, and Steve maneuvered the RHIB wonderfully. With Dave the botswain directing the deck ops, I was gently lifted back onto the deck of the ship.

People actually took my picture! Jamie Hall, our night watch volunteer oceanographic sampler, has three cameras! Luckily, he's a great photographer. I'd get two poor and one bad photo where Jamie gets two good and one great.

We're hoping we can get Dan in the water tomorrow, then Maria, Gale, and Jan, and later in the week Natalie, Tom, Karina, and Amber. These pilots will also write of their adventures, once they have had them. I will be interested in their findings, but right now, it's thanks to Sylvia, Bill Sites (the ship's CO), the ship's crew, and the troika of Nuytco, for this wonderful, exciting experience!

(top) **RETURN**

April 23, 1999

Gale Mead, Expedition Log Editor

Tuesday night, the SSE managers, dive supervisor, and the ship's captain had a decision to make. Wednesday's wind was expected to be just as strong as it had been for the last couple days, and we needed to be in port for Thursday's big Earth Day events. If we didn't leave Drakes Bay by 7:00 a.m., the tide level would prevent us from being able to leave until 3:00 that afternoon. Should we stay, in hopes of getting a chance to dive the sub, or should we assume that the winds would continue to be too hard, and make an early departure in the morning?

Earlier Tuesday night, we'd had another disappointment. We'd completed the entire pre-dive on the sub, and Dan Howard was inside as pilot, all sealed in and ready to go. All of us on the deck, including crew members, the sub ops team, and the pre-dive helpers (myself included) had put in a request for dinners to be set aside for us, as we were working straight through the galley's meal time. Then the wind kicked up to 35 knots, and it wasn't safe for him to dive after all.

The McARTHUR passes under the Golden Gate en route to Earth Day festivities.

Ultimately, they decided to head back to San Francisco early, and as it turned out, winds were stronger than ever, so we wouldn't have been able to dive if we'd stayed. We eventually docked back at Pier 32, which is where we'd started out, and the crew started getting the ship ready for the next day's open house.

Thursday was Earth Day, and what an eventful one if was! The Secretary of Commerce came aboard to see the ship, and talk with Sylvia and the other SSE folks about what we hope to accomplish. We had a press conference and the official

opening ceremony for the Sustainable Seas Expeditions. We'll post more about the day's events shortly.

That night, our sub ops supervisor, Ian, who'd been waiting anxiously for the (two weeks overdue) birth of his second son, was doing maintenance on the subs when he got the call he'd been waiting for! How fortuitous that we were in port! Ian went racing across the bay to take his wife, Liz, to the hospital, and a mere three hours later, Morgan Bernard Griffith made his grand entrance. We now think the reason he came so late was that he wanted to be born on Earth Day.

The ship was in port Friday, an opportunity for some maintenance on both the subs and the ship, and a chance for SSE, sanctuary, and ship's personnel to regroup. Then it's back out to sea for more and better opportunities to explore beneath the surface of the Gulf of the Farallones!

(top) **RETURN**

April 24, 1999

Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary

Maria Brown, Executive Director
Farallones Marine Sanctuary Association

Weather: Foggy. Winds from the south 9-10 knots

Dan Howard writes:

Today was our first day back at sea after our earth day media event and SSE kickoff celebration in San Francisco. The expedition is joined by four new pilots for this leg of the cruise.

Jan Roletto, the Gulf of the Farallones National Marine Sanctuary research coordinator, Tom Laidig, a fisheries research biologist with the National Marine Fisheries Service Tiburon Laboratory, and Amber Mace and Karina Racz, the interpretive and graphic design specialists respectively for the Farallones Marine Sanctuary Association.

Final checkout for Dan Howard before his dive in Drake's Bay. Note the camera and lighting equipment aboard the DeepWorker.

Before leaving for the Farallon Islands, we loaded a remotely operated vehicle (ROV) on board and shoved off from pier 32 in San Francisco under brilliant sunny skies at 0930 hrs. Just past Alcatraz Island we were greeted by a thick wall of fog that obscured the gate. The fog, combined with wind and sea conditions outside, convinces us to alter our cruise plans and head towards the protection of Drake's Bay.

The seas were a bit confused, with six foot northwest swell under a wind driven component from the south. The 10 to 15 knot winds from the south resulted in very different conditions from last week's 25 knot northwesterlies inside Drakes Bay. We

were still able to set up dive operations, and I got my first ocean dive at 1500 hrs. The spring conditions the last several days have stirred up the sand bottom so visibility is 5 to 7 feet but the primary objective of this dive is to get familiar with the sub's systems and get some time in the water.

(top)

The first indications of downwelling, or a relaxation event driven by the southerly winds, were apparent as Pleurobrachia, Beroe, and other offshore gelatinous zooplankters drifted by the acrylic dome of the sub. The gooseberries tentacles were extended and probing the productive waters for prey.

This is the time of year when the alternations between upwelling and downwelling conditions make this part of the California coast one of the most productive pieces of ocean in the world. Juvenile sanddabs hunkered down on a hard sand bottom that is 30 to 40 percent covered by benthic diatoms and riddled with clam siphon holes and polychaete tubes. What looked like a rather barren place to me is teeming with animals adapted to making a living beneath the surface of this shifting sand habitat.

The transient nature of the surface sediment is apparent from the current borne ripples sculpted in a mesmerizing pattern on the seafloor. Totally consumed by my new environment and trying to navigate a true course, my dive of close to three hours is abruptly ended by the topside command to use thrusters to get to the surface and prepare to end the dive. I couldn't help but think about the wonders that await out at Cordell Bank where a granite foundation favors those animals that can claim a space on top of the rock to reap the bounty of the currents there. A myriad of filter feeding invertebrates and marine algae carpet the pinnacles and high ridges on the Bank. Maybe someday soon, the DeepWorker submersibles will provide us a means to investigate this incredible place without having to hang bottles of air in 48 degree water. I feel like today I've taken one more step to realizing this dream.

Our team is starting to click. Turn around times between dives are about an hour and at 1850 hrs Maria Brown, a marine educator, is in the water. Maria will be completing the first night dive of our operation. Conditions have stabilized enough that the dive supervisors feel comfortable continuing operations. Winds are still from the south but have diminished and the swell from the northwest has also dropped.

(top)

Here's what Maria had to say about her experiences diving the DeepWorker at night:

Tonight I was able to complete my check-out dive, and the first night dive of our expedition. I had been on the ship for eight days and was excited to finally get in the water, and by the luck of the draw I was going to dive at night! I had been mentioning to friends that I wanted to dive at night to experience the ocean in the dark.

Maria Brown prepares for her night dive.

I wondered if I would be scared. Alone in a tiny submersible smaller than a VW bug floating underneath the water where know one could see me. When I would emerge from the sea it would be dark.

It was 6:50 p.m. when I was lowered from the ship into the water. There was a gentle swell moving me south toward Drakes Beach off in the distance. The current moved me so fast that soon I was a safe distance away from the ship and was given permission to dive. Slowly I thrusted to the seafloor, only 46 feet deep, and stared through the water column. The water was a light sea foam green filled with tiny particles. I touched bottom. The sea floor was decorated with sand ripples and tiny worm holes. I could not stay hard on bottom. The current pushed me south. As I flew over the bottom I spotted pink and blue leather stars. A tiny silver fish about the size of my pinky finger swam by. A juvenile dungeness crab scrambled across the sand to avoid contact with the sub. Then I saw something very small but alive pass the vision dome of the sub. What was it? I saw another one. It was a goose berry jelly! As the sun began to set, I saw more and more of these alien-like creatures. They look like glass balls the size of a penny with two clear streamers. It is amazing that they are living beings. You can see right through their bodies!

I received a radio message from topside to return to the surface to get a visual of the ship. I was approximately 1,000 feet away, and the fog was getting heavier. I arrived at the surface as the last remaining light of day was fading. I could see the ship in the distance and began to make an attempt to reach within 100 feet of the stern. I soon found out that this task was going to be much more difficult than I had anticipated. The current and wind had increased since I first left the surface. As I tried to thrust forward against the current I was pushed 45 degrees east. As I tried to align myself on a straight course, I would overcompensate for the current and wind, and turn 45 degrees in the opposite direction. I was swinging 90 degrees back and forth as I tried to make headway. Each time I stopped to check my bearings, I would be pushed south away from the ship by the current and wind. The chase boat recognized my struggle. The swimmer jumped into the water and fastened a towline, and the chase boat towed me closer to the ship. Approximately 100 feet away from the ship, the diver removed the towline, and I was giving permission to thrust to the bottom and continue my dive.

It was now dark, and I had all my lights on. The sea in front of me was lit up as if it was daylight. As I reached the bottom, I attempted to make radio contact with topside. I heard nothing in return. I repeated "Topside, this is DeepWorker can you hear me." Again, silence on the other end. I took off my headset to examine the connections. Everything appeared fine. I tried to reach Topside 3 or 4 more times. Periodically I could hear static, and I knew they were trying to reach me. Just as I was about to ascend, a garbled message came through directing me to return to the surface. I confirmed the message and thrusted up. The heavy blanket of night had

come. There were no stars in the sky. All I could see was blackness and the lights of the ship and chase boat. I started to drift further away from the ship. The chase boat again connected a towline and pulled me closer to the vessel for recovery. I bounced across the surface of the sea, turning left and right, swaying forwards and backwards. The current was still strong, and the chase boat was making slow headway.

(top)

I was towed for about 45 minutes until I was approximately 50 feet from the stern of the ship. The chase boat let me loose, and I attempted to make it to the ship. Thrusters full throttle forward, I was determined to get back. Wham! A swell hit me pushing me back and turning me off course. I was hit again and again. I had difficulty seeing over the swells as they approached the sub. I tried again. Thrusters full throttle forward and this time fully engaged turning right. The current was so strong from the starboard side that the sub didn't even budge when I tried to turn. Holding onto the sides of the sub with full throttle forward and the right, I was able to keep a straight course. But I was making very little headway. At times I felt I was losing ground. There weren't any landmarks for me to judge the speed I was traveling or if I was getting closer. I was becoming frustrated and worried.

I wasn't worried about making it back to the ship. I trust the McARTHUR crew and the Nuytco dive supervisors. I knew I would be fine, but I was concerned about the people in the chase boat and on topside. It was getting late. It was approaching 10:00 p.m. I knew people were tired, cold, and wet. I was warm and dry in the sub. Topside directed the chase boat to attach a towline again and bring me to the stern. It was another turbulent ride, bouncing on the surface of the water. Twenty minutes later, I was at the stern and being hoisted back on the boat. It's a good thing I'm not prone to seasickness!

Was I scared diving at night? No, I wasn't. I felt comfortable in my surroundings and confident in the people I was working with. I learned a lesson about currents, and I'm excited about taking the plunge once again into the mysterious underwater world of the Gulf of the Farallones National Marine Sanctuary.

Dan Howard sums it up:

As Maria's experience trying to fight the tidal current illustrates, there are a myriad of variables to consider in these submersible operations. But the retrieval went without a hitch, although Maria's intestinal stamina was tested by the extended period spent bobbing and rolling at the surface. Technology still must bow to mother nature. She completed her dive at 2220 hrs and a tired but satisfied group retired for the evening.

We continue to build on our successes and learn from our mistakes. Everyone is excited about the progress we are making, and people are starting to get better at anticipating what needs to be done. I'm sure the dive supervisors are grateful for that. The crew of the McARTHUR continues to excel, though sometimes I'm sure they wonder what in the heck we are doing. Tomorrow will surely be another day.

(top) RETURN

April 25, 1999

Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary

Jan Roletto, Research Coordinator
Gulf of the Farallones National Marine Sanctuary

Karina Racz, Exhibit Designer and Educator
Farallones Marine Sanctuary Association

Weather: Foggy and cool, mild winds, seas 1-2 feet

Dan Howard writes:

It was a magical day. One of those days that you feel lucky to be alive. Long, slow breaths of clean salt air with a lazy slick sea passing under the boat. The decision was made at the planning meeting on the evening of the 24th to evaluate conditions at the conclusion of the nighttime plankton operations and determine whether to return to Drakes Bay to continue check out dives or try the islands one more time.

When the time came at 0530, winds were still 10 to 15 knots from the south but the seas had settled and a longer period 4 to 6 foot swell was rolling down from the northwest. After consulting with Alex von Sonder, the ships officer on watch, and waking an exhausted Ian Griffith to discuss the dive options, we gambled with the weather and won. Go for the islands!

The wind started to slack under a high overcast sky, the seas started to fall and the trend continued. By late morning, we

An aerial perspective shows the South Farallon Islands, surrounded by the Gulf of the Farallones National Marine Sanctuary.

had 3 to 5 knot variable winds and a two to four foot, long lazy swell - perfect conditions for diving. First one in at 0945 was sanctuary research coordinator Jan Roletto. Visibility was 20 to 25 feet and the conversation on through water communications was lively. Schools of blue rockfish, yellowtail, vermillian ("no not Brazilian--over"), quillback, china, and rosy rockfish shared the outside of the dome with greenling, lingcod, gobies, cottids, and wolf eels. Abalone, anemones, sponges were sometimes difficult to see through the swarms of mysid shrimp schooling over the boulder habitat. We'll let Jan tell the story of her experiences....

9:55 a.m. Jan writes:

I awoke this morning to see that we were just a few miles off of SE Farallon Island. Dan made a good call, to do the plankton tows last night, work our way over to the islands and if the weather is good, then continue to the island.

Yes, we got that rare day in April when the seas are calm, the skies are softly overcast, and the wind is down. This is the relaxation period, during this intense upwelling season.

A portion of Southeast Farallon Island as seen from the deck of the McARTHUR.

I hadn't been in the sub for several weeks and so I was glad to do a complete early morning pre-dive check. Ian and Steve made a quick change in the port scrubber fan and re-programmed the sonar computer. Everything worked great... and the fish cooperated too! I have an extensive species list of fish and invertebrates. I did not see any mammals or birds, even though a gray whale was in the area while I was under. The fish were most abundant between 30 and 40 feet. At 70 feet, there was one school of blue and yellow-tail rockfish that were following me. They turned away once I reached 85 ft.

The sub was an excellent platform to watch the behavior of the fish. In one school of fish, one individual was chasing several others away from an opening in the rocks. I don't know if this was mating or territorial behavior, but it was great to be able to see it. The subs will be very useful when we have more time to sit and watch these behaviors, and document the frequency and sequence of behaviors. But for now it's just great to be checked-out and ready to dive deeper and longer. Thanks Sylvia, for making this possible.

(top)

Dan Howard describes more activities of the day:

Tom Laidig, fisheries research biologist with the Tiburon laboratory was next up. We monitored the radio as Tom sat in a mixed school of blues and yellowtail in 90 feet of water. Tom hit 104 feet with no sign of any "young of the year" rockfish. A disconcerting note since early reports had predicted a strong recruitment for rockfish this year--the first strong year class since 1988. Usually juvenile rockfish show up in large numbers in April in successful reproductive years. We hope they're just a little tardy this year. As the data recorder for Tom's dive, I was charged with monitoring the communications for his dive and recording his life support readings.

Now some people thought I was a little jealous as Tom continued to report superlatives throughout his dive. And I was--just a little. Then the magic began. The Gulf of the Farallones came alive topside for my (and everyone else's) viewing pleasure. The wind died, the sea was placid, the overcast thinned and a warm filtered sun warmed the air. I gazed contentedly out at our support boat drifting with outboard shut down when a gray whale came up and spouted about 10 feet off their bow. I think I enjoyed the reaction of the boat crew as much as the whale sighting. At least two gray whales continued spouting and diving around the boat with the magnificent Farallon Islands as a backdrop for their diving flukes.

I stared idly into the glassy water as I monitored the radio and realized the water was alive with krill swarming at the surface. At that instant a school of blue rockfish exploded from below, driving the krill right out of the water as the fish followed breaking the surface in a frenzied boil. Now I understood why hundreds of gulls were working the surface as they would swirl and circle then pounce down on the surface constantly moving from one area to the next. Common murres fly overhead with fish in bills returning to the nest with food for their young. Cormorants fly by with nesting material clenched in theirs. I take another deep breath through my nostrils and savor the warm salt air.

Next up to dive is Amber Mace, the interpretive specialist for the Farallones Marine Sanctuary Association who willed the flu bug into submission when it came time to sail on the 24th. More incredulous reports of visibility and abundant life as she navigated DeepWorker through the boulders and over life covered reefs. I looked over and the dive supervisors from Nuytco, Ian Griffith, Phil Otalora, and Steve Drover have hooked up the ROV and with the help of the McARTHUR deck crew were deploying it with the starboard hydro winch. As Ian operated the ROV with the joysticks and a smile, one of the crew jokingly commented he was probably the kind of kid who drove imaginary boats around the tub at bathtime. Ian doesn't deny it. He gave a short lesson on ROV (remotely operated vehicle) operations and passed the control unit around for people to try their hand.

Karina Racz will make our fourth diver of the day. Four dives in one day! After the frustrations of last week, this weekend has been absolutely magical.

(top)

Here's Karina's report:

It's early afternoon on Sunday and we're on to our second dive at Southeast Farallon Island. The seas are really cooperating and providing us with pretty ideal diving conditions for this time of year. The McARTHUR is rocking in the gentle swell on the lee side of the Island, just off of Shubrick Point.

I remember the last time I was out here. It was this past October during peak shark season. As a matter of fact, on the afternoon of the day we arrived we were out surveying an intertidal site on this side of the Island when we saw our first shark attack on a juvenile elephant seal, not 50 yards from shore.

The water churned bright red as the shark thrashed at the surface, immobilizing its prey. Watching from the relative safety of the rocky shore (though large waves crashed nearby threatening to pull us out into the danger zone), we were stunned at the swiftness of the attack and raced to get our cameras focused on the not-too-distant scene. It only lasted a couple of minutes before the remnants were left to the birds careening overhead. At that time the Islands were pretty brown and sunbeaten, with comparatively few birds except for the droves of gulls that returned from the mainland each night at sunset.

A nineteen foot white shark cruises the waters around SE Farallon searching for its next meal of an unsuspecting juvenile elephant seal.

Now it's quite a different scene out here: Maintop is tinged with green and there are a ton of birds. Breeding season has arrived and with it a flurry of activity. As we watch from the fantail of the ship, long trails of Brandt's Cormorants cruise by, accompanied by common murres which look like footballs with furiously flapping wings. During infrequent moments of quiet you can hear the swoosh of their wings overhead as they make a beeline for their cliffside nests. Pigeon guillemots, gulls, and tufted puffins are among the other birds we are seeing, as well as several gray whales which have been blowing and fluking at the surface.

Even though it's not shark season, we are working on launching and retrieving the sub without putting a swimmer in the water. No one wants to take a chance on what might be down there, least of all by creating an intriguing silhouette at the surface! The deck crew has rigged the taglines that control the sub so that they release quickly and do not require someone to be in the water after the sub is swung out by the A-frame. I think that Matt, the designated NOAA swimmer, must be appreciating this

with all the shark stories he's been hearing. Just another reminder that it is a true wilderness out there.....

(top)

23:30 Karina describes her experience:

"DeepWorker this is topside. Go ahead and flood your soft ballast--you've got permission to dive." This was the transmission I was waiting for.

DeepWorker launches one of four dives on a very successful Sunday.

From inside the cozy cocoon of the sub I could see the mound of Southeast Farallon rising from the water to the west of me. Bottle-green waves splashed up around the dome on all sides of the acrylic. Thoughts of seasickness were the last thing on my mind as I scanned through the green for any sign of something bigger heading my way.

AR-3 (the rigid hull inflatable boat) was now clear of me and already off in the distance, as was the McARTHUR. Nothing left to do but go for it! I juggled my hand-held voice recorder, took a bearing on the Island with the compass, and reported back to topside, "OK Topside, this is DeepWorker preparing to dive. See you on through-water comms... Whhheeeeeee!!!" I squealed with excitement!

"Here we go.....heading straight for bottom," I reported into my tape recorder. I just wasn't sure how far bottom was. As I thrust down with the foot pedals the light began to change and I looked up through the dome to watch the surface ripples become more and more distant. 30 feet.....45 feet.....65 feet.....I kept an eye on the depth indicator as the number continued to grow. I still had only an estimate of how much further to go until the bottom would appear since there is no equivalent of an altimeter in the sub. Then suddenly, at 72 feet, bottom appeared!

I communicated to topside on the through-water comms headset, "Topside this is DeepWorker, reporting a visual on the bottom." Then touchdown! At 85 feet I eased the sub down onto a rocky bottom covered with invertebrates. The minor surge present at this depth gently swung me around as I let up on the foot controls to concentrate on giving topside my life support readings. All around me was a thick carpet of color. After topside was satisfied that my readings were under control, I was given the heading of 270 and strict instructions to "go have fun!"

(top)

No problem! I was like a child swimming through the elusive entrance to another world. My compass heading took me over large rocky outcrops and down into sandy valleys. Brightly colored anemones waved their tentacles in the slight current while orange sea cucumbers went about their business inching along the bottom. Schools of rockfish hung out midwater with me, eyeing the sub with some suspicion before darting off to join with more of their forces. White plumose anemones loomed hauntingly in the distance until I got closer and could distinguish their shapes. Pink, yellow, red, and green organisms covered the rocks. Sea stars of all shapes and sizes clung to the bumpy surfaces--stars of a different universe.

As I guided the DeepWorker up and over the side of a rock wall, I came down into another sandy valley. Stopping here for more life support checks, I observed my surroundings. The valley seemed to climb up toward the west where it was covered with smaller chunks of rocky cobble. To the east it got deeper with the sand stretching out in ripples and wave patterns along the bottom. It looked like a road to me, like a secret passageway that only the fish knew about. And maybe the perfect hangout for a white shark lying in wait of a stealthy attack on a seal at the surface. The thought unnerved me. I glanced up at the fading light from the surface and wondered what I would do if I happened to see a large fishy silhouette cruise by above. In truth, I felt amazingly calm and welcomed by all that I was seeing.

I continued to follow another heading given to me by topside: this time 060. Then came the request, "DeepWorker this is topside. Please hold your position, we have lost you on the tracking system and we need to reboot the computer." Mmm. Just a little too much information from my perspective. "OK topside, I'll get heavy on bottom and wait." Curiously enough I did not feel worried.

One of the main concerns that I had had about diving the DeepWorker was the fact that I would have to go alone, to places where few, if any, have gone. Unlike SCUBA diving, where the principle of a "buddy system" is strongly encouraged, this was to be more like a solo vision quest, testing the strength and endurance of one's own capabilities. Sitting here on the bottom awaiting the report from topside that they had found me again, I did not feel scared, abandoned, or even lonely. I turned my headlights on and swarms of copepods and krill came over to dance in the light, similar to insects drawn to a porch light on a summer evening. Yellowtail rockfish came in closer for a better view, apparently intrigued by this unusual light in their midst. While there was so much life everywhere, how could I feel alone?

After what was probably only a few minutes I was told that I had been found again and that they were preparing for me to head back to the surface. Already? I could hardly believe that I had already been down for an hour and 20 minutes. Grudgingly I left my newfound friends on the bottom and prepared to make my way to the surface. Keeping an eye out through the dome for any sign of a ship's hull, I broke through the waves and switched to VHF radio. Phil instructed me to thrust on over to the stern of the McARTHUR so they could hook me up again. Over the railing of the fantail I could see the smiling faces of the other pilots, NUYTCO crew, and the deck crew, waiting to haul me back into my world. Now safely back on board and at the computer I know I'll sleep well tonight, dreaming of the wonder of what exists just below the hull of this ship as she sails on into the night.

(top) RETURN

April 26, 1999

Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary

We finished nighttime plankton work and anchored in Bodega Bay at 7:30a.m. to begin preparations for the student summit at the University of California's Bodega Marine Laboratory (BML).

The wind shifted, blowing 20 to 25 knots from the northwest by 9:00a.m. A good day to be on shore, as conditions would have made it difficult to launch the sub had we been scheduled to be out diving.

Students listening at the summit.

Today we turn our attention to focus on another of SSE's objectives -- education and outreach. Media from Sonoma County arrive on the McARTHUR to cover the story of SSE and pass the word to communities lying in the northern reaches of the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries. At the BML, an internet chat session that SSE, NASA, and the sanctuary have put together gets underway at 10:30. Another first for the Expedition, the chat session went without a hitch, as questions ranging from sustainable fisheries to life on other planets came across the wire.

The information age is remarkable. Hours after completing our first dives in the DeepWorker we were sharing the excitement and new discoveries with the world.

At 1:00 p m we began the student summit with over 100 high school and college students from five schools filling the lecture hall. The momentum builds as information is shared and the students break into small groups to digest it all and design future projects for SSE.

And then, the highlight of the summit for me, hearing the students get up and share their ideas. I'm impressed with the energy and innovative thinking of these young adults. Their vision, without baggage to dampen their spirit, fluidly blended new technologies with established field techniques.

Students working in break-out group at summit.

One of the presentations having to do with real time data acquisition and transmission to a land based site is eerily similar to a multi-agency proposal in the works for the Gulf of the Farallones. It's refreshing to see teens in such a positive light when so much of what we hear about this age group is negative. I feel good about passing the baton of ocean stewardship to these kids and this day represents a first step in that transition. The word is getting out. I feel good about the day and another success for the mission of the SSE.

Back on the McARTHUR at 6:00 p m, the wind was still steady and stiff from the northwest. We made our plans for tomorrow as we transited from Bodega Bay to the lee of Pt. Reyes. The calm of two days ago is a fading memory. As the ship wallows in heavy seas and stiff winds, we are reminded why ocean exploration is so challenging. Nonetheless, we look forward to seeing what tomorrow may bring.

(top) **RETURN**

Gulf of the Farallones National Marine Sanctuary

April 13 to April 26, 1999

Included on this pages are the education and outreach events that took place during the two-week Sustainable Seas Expeditions dive at Gulf of the Farallones National Marine Sanctuary. Following the events there is a list of resources with specific information about the sanctuary.

Events

Resources

Events

Marine Sanctuaries Fair
Celebrating the Bay Area's Connection to the Marine Environment

Location: Pier Three, Fort Mason, San Francisco
Date: Saturday, May 8, 1999
Time: 11:00 AM - 4:00 PM

The Farallones Marine Sanctuary Association sponsored a marine sanctuaries fair and McArthur open house. Marine organizations from throughout the San Francisco Bay Area involved the public in hands-on, interactive activities focused on the marine environment. The

People of all ages came on board the ship McArthur so they could learn more about the National Marine Sanctuary Program and the Sustainable Seas Expeditions.

Dressing up in costumes to look like marine "critters" was a popular activity at the fair.

goal of the fair was to educate San Francisco Bay Area residents about the National Marine Sanctuary Program and in particular the Gulf of the Farallones National Marine Sanctuary, Cordell Bank National Marine Sanctuary, and Monterey Bay National Marine Sanctuary. We want to involve the public in learning how they can become stewards of our oceans and sanctuaries.

The activities sponsored by the National Marine Sanctuary Program include:

- a tour of the NOAA vessel McArthur
- photo opportunities with the "DeepWorker 2000" submarine
- interviews with "DeepWorker" Aquanauts

(top)

Teacher at Sea

A high school teacher from the San Francisco Bay Area was selected to participate on the NOAA research vessel McArthur during "Deepworker 2000" dives at the Farallon Islands and Cordell Bank. Kathy Soave, a science teacher at The Branson School, was chosen for this position after a competitive application process. Kathy observed the dive operations, participated in sanctuary research, and interacted with the scientists and educators onboard the McArthur.

Kathy Soave, teacher-at-sea, shares a smile with Ed Ueber, sanctuary manager, on board the ship McArthur.

The goal of the project is to promote oceans as a focus for public education, build the basis for a learning community that uses an interdisciplinary approach to explore ocean issues, and to develop the skills and knowledge to encourage active public participation in monitoring, conserving, and sustaining ocean resources.

Post-Mission Interview with Kathy Soave

What are some of your initial thoughts on your experience?

Teacher-at-Sea was an amazing experience. I got to be a part of a lot of interesting scientific research, got to see what goes on with research, and see and be involved in the deployment of submersible.

I think one of the most important things that I took away from this experience is seeing what a great cooperative spirit the Sustainable Seas Expeditions has garnered with all the people involved. It was pretty amazing seeing everyone who has different goals and different views coming together and bringing their expertise to some of the issues at hand. It is exciting to see all of that energy going into investigating the oceans and to be able to involve myself on the ship and involve my students on land in a student summit. At the summit, the students were able to hear more about the large scale of this expedition and, hopefully, where it is going to take us.

The crew works together to prepare Sylvia Earle for her dive.

Tell us about how you plan to use the information that you gathered from the Sustainable Seas Expeditions.

I have two major ways that I hope to use the information that I gathered from the expeditions. I am working on developing a student monitoring program where a group of students would be trained to carry on research and monitoring of the intertidal zone in the Gulf of the Farallones National Marine Sanctuary. The students could do this on foot, or some of the students could do this in kayaks in the sloughs. The data collection would happen on an ongoing basis,

Kathy Soave on the deck of the McArthur at the Gulf of the Farallones National Marine Sanctuary.

probably four times a year. I'm going to work with the people up in the Olympic Coast National Marine Sanctuary so that we can develop protocols for students to collect data in the same way so it can be shared. We hope to have internet access, sharing information back and forth between that site and, hopefully, other national marine sanctuaries. We have students interested in that project already. It will be great to have baseline data that we can build on and use to monitor the health of the estuary.

In addition to that, I teach marine biology at the Branson School, and I plan on developing classroom activities that come from the Sustainable Seas exploits. Some activities would involve using a sub to do research, and others will involve scientific research in general. I hope to share this with teachers everywhere, for them to include in their curriculum so that they help teach science and make it exciting to students. I also hope to bring to the foreground some information on what is being done with ocean exploration, what can be done, and convey that there is a lot out there that still to be learned. It is pretty fascinating and interesting, and I hope students get involved in that.

What would you like to see happen next year and following four years of program?

Definitely I am looking forward to going out once a year for four years as the Teacher-at-Sea with the Sustainable Seas Expeditions to get extra parts of research and be part of the play, hopefully as a pilot. And I hope we can develop a program to bring a student out to the ship to have a similar experience so we can have a Student-at-Sea. I am working with Maria Brown (from the Farallones Marine Sanctuary Association) on that idea for next year. I would like students to see what kind of research is being done. We hear a lot about the negative impacts we are having on the ocean and it is really hard to find out what we are doing in a positive

way. This is one good way to say that this is just the tip of the ice burg that needs to be done. This is basic research, basic information that needs to be gained before we can understand how the ecosystems work. So my goals are to keep going out with them, learn more, and bring it back to the public. I also plan on giving some seminars at my school, not just for students but for parents, and the Branson community as well. I'm pretty excited about doing all of this - involving students in a larger way.

(top)

Kathy would like to become a pilot of the DeepWorker submersible in future years.

Resources

Brochures and Newsletters

Hydrosphere
Hydrosphere is a biannual newsletter about the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries. It includes articles about current research in the Sanctuaries, educational offerings, volunteer programs, natural and cultural history of the Sanctuaries, and field adventures.

Gulf of the Farallones National Marine Sanctuary Brochure
A full color map brochure with information about the Sanctuary. It is an excellent visual to hang in your classroom.

Posters

Marine Mammals of the Gulf of the Farallones
A map of the Gulf of the Farallones National Marine Sanctuary with illustrations of 23 marine mammals that call the Sanctuary home. On the sidebars are description of the marine mammals.

Los Pajaros de Los Esteros.
"Birds of the Estuaries" is a watercolor of the birds that frequent the Estero Americano and Estero de San Antonio.

Harvestable Bounty of the Sea

A poster of past and present fishing boats used in the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries.

Gulf of the Farallones National Marine Sanctuary Mural
A mural of the underwater open ocean habitat around the Farallon Islands.

Books

Marine and Coastal Educational Resources Directory
This directory lists marine and coastal educational organizations and agencies in the San Francisco and Monterey Bay areas.

Log Book of the Farallones by Michael Whitt
A detail journal of the author's cruises in the Gulf of the Farallones from 1971 to 1972 and several later visits to Southeast Farallon Island. A boat, seabirds, marine mammals, rocks, and the sea are the main characters in this story.

Beached Marine Birds and Mammals of the North American West Coast
This guide discusses how to identify most of the species of marine birds, mammals, sea turtles, sharks, and rays that occur in coastal marine waters, and are known to occur dead on beaches from the Bering Straits along the Pacific Coast of North America to Cabo San Lucas, Baja California.

West Coast Whale Watching by Richard C. Kreitman and Mary Jane Schramm
This comprehensive guide offers the ultimate in whale and marine mammal adventure from Alaska to Mexico with all the practical information watcher need.

Beachcomber's Guide to California Marine Life
A guide to exploring common marine fauna and flora from San Francisco to San Diego.

Great White Sharks edited by A. Peter Klimley and David G. Ainley
An academic book on the evolution, anatomy, physiology, behavior, ecology and distribution, and population biology of white sharks. And of course it includes interactions with humans.

Blue Whales by John Calambokidis and Gretchen Steiger
Full of beautiful photos and information on the largest animal to inhabit the Earth-blue whales.

Discovery Card Sets
12 card sets with color photos, amazing facts, illustrations, and challenging animal

quizzes. Available in the following subjects:

- Marine Mammals
- Gray Whales
- Dolphins
- Humpbacks
- Killer Whales

Education Materials

Rocky Intertidal Teachers and Educators Packet
The Farallones Marine Sanctuary Association (FMSA) is developing a series of Sanctuary habitat packets for use in educational settings. Two versions of the packets are available - one for elementary and one for secondary school levels. "Rocky Intertidal" is the first of these habitat packets available and includes;

- a slide show with corresponding fact sheet ideal for reinforcing important concepts
- a glossary of scientific terms
- a list of additional publications
- field trip ideas, preparation guidelines, and classroom activities based on the rocky intertidal fact sheets on the Gulf of the Farallones
- full color map brochure to hang in your classroom
- a discussion list of "Things to do to Save the Ocean"
- ordering information on additional marine education merchandise and information about access to FMSA's teacher resources library

Visitor Centers

Gulf of the Farallones National Marine Sanctuary Visitor Center
Ideal for a field trip, the Gulf of the Farallones National Marine Sanctuary Visitor Center is filled with fascinating facts and fun activities about the sanctuary. At the visitor center interact with animals in the sanctuary at the touch tank, glimpse under the sea at the sanctuary through our aquarium, see a real white shark jaw, touch the fur of sea otters and seals, discover microscopic animals underneath the microscope, and image giant whales filter tiny shrimp-like krill through baleen. All this and more is possible at the Visitor Center.

Pacifica Visitor Center
The Pacifica Visitor Center highlights recreational activities in the sanctuary and is a great place to see an adult, male sea lion skeleton. Play in the sand box and discover what lives at the beach while finding out how to enjoy the sanctuary.

Farallones Marine Sanctuary Association Marine Education Resource Library for Teachers

The Marine Education Resource Library contains a wealth of materials perfect for bringing the ocean into the classroom. Some of the resources available include:

- Curriculum Guides
- Children's' Books
- Reference Books
- Videos

For more information on how to obtain these resources, please contact:

Farallones Marine Sanctuary Association
The Presidio, P.O. Box 29386
San Francisco, CA 94129
tel: 415/561-6625
fax: 415/561-6610
www.farallones.org

(top) **RETURN**

SUSTAINABLE SEAS EXPEDITIONS

EDUCATION

1999 ARCHIVE

SITE INDEX

The Sustainable Seas Expeditions is providing many ways for the sanctuaries to achieve their educational mission. The specific educational goals of the Sustainable Seas Expeditions include:

•promoting the oceans as a focus for public education
•increasing awareness and knowledge about the national marine sactuaries
•developing ocean stewardship skills in constituencies and encouraging active participation in ocean conservation

Click on the sanctuary name below to access the site events, sanctuary summits and resource lists from the 1999 missions of the Sustainable Seas Expeditions.

Channel Islands
Cordell Bank
Gulf of the Farallones
Monterey Bay
Olympic Coast
Stellwagen Bank
Gray's Reef
Florida Keys
Flower Garden Banks

Site Events

Site events describes educational projects at each sanctuary during the Sustainable Seas Expeditions dives. The events are listed by individual sanctuary.

Sanctuary Summits

Sanctuary summits are half-day interactive sessions designed to bring high school students and teachers together with experts to discuss Sustainable Seas Expeditions in the sanctuaries. This section includes an overview of the summit, post-summit summary, biographies of the panel experts, a list of student project ideas and selected projects to be completed, and a list of references on the summit topic. The summits are listed by the sanctuaries where they took place (not all

sanctuaries offer a summit).

Resource Lists

Resource lists offers the best references that students and teachers can use to find out more information about a particular sanctuary. These references include books, brochures and newsletters, Web sites, and posters. The resources are listed by individual sanctuary.

(top) RETURN

Channel Islands National Marine Sanctuary

May 25 to June 5, 1999

Included on this pages are the education and outreach events and summits that took place during the two-week Sustainable Seas Expeditions dive at Channel Islands National Marine Sanctuary. Following the events and summits are a list of resources with specific information about the sanctuary.

Events

The Volunteer Fish Survey Dive

The Volunteer Fish Survey Dive is a fish census conducted by trained volunteer scuba divers and snorkelers at Channel Islands. The dive will be utilizing techniques from the Great American Fish Count (GAFC), which is an annual fish census done around the country. The Volunteer Fish Survey Dive will be a part of the media/education day during the Sustainable Seas Expeditions program. The dives will be carried out simultaneously with DeepWorker submersible monitoring at 600 ft. in the Anacapa reserve.

(There was a live underwater uplink to the Anacapa Island where media and VIP's were assembled for the event. Click here to download the video and see a summary of the web chat that accompanys the video.)

The purpose of this event is to mobilize and educate the recreational diving community and to increase the awareness and level of concern regarding the condition of fisheries and marine environment within the Channel Islands National Marine Sanctuary. The data gathered during the dives will provide valuable and much needed information on fish species' diversity, abundance and distribution. This program provides a link between research and education and to empower the volunteer divers with the knowledge needed to better understand and develop an ocean stewardship.

Similar to the GAFC pictured here in Monterey Bay, the Volunteer Fish Survey Dive will give divers the opportunity to participate in a fish census at the Channel Island National Marine Sanctuary.

(For information on how to get involved in the Great American Fish Count in your area, please contact GAFC@yahoo.com)

Camp Internet Online Learning Expeditions

This is your chance to interact with Sustainable Seas Expeditions researchers! An internet site sponsored by the Regional Alliance Information Network (RAIN) will be used to connect southern California classroom students grades 4 through 12 with Sustainable Seas Expedition researchers. RAIN is a Public Internet Broadcasting Service that features Camp Internet as an online interactive learning program. With support from the US Department of Education, the California Department of Education, the USDA and the Channel Islands National Marine Sanctuary, Camp Internet is developing, testing, delivering, and assessing innovative distance learning programs to regional, national, and international audiences. Over 96 classrooms representing an audience of 10,000 learners will participate in Camp Internet's "Exploring the California Channel Island Region".

The Sustainable Seas Expeditions visit to Channel Islands National Marine Sanctuary will be featured as a major event in the Camp Internet Expedition program. This will provide opportunities for:

- Coordinating live half-hour chat sessions between visiting scientists aboard the R/V McArthur and Camp Internet students.
- Adding Camp Internet classrooms to Channel Islands National Marine Sanctuary Public listserv (coming soon) so students can ask Channel Island National Marine Sanctuary staff and interns questions about the Sustainable

Seas Expeditions project
•Creating of a dynamic video journal of the research in the Sanctuary. The footage gathered would be used to expand the Marine Science units within Camp Internet and to create a Community Heritage record of the Sustainable Seas Expeditions project.

For more information about the learning expeditions and Sustainable Seas Expeditions chats, please contact: Camp@rain.org

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University of California Santa Barbara Student Intern Program

This is an opportunity for the UCSB's Environmental Studies program to establish a bridge between field science research and classroom learning during the Sustainable Seas Expeditions program. Three interns have been selected to work with Channel Islands National Marine Sanctuary staff in developing and implementing the Sustainable Seas Program within the Channel Island Sanctuary. Their responsibilities include:

•helping to develop floral and faunal species lists for the Channel Islands National Marine Sanctuary
•assisting with data collection aboard the R/V McArthur during the expedition
•participating in chat sessions and videoconferences with classroom students involved with Camp Internet.
•responding to questions generated in the Channel Islands National Marine Sanctuary public listserv

The purpose of this initiative is to involve undergraduate students in the research process and its relationship to education and marine policy. In addition, the purpose is to demonstrate how research protocols are developed with regard to addressing resource management within the Channel Islands National Marine Sanctuary.

Virtual Submersible Exhibit in Santa Barbara Maritime Museum

Channel Islands National Marine Sanctuary will create a virtual submersible exhibit that exposes students and the general public to the latest technology in underwater non-intrusive exploratory research. The exhibit will include footage collected from

A virtual submersible exhibit is scheduled to be opened sometime in the year 2000 at the Santa Barbara Maritime Museum.

the DeepWorker during the Sustainable Seas Expeditions providing examples of different habitat types within the Channel Islands National Marine Sanctuary. The dramatic underwater voyage of the Deepworker along the underwater escarpment will be re-lived by museum visitors. Footage will be of broadcast quality and there will be a pre-scripted choreographed flight-motion from submersibles. This virtual submersible exhibit will provide an important link between historical maritime exploration and new technologies in ocean exploration. It is anticipated that over 100,000 visitors per year will visit the Santa Barbara Maritime Museum when it opens.

The goals and objectives of this initiative are to engage student and the general public in submersible technology and increase awareness of marine sanctuary resources, especially underwater habitats with the sanctuary.

For more information on the exhibit go to:
www.sbmm.org or www.cinms.nos.noaa.gov

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Summits

Survey of Living Resources

Date: May 24, 1999
Location: To be Determined
Participants: 30 high schools students from San Luis Obispo, Santa Barbara, and Ventura counties

The students involved in this year's Sanctuary Summit will discuss the living resources in the Channel Islands National Marine Sanctuary. The goal of the summit is for students and teachers to look at the kinds of baseline data collected during the expedition dives and recommend a student research project for future Sustainable Seas Expeditions. The project will focus on a living resource of the sanctuary and possibly include recommendations on developing policies for the Channel Islands National Marine Sanctuary management plan. The benefits

students will gain by participating in the summit are; an increased understanding of the underwater cultural and living resources in the region, and knowledge on how the research process can be used in developing future exploration missions.

The Channel Islands summit will cover issues related to living resources in the sanctuary. Pictured here is a treefish which is one species of rockfish that can be found in the sanctuary.

The Sanctuary Summit will have a panel of experts including:

- Dr. Sylvia Earle, Explorer-in-Residence, National Geographic Society
- Ed Cassano, Channel Islands National Marine Sanctuary Manager
- Channel Islands Sustainable Seas Expeditions Project Researchers
- Representatives from the Regional Alliance for Information Networking (RAIN)

Students at the summit will participate as field reporters and will report findings back to students and the general public through the Camp Internet program and on this site's post-summit summary.

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Panel of Experts

Sylvia Earle
National Geographic Society

Marine biologist Sylvia Earle is Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion - oceans - especially serving as project director of Sustainable Seas Expeditions and writing three books for publication in 1999.

Named one of Time Magazine's "heroes for the planet" in 1998, Earle has pioneered

research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She holds numerous diving records and is the author of more than 100 scientific and popular publications, including a 1995 book "Sea Change."

Earle was born August 30, 1935, in Gibbstown, NJ. She has a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as well as nine honorary doctorate degrees. She lives in Oakland, California.

LCDR Edward Cassano
Channel Islands National Marine Sanctuary Manager

Edward Cassano has led the efforts to broaden the role of the National Marine Sanctuary Program in the Southern California region. He has worked hard to increase protection and education of sensitive resources and to improve research capabilities. LCDR Cassano has been a commissioned officer with the NOAA Corps since 1986 and has conducted marine mammal, fisheries and oceanographic research. He serves on several marine management boards, including the Advisory Council to the Monterey Bay National Marine Sanctuary and the Mineral Management Service High Energy Seismic Survey Team.

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Post Summit Summary

Overview

The Sanctuary Summit was held on Monday, May 24 1999 from 4:00 - 9:00 p.m. at the Santa Barbara County Hearing Chambers. Twenty-nine high school students were selected to participate as team members in the summit. The High Schools participating were: Paso Robles, Cabrillo, San Marcos, Dos

The 1999 Channel Islands National Marine Sanctuary Sanctuary Summit participants.

Pueblos, Santa Barbara, Adolfo Camarillo, Buena, Oxnard Unifies, Rio Mesa, and Ventura.

The goal of the summit was for students and teachers to recommend a student research project for the Sustainable Seas Expeditions that focus on a living resource of the Channel Islands National Marine Sanctuary. The benefits students gained by participating in the summit were an increased understanding of the underwater cultural and living resources in this region and an understanding of how the research process is used in developing management policies to protect natural resources.

Prior to the actual conference, there was a reception for the students and panel members so they could spend more time getting to know each other and relax before the big event. After the reception and introductions, the students presented four proposals on potential student research projects for the future Sustainable Seas Expeditions. The proposals were outlined in Powerpoint and presented to a panel of experts for review and discussion.

Students and teachers getting to know each other at the reception.

The panel of experts consisted of Dr. Sylvia Earle, LCDR Edward Cassano, Chris Miller (Commercial Fisherman), Dr. Guy Cochran (USGS), Timothy Tyndall (RAIN Network) and Dr. Edie Widder (Harbor Branch Oceanographic Institution). The panel members did a remarkable job of communicating the ideas of science to the students, and the students and panel members were able to carry on discussions in a relaxed manner. Everyone in the room seemed to have a really good time sharing stories about the ocean,

Panel of Expert members: Dr. Sylvia Earle and LCDR Ed Cassano.

laughing at awkward moments and carrying on meaningful discussions about science and the scientific process.

Student Projects

In spite of hectic school schedules during this time of the year, the students managed to develop interesting project ideas. They were assisted in developing project ideas prior to the summit by entering a chat session on the RAIN web site that was hosted by the Channel Island National Marine Sanctuary education coordinator, Julie Goodson, and researcher Russ Vetter of NOAA and the Southwest Fisheries Science Center. During the chat session, students were able to ask questions about possible topics for the projects. This proved to be very helpful because students were given resources about specific project ideas, and were warned against ideas that would be difficult to research. The four projects that did surface and were presented are:

1. Distribution, Size Frequency and Abundance of California Sheephead in the Channel Islands National Marine Sanctuary. (Ventura and Santa Barbara group)

Rosa presenting the CA sheephead research proposal for this team.

There are four possible objects to this project: 1). To study the size, sex, and number of CA Sheephead in both take and no-take fishing zones, 2). To study distribution of CA Sheephead in warm vs. cold water, 3). To study reproductive habits of CA Sheephead in warm vs. cold water, and 4) to study the dietary habits during an El Nino or La Nina. Some possible hypothesis ideas were if female Sheephead change sex in areas of fish and no-fish zones or if there is a survival but no reproduction in cold years. Are Sheephead affected by El Nino or La Nina? Also, a hypothesis could be that Sheephead size is affected by their range or if fisheries are taking too many of the fish. Data collection methods could be observations from deep sea submarines, snorkeling, or SCUBA diving.

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2. CONQFISH1 - A Closer Look at Physical Oceanography. (Cabrillo High School team)

This group from Cabrillo High School, has developed an underwater living space for mice called "Conqfish1". They demonstrated a module with chambers for the mice to

Students from Cabrillo High School demonstrate how the CONQFISH 1 underwater habitat works.

move around. The students proposed moving the mice habitat into the Channel environment to study living creatures underwater.

3. The Distribution of Gorgonians in the Channel Islands (Ventura group)

The purpose of this project was to determine the distribution of gogonians in the Channel Islands with the objectives of determining the depths, substrate, and population density at which these corals live. To reach these objectives, the students suggested using the submersible in the study areas observe the substrates and depths of the gorgonians and to determine the population density.

Tim presenting the Gorgonian research proposal.

4. An Underwater World of Magic: A Sustainable Seas Project (Paso Robles team)

This was another suggested project that concentrates on the species of California Sheephead. This research study objective is to determine the population of California Sheephead on the coast of Anacapa Island in relation to the effects of the temperature during a 24-hour period. They want to know if the temperature of the water effects the number of Sheephead found in a study area. The methodology

Aimee and Aubrey from Paso Robles High School have a good time while presenting their CA Sheephead research proposal.

would include taking the Deep Worker submersible along a predetermined transect twice a day over a period of five years. The significance of this project would be to understand the patterns and effects on the daily population of the fish in the Channel Island coastal region in relation to temperature variations within a 24-hour period.

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Comments from Participants

"The program with the Sustainable Seas was a very good experience to be able to see the researchers up close in action. I think that the conference on Monday was very educational and I learned a lot from it. At first it was hard to know what to expect, but it was very relaxing and comfortable soon later." - *10th grade student*

"I was truly impressed with the student team and their ability to discuss science and science methodology with the panel of experts. Their raw enthusiasm came through and was catching! Even the Panel members got into it!" - *Julie Goodson, education coordinator*

Sanctuary Summit Team Field Trip

Three days after the summit, the student participants were given the opportunity to join Julie Goodson and others on a field trip to Anacapa Island. After a two hour boat ride to the island, the students were able to witness and participate in a NASA Quest Live uplink broadcast of the Great American Fish Count (GAFC) at the Channel Islands. They participated by asking questions to Laura Francis, Sustainable Seas Expeditions education coordinator, who was hooked up to a microphone (of sorts) while SCUBA diving so she could talk with

Students involving themselves in the "virtual fish count" during the live underwater broadcast at Anacapa Island.

the students.

Laura Francis and Ed Cassano reacting to the taped underwater broadcast footage of "where is Ed?" during the media day.

Also participating in the GAFC was Ed Cassano piloting the Deep Worker submersible. Although Ed was unable to communicate to the students on deck and Laura underwater, he and the divers did manage to find each other. To view a video of the dive and read the accompanying chat session click here.

After the live uplink and checking out the events from the Media Day, the students ate lunch and then hiked around the island with a Naturalist/Instructor from Island Packers. After the hike and lecture, the students boarded the boat for the two-hour ride back home.

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Resources

Brochures

Diving in the Channel Islands National Marine Sanctuary
This provides a dive map for each of the Channel Islands within the sanctuary boundaries complete with information on anchorage, good diving spots, shipwrecks and sea lion rookeries. Included are tips on how divers can have a positive effect on the marine environment and protect the sanctuary to ensure its continued beauty for future generations.

Things to Do
Gives an overview of different activities visitors can do within the Channel Islands National Marine Sanctuary and contact information or both Ventura and Santa Barbara harbors. As well there is information on pinnipeds, whales, dolphins, and sharks and a map illustrating the pinniped hauling and breeding areas at each of the five islands within the sanctuary boundaries.

Shipwrecks of the Channel Islands
Provides a historical perspective about each shipwreck site within the sanctuary. Included is a map showing each of the shipwreck sites, information on public transportation to the islands, what to do if divers discover a shipwreck and safety tips for boaters.

Newsletters & Newspapers

Alolkoy
This quarterly newsletter offers highlights into current research projects and educational programs within the Channel Islands National Marine Sanctuary. Each issue is themed around an event or topic and authors are selected to contribute their expertise on a particular subject. Included in each issue is a calendar of events, a constituent commentary page and a kid's page created by students in the Los Marineros marine education program.

Annual Reports
An overview of the Channel Islands National Marine Sanctuary programs and activities to provide accountability for fulfilling the guidelines provided by the management plan.

Living Journal
Available on the CINMS website. Sanctuary staff and interns write entries to offer perspective on different sanctuary projects and events as well as local and national events involving Sanctuary resources. (www.cinms.nos.noaa.gov)

Directories

1995 Marine & Coastal Educational Resources Directory for the South Central California Coast
A comprehensive guide to organizations providing information and resources on marine and coastal education.

Books

Window to the Channel
Provides a look at the varied resources that make the Channel Islands National Marine Sanctuary a national treasure. The book is intended to help readers appreciate the importance of conserving this beautiful part of our country.

Posters & Charts

Channel Islands Aerial View poster
Aerial photograph showing the four northern Channel Islands from the perspective of Anacapa Island looking west. Poster includes a description of the Channel Islands National Marine Sanctuary boundaries.

Sharks of the Channel poster
Color poster showing a collection of the kinds of sharks found within the Channel Islands National Marine Sanctuary

Educational Materials

Los Marineros Education Program Curriculum
Multidisciplinary approach to marine education. The science lessons target the fifth grade educational curriculum goals and feature background information on different earth, physical and life science concepts, activities based on accepted scientific principles and enrichment experiences that extend these scientific concepts into other areas of the curriculum.

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Web sites

Audubon Society, South Coast Chapter
www.audubon.org/chapter/ca/socal

Cabrillo High School Aquarium
www.cabrillo-aquarium.org//

California Department of Fish & Game
www.delta.dfg.ca.gov/index.html

Channel Islands National Park
www.nps.gov/chis

Island Packers
www.islandpackers.com

Los Marineros
www.rain.org/~losmar/mariner.htm

Passage Productions
www.passagepro.com

Santa Barbara Museum of Natural History
www.sbnature.org

Santa Barbara Maritime Museum
www.sbmm.org

University of California, Santa Barbara Biodiversity Forum
real.geog.ucsb.edu/bioforum

For more information on events, summets, and resources, please contact:

Julie Goodson, Education Coordinator
113 Harbor Way
Santa Barbara, CA 93109-2315
(805) 884-1462
Julie.Goodson@noaa.gov

(top) **RETURN**

Cordell Bank National Marine Sanctuary

April 27 to May 8, 1999

Included on this pages are the education and outreach events and summits that took place during the two-week Sustainable Seas Expeditions dive at Cordell Bank National Marine Sanctuary. Following the events and summits are a list of resources with specific information about the sanctuary.

Events

Sanctuary Summit
"Exploration in Cordell Bank"

Date: April 26, 1999
Location: Bodega Marine Laboratory
Participants: Science classes from the Sonoma County area
Theme: Exploration in Cordell Bank

High school science classes from the Sonoma County area will participate in a Sustainable Seas Expedition Sanctuary Summit on April 26, 1999 at the Bodega Marine Laboratory. Please go to the Sanctuary Summit pages for more information.

Summits

General Information

Date: April 26, 1999
Location: Bodega Marine Laboratory
Participants: Science classes from the Sonoma County area
Theme: Exploration in Cordell Bank

High school science classes from the Sonoma County area will participate in a Sustainable Seas Expedition Sanctuary Summit on April 26, 1999 at the Bodega Marine Laboratory.

Panel experts:

- Dr. Sylvia Earle, Explorer-in-Residence, National Geographic Society
- Ed Ueber, Gulf of the Farallones & Cordell Bank Sanctuary Manager
- Dan Howard, Cordell Bank National Marine Sanctuary Assistant Manager
- Kathy Soave, 1999 Bay Area Teacher-at-Sea
- Tom Laidig, Sustainable Seas Expeditions researcher and aquanaut.

Following an introduction by Dr. Earle, there will be a slide show about Cordell Bank National Marine Sanctuary and statements from panel members regarding their roles in the project. Then Dr. Earle will divide students into smaller focus groups. Using the information and details covered during the presentations, as well as the supplemental material they will receive on arrival, the student focus groups will be charged with designing and developing an original research proposal. A student proposal may be selected and incorporated into the following years of Sustainable Seas Expeditions in Cordell Bank National Marine Sanctuary. A high-school class may be part of the research team for the year 2000!

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About the Panel of Experts

Sylvia Earle
National Geographic Society

Marine biologist Sylvia Earle is Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion -oceans - especially serving as project director of Sustainable Seas Expeditions and writing three books for publication in 1999.

Named one of Time Magazine's "heroes for the planet" in 1998, Earle has pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She holds numerous diving records and is the author of more than 100 scientific and popular publications, including a 1995 book "Sea Change."

Earle was born August 30, 1935, in Gibbstown, NJ. She has a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as well as nine honorary doctorate degrees. She lives in Oakland, California.

Ed Ueber
Gulf of the Farallones National Marine Sanctuary

Ed Ueber is the manager of Cordell Bank and Gulf of the Farallones National Marine Sanctuaries, and co-manager of the northern portion of the Monterey Bay National Marine Sanctuary. Mr. Ueber oversees all administrative, research, education, and enforcement programs that occur within the sanctuary boundaries. He is also the Department of Commerce trustee for the Apex Houston and Cape Mohican oil spill settlements. Prior to becoming sanctuary manager, Mr. Ueber conducted fisheries research. He has published peer-reviewed papers on fish biology, fishing techniques, global warming, fishery economics, fish trade, fishery management, wooden boat building, wooden ship construction, oceanography and marine operations.

Dan Howard
Cordell Bank National Marine Sanctuary

Dan Howard is the assistant manager of Cordell Bank National Marine Sanctuary. He is currently involved in education, research and management activities associated with Cordell Bank and Gulf of the Farallones National Marine Sanctuaries. Since 1980, he has been studying nearshore ecology of cold temperate, warm temperate, and tropical marine environments. He has completed over 2000 dives investigating nearshore reef communities in California and Hawaii and participated in a series of oceanographic research cruises over California's continental shelf. Much of this work investigated relationships between fish

predators and their prey. He has published on a variety of subjects relating to his research. Topics range from natural mortality rates for first year juvenile rockfish to the effects of Hurricane Iniki on deep water corals in Hawaii. During the Sustainable Seas Expeditions, Mr. Howard will be using DeepWorker to investigate deep water habitats at Cordell Bank. Visual and video transects will be used to characterize habitats and assess algae, invertebrate and fish populations around the Bank.

Kathy Soave
Teacher at Sea

Kathy Soave was chosen to be Cordell Bank and Gulf of the Farallones "Teacher at Sea." Kathy will observe the dive operations, participate in sanctuary research, and interact with the scientists and educators onboard the NOAA ship McArthur. Kathy is a science teacher at the Branson School located in Ross, California. She currently teaches Marine Biology, Honors Chemistry and Environmental Science. In addition to designing and building the Marine Biology curriculum at Branson, she uses local field sites for her students to investigate varying ocean habitats, has created an immensely popular marine biology "mini-seminar " for Parents' Day, and organized an all-school, all-day assembly around the topic of the marine environment. At her school, she has won two prestigious awards as an outstanding faculty member/teacher and has been Junior Class Dean for three years.

Her leadership roles in education have included being a Master and Mentor Teacher as well as being involved with the Expanding Your Horizons workshops to foster middle/high school girls interest in math and science. Kathy is also an avid diver and has considerable skills in marine photography.

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References

Ecology of an Underwater Island by Robert W. Schmieder
The book is a summary of what is known about the ecology of Cordell Bank. It is

based on a series of exploratory expeditions led by the author and colleagues. The book summarizes the physical factors that appear important to the biotic community living on Cordell Bank, and how the community interacts with itself and its surroundings.

Cordell Bank Fact Sheet.
This is an educational fact sheet on the unique features of Cordell Bank.

Post-Summit Summary

Overview

Maria Brown welcomes the nearly 100 high school students from The Branson School, Cloverdale, El Molino, and Tomales High Schools to the Sanctuary Summit.

The first Student Summit of the Sustainable Seas Expeditions took place in the auditorium of the Bodega Marine Laboratory, directly inland from Cordell Bank National Marine Sanctuary. Nearly 100 high school students from Sonoma County traveled to the site to participate in the discussions of the day. Attendees included students from The Branson School, Cloverdale, El Molino, and Tomales High Schools, and their teachers.

The audience was welcomed by Maria Brown, Executive Director of the Farallones Marine Sanctuary Association and organizer of the event. Dr. Sylvia Earle, National Geographic's Explorer-in-Residence and the Chief Scientist for the Sustainable Seas Expeditions, then spoke to the students and showed them a brief video to better familiarize them with the

mission of this unique project. Dan Howard, Assistant Manager for Cordell Bank National Marine Sanctuary, presented a slide show on the resources of the Sanctuary, as well as the challenges of accessing it, and how the DeepWorker technology offers many opprotunities for further research and exploration. Presentations from Ed Ueber (Sanctuary Manager), Kathy Soave (Teacher at Sea), and Tom Laidig (National Marine Fisheries Service biologist and pilot of the DeepWorker) concluded the students' orientation to the project at hand.

After hearing from the panel members, the students were given their assignment to

design a research project and were divided into smaller groups. These groups were guided by submersible pilots for the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries' Expeditions. For the next hour the students unleashed their ideas and explored the range of future possibilities for the DeepWorker.

(top)

Dr. Sylvia Earle familiarized the students at the summit with the mission of the Sustainable Seas Expeditions.

Students work in small groups to formalize ideas for ocean exploration at Cordell Bank.

Project Ideas

The students came up with the following concepts for exploration at Cordell Bank:

1.) "Current Effects on Sessile Marine Organisms"--researching the relationship between the currents and seasonal upwelling on the location, population size, and density of the strawberry anemone in the Cordell Bank area. (The Branson School)

2.) "Diurnal and Vertical Biogeography of Cordell Bank"--analyzing vertical migratory and behavior patterns in relationship to topography and productivity. (The Branson School)

3.) "Establishing a Health Rating for the Bank"--surveying diversity and abundance of species over a four year period in order to establish comparable results over the next seven years. (El Molino High School)

4.) "Fossils Are Our Friends"--investigating the number and type of fossils left in the sediment of Cordell Bank in order to determine its origin. (Tomales High School)

5.) "Don't Destroy It Before You Explore It: Human Effects on the Ocean"--taking the sub down to all possible areas to show what is there and what has been

negatively affected by us. Educate the public through multimedia presentations and the web. (Cloverdale High School)

6.) "Exploration and Research Day and Night on Cordell Bank"--observing changes in the daily location and abundance of krill, and how this affects the food chain. (Cloverdale High School)

Students present their concepts for future expeditions to the assembly.

An elected student from each of the six groups presented the concept of their project to the assembly and how it would further the missions of the SSE. Closing remarks from Maria Brown complemented the students on their ingenuity, as did Sylvia Earle who saw great hope for changes to be made in the future by these talented young people.

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Quotes

Students

"You've got to study the whole system in order to really understand what's going on out there. Everything is part of something bigger and affects everything else. That's why we propose doing a biogeography study--putting together all the pieces for a complete picture." --*Lauren Morlock*

"We think education is really where it's at. People have to know what's out there in order to want to protect it and with all the possibilities in the field of multimedia, we can reach people as far inland as Kansas and bring the ocean to them." --*Jason and Kyle Siebenthall*

"The only thing missing from this day is that you should let the students pilot the DeepWorkers for a taste of what it's really like." --*unanimous*

Teachers

"I was impressed with the interesting and thoughtful research projects my students developed."--*Steve Salkovics, Cloverdale High School*

"This has been a great experience! I'm looking forward to participating in SSE in the coming years of the Expeditions. This is so important, bringing to the public why we need to protect the oceans. We need the oceans in order to survive, they don't need us. We need to figure out what it's going to take to make things sustainable."--*Kathy Soave, The Branson School*

Organizer

"I think the day went really well. The students have great ideas and it was inspiring to see them so fired up about sanctuary research." --*Maria Brown*

Panel Members

This Student Summit was a chance for us to reenergize ourselves with new ideas from younger people." --*Ed Ueber*

" It was heartening to see a gathering of teenagers with such great ideas and genuine concern for the health of our marine environment, as opposed to the negative image of teens usually portrayed in the media."--*Dan Howard*

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Student Projects

Project #1: A day & night at Cordell Bank National Marine Sanctuary

Project Duration: October 1, 2000 to October 14, 2000
School: Cloverdale High School
Student Names: Jake B., Sophia D., Megan A., Kari M., Arthur C., Doug S., Josh S.
Teacher: Preston Addison
E-mail: addisonp@cusd.org

Project Abstract:
The team would observe marine life at Cordell Banks during times of peak daylight and total darkness in the mid water zone at specific depths and times. The species of concentration would be krill because they are most abundant and are more likely to travel from the depths off the edge of the back to the mid water zone. The deep worker would be used to document the expedition on film and this footage would later be made into an educational video available for distribution around the country to schools and other educational institutions.

Project Description:
Observe marine life during the day and during the night. Samples would be taken at 150, 170, and 180 feet. Sample and counting times would be at 12:00 noon and 12:00 midnight. The specific species of focus would be Krill from the continental shelf to the mid water column. Focusing specifically on the Abundance of Krill in a given depth during both day and night. Equipment: plankton nets, submersible "deep worker" with video cameras, night vision system, limited light equipment, light meter, collection bags. The team would watch krill in density during the day and night hours. October would be a good month because of optimum sea conditions.

Project Requirements and Restraints:
Being able to dive at night. Being able to do one day dive and one day dive every day for two weeks and find a pilot willing to do that. Being able to film in low light. Being able to get into the water on a daily basis.

Correlation with SSE Goals:
The project supports the monitoring and education goals because the information learned would be documented and distributed to the public after monitoring was completed.

Comments or Additional Material:
The pilot of the deep worker could start very deep and film the traveling marine life as they ascend to the mid water column.

Project #2: Don't Destroy It Before You Explore It": Human Effects on the Ocean

School: Cloverdale High School
Student Names: Shawna C., Heather C., Whitney C., Alan F., Ian J., Natasha L., Jason S., Kyle S.
Teachers: Preston Addison and Steve Salkovics
Email: addiosnp@cusd.org and salkovis@cusd.org

Abstract
Our project is titled "Don't Destroy It Before You Explore It.": Human Effect on the Ocean. We would use the Deep Worker submersibles to go down to all possible areas in the Cordell Bank to show what is there, what is affected, and what can be affected by humans. We would then process our information, and show it to our target audience: teens. Teens are the future, and the choices they make now will affect the oceans later. We would show them our information through multimedia presentations and virtual reality, which could be put on the Internet. People need to see the variety of species in the ocean, and those that have not been discovered yet. But we shouldn't destroy it before we explore it.

Project Description:
The goals of our project are to show the public what is there at Cordell Bank, what has been damaged by humans, and to tell them how to save that which is left. We would study all the habitats at Cordell Bank, and at different depths, as far down as is allowed by the Deep Worker submersibles. The equipment that we would need would be:
1. 2 Deep Worker 2000 submersibles
2. The McArthur ship
3. Camera equipment to be mounted on the Deep Workers
4. Computers with enough power to put together virtual maps

We would also need pilots to operate the submersible, people to work the computers to assemble the maps and multimedia presentations, and one or two people for publicity. One of the proposed research methods is to arrange a grid over Cordell Bank, put the two submersibles on opposite sides of the Bank, and work inward, covering as much area as possible, documenting the effects of humans on Cordell Bank.

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The project would be divided into four phases:
Phase I

During phase I of the project, we would conduct our research. We would load up the McArthur at Bodega Bay, and go out to Cordell Bank. We would use our grid to position the two Deep Workers on opposite sides of the Bank. We would try to do 4 dives a day, two hours in length. We would document everything we found down there, the diversity of life, and the damage done by humans.

Phase II
During phase II of the project, we would process all the data gathered in phase I. We would then produce a video using film taken while down at the Bank. Along with the video, we would produce a multimedia presentation to be put up on the Internet and shown at conferences and assemblies, and we would produce virtual reality maps of the Bank. To further get our message out, we would distribute the video to TV stations, and to teachers along with a lesson plan about Cordell Bank and how humans are affecting the ocean through pollution, and how to save that which is still there. Because of the demands put on a computer to display virtual reality, we would outfit a van with the latest equipment available, and we would drive it around the country to schools.

Phase III
As was mentioned by the pilots and others at the summit, why would the person in Kansas care about the ocean? "Out of sight, out of mind." We would hold a nation-wide lottery for adults and students. Those who won would get to go out for a day on the McArthur. We would go down to Cordell Bank in the Deep Workers, and use live video links to let those on the sip see what was going on under the ship. This would bring them closer to the whole project, and hopefully impact how they feel about ocean pollution.

Phase IV
During phase IV, we would follow up on all of our research. We would try to see if anything had changed. We would set up monitoring systems to continually see what is going on at the Bank.

During this project, we would use all the technology available. But, because technology is ever expanding, in the future more advanced technology would become available, which would allow us to go back to the bank, and go deeper to see if humans can impact life further down in the ocean.

Project Requirements and Restraints:
For our project to be implemented, we would need pilots, publicity directors, people to operate the computers, and project directors. Some of the restraints would be time, and the seasons (condition of the sea).

We would use the 2 submersibles to dive about 4 times a day, at about 2 hours per dive. We don't know exactly how long the project would take, but the majority of the time would be spent analyzing the data collected.

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Correlation with SSE Goals:
(I) Ocean Observatory and Monitoring Sites:
For follow up to our project, we would want to set up monitoring stations at the Bank to see if the condition of the Bank improves.
(II) Exploration:
We would be exploring the Bank during phase I of the project. We would use the submersibles to not only study the pollution at the Bank, but the amount of life down there. After the project is over, when new technology arises, we might be given the chance to do more at the Bank, like go deeper.
(III) Research on a Resource Management Issue:
We would be seeing the connection between ocean health and human activities.
(IV) Education and Outreach:
We would be raising awareness about the Bank, and the impact humans have on the ocean. After we produced our video, we would send it out to teachers along with lesson plan to teach students about Cordell Bank and the impact humans have on the ocean. We would be able to show the public that the ocean is a precious as the National Parks on land.

Comments or Additional Material:
This is quite an extensive project, which could be narrowed if needed. With this project, we hope we can raise awareness about the pollution in the ocean, and to teach people how to save what is left for future generations to enjoy. So remember, "Don't Destroy it Before You Explore It!"

Resources

Brochures and Newsletters

Cordell Bank Fact Sheet.
This is an educational fact sheet on the unique features of Cordell Bank.

Hydrosphere
Hydrosphere is a biannual newsletter about the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries. It includes articles about current research in the Sanctuaries, educational offerings, volunteer programs, natural and cultural history

of the sanctuaries, and field adventures.

Posters

Harvestable Bounty of the Sea
A poster of past and present fishing boats used in the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries.

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Books

Marine and Coastal Educational Resources Directory
This directory lists marine and coastal educational organizations and agencies in the San Francisco and Monterey Bay areas.

Ecology of an Underwater Island by Robert W. Schmieder
The book is a summary of what is known about the ecology of Cordell Bank. It is based on a series of exploratory expeditions led by the author and colleagues. The book summarizes the physical factors that appear important to the biotic community living on Cordell Bank, and how the community interacts with itself and its surroundings.

Ocean Birds of the Nearshore Pacific by Rich Stallcup
A guide for the field-going naturalist that covers more than birds. The guide includes whales, dolphins, and porpoises, sea otter, seals and sea lions, sea turtles, and other marine creatures.

West Coast Whale Watching by Richard C. Kreitman and Mary Jane Schramm This comprehensive guide offers the ultimate in whale and marine mammal adventure from Alaska to Mexico with all the practical information watchers need.

Blue Whales by John Calambokidis and Gretchen Steiger
Full of beautiful photos and information on the largest animal to inhabit the Earth-blue whales.

Discovery Card Sets
Twelve card sets with color photos, amazing facts, illustrations, and challenging animal quizzes. Available in the following subjects:

- Marine Mammals
- Gray Whales

- Dolphins
- Humpbacks
- Killer Whales

Visitor Centers

Gulf of the Farallones National Marine Sanctuary Visitor Center
Information and exhibits on Cordell Bank National Marine Sanctuary can be found at the The Gulf of the Farallones National Marine Sanctuary Visitor Center. Ideal for a field trip, the Visitor Center is filled with fascinating facts and fun activities about the sanctuaries. At the visitor center, you can interact with animals in the sanctuaries at the touch tank, glimpse under the sea at the sanctuaries through the aquarium, see a real white shark jaw, touch the fur of sea otters and seals, discover microscopic animals underneath the microscope, and imagine giant whales filter tiny shrimp-like krill through baleen. All this and more is possible at the Visitor Center.

Farallones Marine Sanctuary Association Marine Education Resource Library for Teachers
The Marine Education Resource Library contains a wealth of materials perfect for bringing the ocean into the classroom. Some of the resources available include:

- Curriculum Guides
- Children's Books
- Reference Books
- Videos

For more information on how to obtain these resources, please contact:

Farallones Marine Sanctuary Association
The Presidio, P.O. Box 29386
San Francisco, CA 94129
tel: 415/561-6625
fax: 415/561-6610
www.farallones.org

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Monterey Bay National Marine Sanctuary

May 9 to May 22, 1999

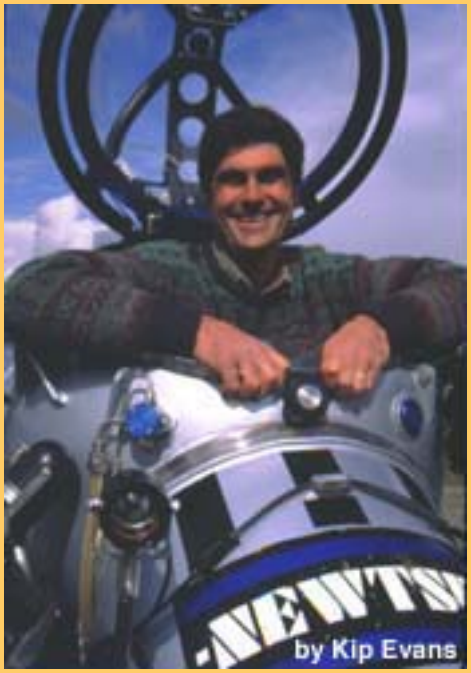
Included on this pages are the education and outreach events and summits that took place during the two-week Sustainable Seas Expeditions dive at Monterey Bay National Marine Sanctuary. Following the events and summits are a list of resources with specific information about the sanctuary.

Events

Teacher in the Sea

Have you ever wanted to send your teacher 2000 feet below the ocean surface? We are doing just that! One grade 9 -12 teacher from the Monterey Bay region was trained to pilot the DeepWorker submersible this year. Mike Guardino, a teacher at Carmel High School, was selected for this position after a competitive application process. He will make up to three DeepWorker dives in the Carmel canyon during a period of one to two days.

One of Mike's main roles is to conduct student research projects related to no-take marine reserves. Dr. Steve Webster from the Monterey Bay Aquarium will assist Mike in conducting these student research projects. Mike is also giving many public presentations on the Sustainable Seas Expeditions to schools and to the regional community. In addition, he is developing Sustainable Seas Expeditions classroom



activities for grade 9 - 12 teachers.

The teacher in the sea will help develop programs to inspire interest and learning in science, natural history, conservation, technology, communications, and related careers. The goal of the project is to promote oceans as a focus for public education, build the basis for a learning community that uses an interdisciplinary approach to explore ocean issues, and to develop the skills and knowledge to encourage active public participation in monitoring, conserving, and sustaining ocean resources.

At 6'2 and 195 pounds, Mike Guardino had to lose 25 pounds to fit in the Deepworker submersible!

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Students in the Sea

The Carmel High School SCUBA/Marine Research team, composed of 18 students from four Monterey Bay Area High Schools (Carmel, Pacific Grove, Aptos, and MAOS), is collecting data inside and adjacent to Point Lobos Reserve a few kilometers south of Carmel, California. Point Lobos is one of three designated "No-Take" Zones located within The Monterey Bay National Marine Sanctuary.

The students are completing site characterizations at Whaler's Cove in the Point Lobos State Reserve and at South Monastery Beach just outside of this protected area in order to analyze invertebrate assemblages. The data collected will be used to determine whether marine "No-Take" zones are a viable strategy for fisheries management.

Students have learned the scientific

and common names of, and how to recognize, 97 species of marine invertebrates and 63 fishes indigenous to the Carmel Bay area. To date, 190 student dives have been conducted on twenty separate days and they have compiled a large and ever growing data base that enumerates the abundance, diversity, & maturity of invertebrates and game fish.

Mike Guardino's SCUBA/Marine Research team will earn five credits for their efforts in underwater research.

Still and video images are being taken to document their experimental technique. A pair of parallel lasers mounted on a video housing are being used to photograph and later determine the length of fishes in the transects. The SCUBA/Marine Research team will statistically analyze the data in order to determine whether there is a significant difference in the assemblages of resident fish species inside and adjacent to Point Lobos Reserve.

Shallow water research (*21 meters) conducted by students in SCUBA will be combined with data collected by the Deepworker submarine in deeper water regions (*21 meters) inside and outside of the Reserve. The Deepworker research will be conducted by Dr. Steven Webster and Mike Guardino on their Sustainable Seas Expeditions Education Dives on May 18 and 19.

The data gathered by students in shallow water will be combined with data gathered in the Deepworker submersible.

A preliminary presentation of the data occurred at the Sanctuary Summit in Monterey on May 17, 1999.

McArthur & DeepWorker Open House

The public was invited to tour the McArthur, view the DeepWorker submersible and other displays (posters on Sustainable Seas Expeditions research projects, National Marine Sanctuaries and Sustainable Seas Expeditions exhibits, etc.), and meet with

national marine sanctuary and Sustainable Seas Expeditions staff, scientists, students and teachers to learn about Sustainable Seas Expeditions goals and activities.

This event was held on Wednesday, May 12th.

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There were opportunities for people to board the ship McArthur while it was in port.

Summits

General Information

Date: May 17, 1999
Location: Maritime Museum in Monterey
Participants: 10-12 high schools from the Central Coast region
Theme: No-Take Marine Reserves

A student summit will be held on May 17, 1999 from 9:30 - noon at the Maritime Museum in Monterey to discuss student projects and conservation issues related to the health and protection of our oceans. The summit will specifically focus on the topic of no-take marine reserves. The summit will include a panel with:

- Dr. Sylvia Earle, Explorer-in-Residence, National Geographic Society
- Steve Webster, Monterey Bay Aquarium
- Dr. Greg Calliet, Moss Landing Marine Laboratories
- Dr. Andrew Devogelaere, Monterey Bay National Marine Sanctuary
- Mike Guardino, Teacher in the Sea, and some of his students.

Dr. Sylvia Earle will introduce Sustainable Seas Expeditions and general conservation issues related to the health and protection of our oceans. Steve will introduce and share general information about no-take marine reserves. Mary Yoklavich will discuss her Big Creek Reserve research project, and Mike and the students will discuss the Pt. Lobos Reserve student research project. Following the panel, student teams (4-5 students each) will share their Sustainable Seas Expeditions projects with one another.

One grade 9-12 student team science project has been chosen to be deployed by the DeepWorker in the Monterey Bay National Marine Sanctuary and conducted by the teacher pilot and Dr. Steve Webster. The project will look at the effectiveness of a no-take marine reserve, focusing on the Pt. Lobos Reserve and deep-water

Research on deep-water rockfish, like this China Rockfish, will be conducted from the Deepworker by teacher pilot Mike Guardino.

rockfish and spot prawns.

Other 9-12 student team projects (not necessarily science-oriented) will also be encouraged around the topic of no-take marine reserves. The preparation, progress and results of the student projects (information, reports, images and data) will be posted on this site in the future, or will be on a student maintained webpage that showcases student projects and ideas, and provide the main vehicle for communication among the students involved in Sustainable Seas Expeditions nationwide.

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Panel of Experts

Sylvia Earle
National Geographic Society

Marine biologist Sylvia Earle is Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion - oceans - especially serving as project director of Sustainable Seas Expeditions and writing three books for publication in 1999.

Named one of Time Magazine's "heroes for the planet" in 1998, Earle has pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She holds numerous diving records and is the author of more than 100 scientific and popular publications, including a 1995 book "Sea Change."

Earle was born August 30, 1935, in Gibbstown, NJ. She has a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as

well as nine honorary doctorate degrees. She lives in Oakland, California.

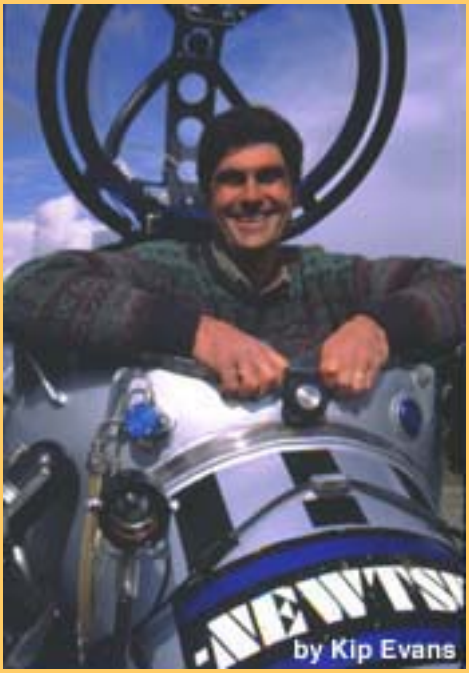
Dr. Steve Webster
Senior Marine Biologist, Monterey Bay Aquarium
Chairman, Monterey Bay National Marine Sanctuary Advisory Council

Dr. Greg Calliet
Professor and icthyologist with Moss Landing Marine Laboratories

Dr. Andrew Devogelaere
Research Coordinator for the Monterey Bay National Marine Sanctuary

Mike Guardino
Teacher in the Sea

Mike earned a biology degree and California Teaching Credential from California State University, Chico in 1982. This is his seventeenth year working as a high school biology, marine biology, chemistry, and physics teacher. His current teaching assignment includes Advanced Placement Chemistry, Honors Chemistry, and Honors Physics at Carmel High School. He also volunteer his time to teach a course in SCUBA Certification and Marine Research for his students through the Carmel Adult School.



Mike takes pride in his work and devote a great deal of time trying to be a good teacher. His students learn in a friendly environment that includes high expectations, current technology, and active participation. He wrote and developed the marine biology program for the Salinas Union High School District and taught a summer course in marine biology at Santa Catalina School for five years. His AP Chemistry students excel in standardized tests with virtually all of them passing the Golden State, SAT II, and Advanced Placement Chemistry Examinations. Most of his students earn college credit based upon their performance in Advanced Placement Chemistry.

Mike has also worked for the Education Department at The Monterey Bay Aquarium since 1988. His duties at the aquarium include helping teach the (summer) Marine Science Teacher Institute and writing curriculum materials. He has been a a volunteer scuba diver at the Monterey Bay Aquarium since 1993 where he completes weekly feeding shows and maintenance duties. Mike has taken a variety of Marine Biology courses at UC Santa Cruz and Hopkins Marine Station in order to increase his knowledge of the sea.

As the Sustainable Seas Expeditions' Teacher in the Sea, Mike has made over fifty public appearances, written six high school science classroom activities for distribution through the SSE web site and education package, and turned eighteen high school kids into "Students in the Sea".

Mike lives in Carmel, California with his wife and three children. He is 42 years old, 6'2" tall, 195 pounds, and enjoy perfect health. His hobbies include scuba diving and underwater photography. He is an Open Water SCUBA Instructor and has completed almost 1,600 dives in the Monterey Bay area. He also reads a lot, spends time with his family, and enjoys nature.

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Suggested Student Projects

Project 1-3: Design a no-take marine reserve (High time intensity)

Using suggested references and contacts, develop recommendations for the design of a no-take marine reserve in California. Identify its purpose, criteria for selection, and management goals. This project would be shared among three student teams, with each team focusing their design on one of the following three components:

1. Biologic considerations, i.e. fisheries issues

2. Oceanographic and/or geologic considerations, i.e. ocean currents and bottom types (sandy, rocky)

3. Social, economic, political and enforcement issues

Each student team will develop recommendations based on their selected component, present and discuss their recommendations to the other two student teams at the Summit, and together develop a list of recommendations using the three components.

Project 4: Conduct a case study of a local marine reserve: Ed Ricketts Underwater Park on the Monterey Peninsula (Medium-High time intensity)

Report on the history and status of the park, and conduct an analysis of the process to establish the park, focusing on the pros and cons of the designation process:

- :Who initiated the movement to designate the park?
- :Where is the park located? Why was this location selected?
- :Who has jurisdiction?
- :Who supports the park? Why?
- :Who opposes the park? Why?
- :What were the initial management goals of the park?
- :What were the initial proposed regulations?
- :What were other proposed regulations?
- :What is the status? What has the City of Pacific Grove decided? What has the City of Monterey decided?

CONCLUDE WITH: What are the valuable lessons we can learn from this process? What specific recommendations for designing a marine reserve can be made as a result of reviewing the process to establish the Ed Ricketts Underwater Park?

Project 5: Conduct a case study of a national marine reserve: Tortugas 2000 (Medium time intensity)

Report on the history and status of Tortugas 2000, and conduct an analysis of the

process to establish Tortugas 2000, focusing on the pros and cons of the designation process:

- •:Who initiated the movement to designate Tortugas 2000?
- •:Where is Tortugas 2000 located? Why was this location selected?
- •:What is the history of marine reserves in the Florida Keys National Marine Sanctuary?
- •:Who has jurisdiction over the Tortugas 2000?
- •:Who supports the designation? Why?
- •:Who opposes the designation? Why?
- •:What are the management goals of Tortugas 2000?
- •:What are the proposed regulations?
- •:What is the status?

CONCLUDE WITH: What are the valuable lessons we can learn from this process? What specific recommendations for designing a marine reserve can be made as a result of reviewing the process to establish Tortugas 2000?

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Project 6: Conduct a case study of an international marine reserve: New Zealand and/or the Philippines (Medium time intensity)

Report on the history and status of marine reserves within New Zealand or the Philippines, and conduct an analysis of the process to establish these reserves, focusing on the pros and cons of the designation and management process:

- •:Who initiated the movement to designate the marine reserves?
- •:Where are the marine reserves located? Why were these locations selected?
- •:Who has jurisdiction?
- •:Who supported the designation of marine reserves? Why?
- •:Who opposed the designation? Why?|
- •:What are the management goals of the marine reserves?
- •:What are the regulations?
- •:What is the status?

CONCLUDE WITH: What are the valuable lessons we can learn from this process? What specific recommendations for designing a marine reserve can be made as a result of reviewing the process to establish marine reserves in New Zealand and/or the Philippines?

Project 7: Develop a dictionary/handbook of California marine protected areas (Medium time intensity)

Develop a list of terminology/categories to identify different levels of protection of marine areas; define terms by listing the management goals, criteria for selection, and levels of protection, i.e. regulations.

Example: Term Management Goal Criteria Regulations

Strict Marine Reserve Communities and species and natural processes must be maintained in an undisturbed state to have ecologically representative samples of the environment available for scientific study, environmental monitoring, education, and the maintenance of genetic resources in a dynamic state Outstanding ecosystems, features, or species of flora and fauna representative of particular natural areas No human activities allowed with the exception of non-manipulated (observational) research

Project 8: Develop and implement a community survey on attitudes toward marine reserves

Interview various user groups and stakeholders about their perceptions of marine reserves. Present results by summarizing surveys or interviews. Interview the following:

Three managers - representatives from the Department of Fish and Game, the National Marine Fisheries Service, and the Monterey Bay National Marine Sanctuary

Fishermen - groundfish fisherman (gillnetters and trappers), squid fisherman, sardine fisherman, albacore fisherman, shellfish fishermen

Kelp harvesters - members of the Monterey Bay Kelp Harvesters Cooperative, harvesters who are not part of the Cooperative

Divers - dive operation manager, recreational divers, spearfisherman

Surfers - Surfrider Foundation, individual surfers

Kayakers - kayak operation manager, individual kayakers

Conservation groups - Center for Marine Conservation, Save Our Shores, others

Scientists - researchers at Moss Landing Marine Labs or UCSC or other institutions

Project 9: Document and report on SSE Expeditions and Student Summit

Provide onsite documentation of SSE expeditions using slide and digital photos, video and interviews with scientists; report on the Ocean Summit and include information about the schools and students involved. Present as a "newscast" or movie, or as a "photo album" to place on the sanctuary web page.

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Project 1

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Project 2

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White, A.T. 1988. The effect of community-managed marine reserves in the Philippines on their associated coral reef fish populations. ICLARM Coastal Resources Management Project Technical Report, Manila, Philippines.

Wolfenden, J., F. Cram, and B. Kirkwood. 1994. Marine reserves in New Zealand: A survey of community reactions. Ocean and Coastal Management 25:31-51.

Yoklavich, M.M., ed., 1998. Marine Harvest Refugia for West Coast Rockfish: A Workshop. NOAA/NMFS Tech. Memo.

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Project 4

Because the Ed Ricketts Park process is ongoing, the best references are local newspaper articles and personal interviews. People who should be contacted are:

- Steve Webster - Monterey Bay Aquarium
- Aaron King - Monterey Bay National Marine Sanctuary
- Rachel Saunders - Center for Marine Conservation
- Ed Cooper - diver
- Fishermen
- Michelle Knight - Adventures by the Sea
- Department of Parks and Recreation
- Cities of Pacific Grove and Monterey

Documents that should be reviewed are:

- The Center for Marine Conservation proposal
- Recommendations from the Department of Parks and Recreation
- Recommendations from the Monterey Bay National Marine Sanctuary

Project 5

The Tortugas 2000 process is ongoing. The best reference to start researching Tortugas 2000 is the web page at fpac.fsu.edu/tortugas/index.html. Also try to contact the Florida Keys National Marine Sanctuary.

Project 6

New Zealand references:

website: www.hmu.auckland.ac.nz:8001/sanctuary/index.html

Ballantine, W.J. 1995. Marine reserves in New Zealand: Principles and lessons. Center for Marine Conservation Workshop.

Wolfenden, J., F. Cram, and B. Kirkwood. 1994. Marine reserves in New Zealand: A survey of community reactions. Ocean and Coastal Management 25:31-51.

Philippines references:

website: www.pbs.org (once on the pbs home page, do a search for "kingdom of the seahorse")

Russ, G.R., and A.C. Acala. 1996. Do marine reserves export adult fish biomass? Evidence from Apo Island, Central Philippine. Marine Ecology Progress Series 132:1-9.

White, A.T., and G.C. Savina, 1987. Community-based marine reserves: A Philippine first. In Proceedings of Coastal Zone 1987, pp. 2022-2036: American Society for Civil Engineers.

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McArdle, D.A., ed., 1997. Marine Protected Areas of California. University of California Sea Grant publication.

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Kelleher, G., 1992. Guidelines for establishing marine protected areas. Gland: IUCN.

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Kaza, S. 1988. Community involvement in marine protected areas. Oceanus 29:13-19.

Milbrath, L.W., 1981. Citizen surveys as citizen participation mechanisms. The Journal of Applied Behavioral Science 17(4):478-496.

Nies, B. 1995. Fishers' ecological knowledge and marine protected areas. Pages 265-272 In N. Shackell and J.H.M. Willison, eds. Marine protected areas and sustainable fisheries. Science and Management of Protected Areas Association, Wolfville, Nova Scotia, Canada.

Suman, D. 1998. Stakeholder Group Perceptions of Marine Reserves in the Florida Keys National Marine Sanctuary. In M.M. Yoklavich, ed., Marine Harvest Refugia for West Coast Rockfish: A Workshop. NOAA/NMFS Tech. Memo.

Wells, S., and A.T. White. 1995. Involving the community. Pages 61-84 In S. Gubbay, ed. Marine Protected Areas: Principles and Techniques for Management. Chapman & Hall, London.

Call Lisa de Marignac at the Monterey National Marine Sanctuary office for a sample survey used to interview user groups at the Florida Keys National Marine Sanctuary - (831) 647-4246

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Post-Summit Summary

Overview

Dr. Sylvia Earle addressed the over 40 students that attended the Sanctuary Summit at Monterey Bay.

The Monterey Bay National Marine Sanctuary hosted its first Sustainable Seas Expeditions Sanctuary Summit at the Maritime Museum in Monterey, California. The summit focused on the theme of No-Take Marine Reserves. In attendance were more than 40 students and their teachers representing seven area high schools: Aptos High, Carmel High, Morro Bay High, Monterey Academy of Oceanographic Science, Salinas High, Santa Catalina School, and Watsonville High. Joining the students was a panel of experts and guest speakers including; Dr. Sylvia Earle, National Geographic Society's Explorer-in-Residence and spokeswoman for the Sustainable Seas Expeditions; Dr. Steve Webster, Senior Marine Biologist for the Monterey Bay Aquarium; Dr. Andrew Devogelaere, Research Coordinator for the Monterey Bay National Marine Sanctuary; Dr. Greg Cailliet, Professor and icthyologist with Moss Landing Marine Laboratories; and Mike Guardino, science

teacher at Carmel High School and Sustainable Seas Expeditions' Teacher-in-the-Sea.

Mike Guardino shared insights on his Sustainable Seas Expeditions projects.

The summit was launched with a welcome from Steve Webster and brief presentations by each of the panel members. Sylvia Earle provided background on the Sustainable Seas Expeditions and an inspirational message about marine conservation. Andrew Devogelaere introduced the research and management goals of the Monterey Bay National Marine Sanctuary. Greg Cailliet gave a short lecture and slide presentation on marine reserves and discussed some scientific hypotheses to consider when researching the effectiveness of no-take reserves. Mike Guardino shared his insights on the Teacher-in-the-Sea program and described the SCUBA certification and marine research course that he taught for 18 local high school students. The data collected by Mike and his students address the effectiveness of no-take marine reserves in protecting fish stocks and complement one of the DeepWorker submersible research projects.

Students were given the opportunity to present their research projects to the summit audience.

After the introductions, it was the students' turn to be in the spotlight. Ten student groups gave presentations on research projects that they had conducted during the last several months. Project topics ranged from analysis of beach debris to surveys of public opinion on marine reserves; many projects addressed the summit theme of no-take marine reserves. The presentations, limited to five minutes in length, were well-prepared and expertly-presented. The presenters included visual aids such as overheads and Powerpoint slides with their speeches, and fielded questions posed by fellow students and panel members. Many of the most challenging questions were asked by Professor Greg Cailliet, and his constructive inquisitions gave the summit an atmosphere similar to that of an informal scientific conference. Students were encouraged to post descriptions of their research projects on the Sustainable Seas Expeditions website after the summit.

Finally, students, teachers, and panel members broke into six small discussion groups. Each group faced the task of working together to design a project for next year's student summit. The projects could be educational or research-oriented, and could involve either student researchers or DeepWorker submersibles. After 45 minutes of cooperative brainstorming, all participants reconvened and each group presented a brief outline of their project suggestion to the summit audience. After a few closing comments the summit concluded with a friendly and tasty reception.

Each breakout group faced the task of working together to design a project for next year's summit.

Student Designed Projects

1. "The Ocean: Our Future Provider." An educational project aimed at K-12 school children, this project would obtain grants and fund school field trips to nearby marine areas, with the goal of increasing awareness and interest in marine reserves and sanctuaries.

2. "Bringing the Sea to Kansas." An educational project aimed at the general public and especially children, this project would feature a touring marine "fair", popular media and internet components.

3. "The Effects of Overfishing: A Public View." This project proposed a six-month campaign of interviews and surveys to measure public opinion on fishery issues and raise public awareness of overfishing problems in the Monterey Bay National Marine Sanctuary.

4. A five-year monitoring project was proposed to study the effect of kelp harvesting on marine life in the kelp canopy and water column. The project would employ SCUBA survey methods to compare invertebrate communities between a "no-take" marine reserve and a non-reserve area within the Monterey Bay National Marine Sanctuary.

5. "Effects of Introduced Species on Native Populations." This long-term monitoring project was proposed to study the possible displacement of native sessile shellfish species by introduced shellfish such as the zebra mussel in bays and harbors of the

Monterey Bay National Marine Sanctuary.

6. "Monitoring Water Quality of the Tributaries that Drain into the Monterey Bay National Marine Sanctuary." This on-going monitoring project would utilize volunteers from the community and classrooms to test water quality parameters in five tributaries that drain into the sanctuary. The project would monitor the impact of human actions upstream on the sanctuary's water quality, and would raise public awareness through hands-on volunteer involvement and internet database access.

Feedback from Participants

"I liked the question and answer sessions, the going back and forth between the scientists and us."--*Seamus Perry, student, Morro Bay High School*

"I strongly believe that other high school students talking to me about what they've learned is a lot more effective than teachers telling me about their experiences... peer communication is a strong form of influence."--*Kenrick Callwood, student, Morro Bay High School*

"I think today went very well. It was really exciting to hear students give their presentations on projects they've worked so hard on... Today was very inspiring from an educational standpoint."--*Liz Love, Education Coordinator, Monterey Bay National Marine Sanctuary*

"I am very proud to be associated with this exceptional group of young men and women. They have proved that students can take responsibility for their educations and that young people can make a difference in the defense of the ocean and its resources."--*Mike Guardino, Teacher-in-the-Sea, Carmel High School*

"I was very encouraged to see that these kids are being taught to think, to ask questions and answer them critically, to go to the trouble to go to the library and the field and get answers that way. I saw a lot of promise there."--*Greg Cailliet, Professor,*

Moss Landing Marine Laboratories

Resources

Web sites

The Monterey Bay National Marine Sanctuary Program's Web site *bonita.mbnms.nos.noaa.gov*

We try to keep comprehensive and updated material on this site about the Monterey Bay National Marine Sanctuary. For environmental and natural history questions about the sanctuary, might we particularly recommend our "Site Characterization" under our "Research" subsection. This Site Characterization contains a 10,000+ citation Bibliographic Database that is searchable over the Web. Also, under the "Introduction" subsection you will find a "Related Website" link which will lead you to many other associated organizations' Web pages.

The Monterey Bay Aquarium Web site *www.mbayaq.org*

Opened in 1984, the Monterey Bay Aquarium is host to millions of tourists every year. It's inventory and display of marine organisms is one of the world's largest. Be sure and take the virtual "Habitats Tour" of the Monterey Bay area, from the wind-swept tidepools to the depths of the submarine canyon at (www.mbayaq.org/hp/index.htm).

The Elkhorn Slough National Estuarine Research Reserve Web site *inlet.geol.sc.edu/ELK/home.html*

Adjacent to the Monterey Bay National Marine Sanctuary, the Elkhorn Slough National Estuarine Research Reserve is a tidal embayment located midway between the coastal towns of Santa Cruz and Monterey at the apex of the Monterey Submarine Canyon. The reserve encompasses over 1,400 acres of marsh and tidelands.

The Monterey Bay Aquarium Research Institute Web site *www.mbari.org*

The Institute was founded in 1987 by David Packard with a mission "to achieve and maintain a position as a world center for advanced research and education in ocean

science and technology, through the development of better instruments, systems, and methods for scientific research in the deep waters of the ocean." The Institute is located in Moss Landing, California, where its two research ships and remotely operated vehicles are berthed, giving them immediate access to Monterey Bay and its Submarine Canyon. Be sure and observe the telemetered Real-Time Deep Sea Research from the R/V Point Lobos. The ship's position and ROV video is telemetered, along with data from a multitude of sensors, using a two-way microwave link (www.mbari.org/cruises/lobos/index.html).

Moss Landing Marine Laboratories Web site color.mlml.calstate.edu/www/
One of several University/Academic research institutions on Monterey Bay, Moss Landing Marine Laboratories are the marine research and teaching facilities which serve a consortium of seven California State Universities in Northern California. Since its establishment in 1966, the Moss Landing Marine Laboratories has earned an international reputation for excellence in marine research, education and is the second oldest marine lab on Monterey Bay.

The Monterey Bay Sanctuary Foundation Web site www.mbnmsf.org/pages/education.html
The Monterey Bay Sanctuary Foundation is a California nonprofit public benefit corporation whose goal is to promote protection and public understanding of the Monterey Bay National Marine Sanctuary. Incorporated in 1995, the Foundation focuses its efforts on educating the public about the extraordinary environment and resources of Monterey Bay. As a private organization, the Foundation has the flexibility to implement programs and projects that NOAA, as a lightly staffed federal agency, can not.

The California State Ocean Data Information Web site ceres.ca.gov/ocean/
The California Ocean and Coastal Environmental Access Network (Cal OCEAN) is a web-based virtual library for the discovery of and access to ocean and coastal data and information from a wide variety of sources and in a range of types and formats. The goal of Cal OCEAN is to provide the information and tools to support ocean and coastal resource management, planning, research and education via the Internet. Cal OCEAN is a project of the California Resources Agency's Ocean Resources Management Program.

Books

Natural History of the Monterey Bay National Marine Sanctuary. Monterey Bay Aquarium and NOAA/SRD. Nora L. Deans, Managing Editor (available through the

Monterey Bay National Marine Sanctuary Foundation). ISBN 1-878244-11-6
In 1997, the Monterey Bay National Marine Sanctuary and the Monterey Bay Aquarium co-produced this book as an educational text for sale to the public. From the Marin Headlands north of San Francisco's Golden Gate to the majestic Big Sur coastline, this book takes you beside and beneath the waters of the nation's largest marine sanctuary. Explore the breathtaking habitats and incredible sea life that make this the crown jewel of the sanctuary system. It's a place where playful sea otters tumble in the nearshore kelp forests...flocks of shorebirds scurry on wave-swept beaches...and mysterious vampire squid hunt in the perpetual night of a vast undersea submarine canyon. Includes species lists, appendices, suggestions for further reading, glossary, index and over 300 photographs, illustrations, scientific diagrams and maps.

Between Pacific Tides by Ricketts, Edward F. and Jack Calvin. 1968. Stanford University Press, Fourth Edition.
First written by Edward (Doc) F. Ricketts and Jack Calvin in 1939, with a forward by John Steinbeck, this book is considered the "Bible" for California intertidal natural historians. Later editions contain revisions by Joel Hedgepeth.

Sanctuary Explorations by Julia Davenport. 1997. UC Printing, University of California, Berkeley.
A cooperative effort by the University of California Santa Cruz Institute of Marine Sciences, the Joseph M. Long Marine Laboratory and the Monterey Bay National Marine Sanctuary, this 44 page paperback is an ideal primer for those persons interested in the natural history of the Monterey Bay National Marine Sanctuary.

Libraries

The Central California area is rich in marine science libraries that can be used for further exploration of the beauty and wonder of the Monterey Bay National Marine Sanctuary. A few examples include:

Moss Landing Marine Laboratories Library
http://color.mlml.calstate.edu/www/library/library.htm

Hopkins Marine Station Library
http://www-sul.stanford.edu/depts/miller/ index.html

California State University, Monterey Bay Library
http://library.monterey.edu/

U.S. Naval Postgraduate School Library
http://web.nps.navy.mil/~library/

University of California, Santa Cruz Library
http://bob.ucsc.edu/library/

For more information on how to obtain these resources, please contact:

Monterey Bay National Marine Sanctuary
299 Foam Street, Suite D
Monterey, CA 93940
tel: 831/647-4201
fax: 831/647-4250
mbnms@ocean.nos.noaa.gov

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Olympic Coast National Marine Sanctuary

June 16 to June 30, 1999

Included on this pages are the education and outreach events and summits that took place during the two-week Sustainable Seas Expeditions dive at Olympic Coast National Marine Sanctuary. Following the events and summits are a list of resources with specific information about the sanctuary.

Events

Sustainable Seas Expeditions Open Houses

Location: Seattle Aquarium, Pier 59 and Port Angeles City Pier
Date: June 16, 1999 and June 30, 1999

The open houses gave the public the opportunity to board the Navy ship Discovery Bay see the Sustainable Seas Expeditions technology up-close. Participants learned about the Sustainable Seas Expeditions and the Olympic Coast National Marine Sanctuary. Dr. Earle was on board to meet the public, as were other Sustainable Seas Expeditions pilots and researchers.

Dr. Sylvia Earle was on hand to meet the public and autograph copies of her book.

Visitors marvel at the size of the one-person submersible.

The crowds were enthusiatic to board the Navy Ship and to see the Deep Worker submersible in person. Submersible pilots were able to explain how the Deep Worker manuvers in the water and how it is loaded on and off the vessel. The Navy Yard Torpedo Test (YTT) range craft ship usually supports launch and recovery exercises for military operations, but has been made available for the Sustainable Seas Expeditions.

Sustainable Seas Expeditions Exhibit

An exhibit on the Sustainable Seas Expeditions was installed at the Seattle Aquarium on June 10, 1999 and remained on display until June 25, 1999. The exhibit includes a Deep Worker model and interpretive panels. Thousands of visitors came the aquarium, and the exhibit gave them the opportunity to learn more about the Sustainable Seas Expeditions and the National Marine Sanctuary Program.

The exhibit panels and Deep Worker model.

This is a traveling exhibit that will be at each sanctuary at the time of the Sustainble Seas Expeditions dives.

The Deep Worker submersible model fits into a box for shipping, and the panels are easily carried by Laura Francis, SSE education coordinator.

Seattle Aquarium Public Lecture by Sylvia Earle

National Geographic Society's famous Exporer-in-Residence. Dr. Earle spoke at the Omnidome at the Seattle Aquarium on June 15th. Her talk was preceded by a showing of the IMAX "Whales" feature. The lecture helped increase public knowledge about the Sustainable Seas Expeditions missions and build public support for Sustainable Seas Expeditions' marine conservation goals.

Sustainable Seas Expeditions VIP/Media tours

Selected teachers, opinion leaders, local government, partner agency staff, and others were given daily trips to the Navy Ship "YTT Discovery Bay" aboard the sanctuary vessel "Tataoosh". The news media was also invited, which provided the opportunity for the general public to get in-depth information about Sustainable Seas Expeditions operations and ocean research.

(top)

The sanctuary vessel "Tatoosh" shuttled selected officials to the ship where the Sustainable Seas Expeditions dives took place.

Summits

General Information

Date: May 18th, 1998
Location: Penninsula College, Port Angeles
Participants: Middle and High School students near the Olympic Coast
Theme: Year of the Ocean

Dr. Sylvia Earle talks with the students in a casual, intimate setting.

To commemorate "The Year of the Ocean", about 40 high school and middle school classes from areas near the Olympic Coast National Marine Sanctuary participated in a student summit with Dr. Sylvia Earle, National Geographic's Explorer-in-Residence. The purpose of the summit was to foster a questioning attitude among young people and give students an opportunity to voice their concerns about the ocean and marine environment. The students who participated in the summit all live in rural areas, indian reservations, or small towns whose culture and economy depend heavily on the ocean.

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Post-Summit Summary

Overview

The summit was an occasion for relaxed, intimate dialogue between students and Dr. Earle. The students posed thought- provoking questions to Dr. Earle such as:

•What encouraged you to explore our oceans?
•What do you think about the current problem of overfishing?
•Where do you see the state of the ocean in 20 years?
•What affect will El Niñ o have on toxic algal blooms?
•How will the hole in the ozone affect the ocean?
•How do you feel about the local tribe's permission to hunt the gray whale?
•What can we do to protect our oceans?

The students were able to hear answers to their thoughtful questions from one of the leading experts in ocean exploration.

Dr. Earle's answers were inspiring and she continually encouraged the students to think critically about ocean exploration and conservation. She told the crowd that she has been interested in ocean exploration ever since she was a child. "Like most kids, I was curious. Curiosity is not just limited to human beings. I've seen curious whales, cats, dogs and horses... and some keep it all their lives. Scientists are among those who keep that sense of curiosity all their lives".

A student ponders Sylvia's question "are we going to change our ways?"

Dr. Earle expressed that overfishing is one of the major current issues in ocean conservation. "Those in the future will look back on those of us now making decisions about ocean wildlife that will be regarded as one of the critical decisions of our time. Are we going to continue to regard (sea creatures) only as a commodity?". She continued with this theme in answering the question about the state of the ocean in 20 years. "Are we going to allow the same dumb ways to continue or are we going to draw the line and say we have to change our ways?". She stressed that the answer toward the future "does not have to be a big 'no' with more regulations, but a big 'yes' to taking

care of the oceans that take care us us". She then continued to say that "the worst thing we can do is nothing. That is a decision in default."

This student wondered how El Nino has had an effect on the ocean.

In response to the questions on weather and climate change, Dr. Earle concentrated on the effects related to planktonic development and the life cycle of the ocean. Regarding El Niñ o, she said, "it is a matter of those creatures that prosper when it is cold, they have a good time in that kind of area. But, if the water is warm…" Dr. Earle pointed out the effect of El Niñ o in waters along the coastal area of California. "In an El Niñ o year, there is a change in the kind of plankton that flourish. The usual citizens are in short supply and then other, new species come in. For the (native) creatures that are already under pressure, a natural phenomenon such as El Niñ o could push them over the edge to extinction".

Sylvia responded to this student's straight question about the ozone layer.

Dr. Earle thought that the question on the ozone layer was "a straight question with not too many straight answers". She noted that there is a pattern that seems to be clear that radiation will have a broad effect on the occurrence of natural systems. She went on to say that the increasing hole in the ozone layer increases radiation, which seems to have an immeasurable effect on the growth of certain microscopic plants. "Imagine the consequences of a decrease in phytoplankton due to an increase in radiation. This increase in radiation will prohibit photosynthesis in some of the critical organisms, or change the life cycle of krill or other planktonic organisms". She noted that this could effect the entire ocean system in both the southern and northern hemispheres. "This is a really good question for someone like you, any of you, to take on…to look at the connection of what's happening high in the sky and what's happening right here".

The question about the local Makah indian tribe's recent permission to hunt the grey whale generated the most dialogue between the students. Dr. Earle admitted that this is a tough question. "There is no easy answer to a question about the effects of taking a whale, or whales, from a population that has rebounded significantly in the last 20 years because people have taken protective measures". She then asked the students what they thought since this is a "holding your hands" kind of issue on the Olympic Coast that is happening around the world.

Student A: *"I have always been opposed to it. It has been a big controversy here on the Olympic Penninsula. I feel that they are a big part of our marine ecosystem and we need to preserve that"*

Sylvia: *"Many people think that all people have rights to ocean resources. There will be some impact (from hunting whales), but will the impact affect future generations?"*

The question about a local tribe's permission to hunt the gray whale generated a lot of interesting dialogue.

Student B: *"What concerns me is that technology may mean the tribes can hunt more than they did using more traditional hunting practices"*

Student C: *"We are not using traditional methods because it is too inhumane, and it will be more humane with technology. We are only allowed to hunt four whales a year. The gray whale has been off the ESL (endangered species list) since 1994. Taking four won't make a big difference."*

Sylvia wrapped up the dialogue by stating "It is not what we are putting into the ocean, and it is not what we are taking out... It is ignorance". She stressed that this is where the students really have a chance to impact everything that follows. "You must take it upon yourselves to not just react to some of these tough questions, but to act. The truth is that we cannot please everybody all the time."

Sylvia Earle tells the students, "I hope this is just the beginning of the dialogue".

Sylvia ended the summit by asking the students to try to think of what would they like to see in 10, 20, 50, or 100 years from now. Would they like to have their children, grandchildren, friends of friends, look back on them and say, "You idiots, you fools! Why didn't you do (blank)? How could you let this happen?". Or the people in the future could say, "Right on, guys! Thanks. You made the right decisions at the right time. You held the line to enable us to turn things around."

On that optimistic note, Sylvia concluded

the summit by saying, "I'm glad to have had this chance to talk with you and I hope it is not over. I hope this is just the beginning of the dialogue. You can count on hearing from me, and I really hope to hear from you".

(top)

About Sylvia Earle

Sylvia Earle
National Geographic Society

Marine biologist Sylvia Earle is Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion - oceans - especially serving as project director of Sustainable Seas Expeditions and writing three books for publication in 1999.

Named one of Time Magazine's "heroes for the planet" in 1998, Earle has pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She holds numerous diving records and is the author of more than 100 scientific and popular publications, including a 1995 book "Sea Change."

Earle was born August 30, 1935, in Gibbstown, NJ. She has a bachelor's degree from Florida State University and a master's and doctorate from Duke University as well as nine honorary doctorate degrees. She lives in Oakland, California.

Resources

Books

Guide to Marine Mammals of Alaska. Kate Wynne. Alaska Sea Grant. 1993.
This is a pictoral guide to marine mammals of the Northeast Pacific. Includes all

whales, dolphins, pinnipeds, and otters found in the Olympic Coast National Marine Sanctuary. Good quick reference for whale watching.

Seashore Life of the Northern Pacific Coast. Eugene Kozloff. University of Washington Press. 1983.
This is a detailed guide to marine organisms of the Olympic Coast National Marine Sanctuary. The book describes in detail the different habitat types and inhabitants.

Coastal Washington: A Synthesis of Information. Strickland and Chasan. Washington Sea Grant. 1989.
This book analyzes the Washington Coast's ecological and economic resources. Written before the Olympic Coast National Marine Sanctuary was designated, it is nevertheless a valuable resource for understanding the sanctuary.

Intertidal Wilderness. Ann Werthiem. Sierra Club Books. 1984.
This includes photographs and text describing the intertidal ecology of the northwest rocky shores. Most of the pictures were photographed at Tatoosh Island.

For more information on how to obtain these resources, please contact:

Olympic Coast National Marine Sanctuary
138 West First Street
Port Angeles, SA 98362
tel: 360/457-6622
fax: 360/457-8496
ocnms@ocean.nos.noaa.gov

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Stellwagen Bank National Marine Sanctuary

July 9 to July 15, 1999

Included on this pages are the education and outreach events and summits that took place during the two-week Sustainable Seas Expeditions dive at Stellwagen Bank National Marine Sanctuary. Following the events and summits are a list of resources with specific information about the sanctuary.

Events

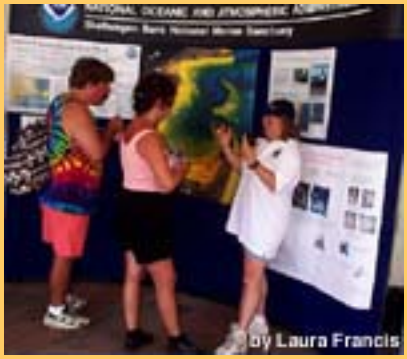
Exhibit Tent

Date: July 4th and 5th, 1999
Time: 10:00am - 6:00pm
Place: Plaza in front of the New England Aquarium, Central Wharf, Boston
Admission: General Admission, free

The exhibit tent at the Aquarium focused on the "Sustainable Seas Expeditions Mission to Stellwagen Bank National Marine Sanctuary". Thousands of visitors came by the tent and learned about the upcoming expedition in the sanctuary. The holiday weekend was unusually hot for New England, so the crowds were enthusiastic to get in the shade and learn more about underwater exploration.

The exhibit tent on the grounds of the New England Aquarium.

Exhibits included information about the National Marine Sanctuary Program and the biodiversity, acoustics, bathymetry, and marine mammals of Stellwagen Bank National Marine Sanctuary. One exhibit was a colorful poster that shows the complex seafloor topography of Stellwagen Bank (seen in photo on right). On hand to explain the exhibit information and to answer questions were the dedicated staff and volunteers of the sanctuary.



Anne Smrcina, education coordinator, talks with visitors.

There was also information on the Sustainable Seas Expeditions mission at all twelve National Marine Sanctuaries, as well as a life-size model of the Deep Worker submersible. The Sustainable Seas Expeditions exhibit panels and submersible model has traveled across the country to be at each sanctuary during the time of the expeditions. Since not everyone can pilot the unique submersible, a great way to understand the space constraints inside the sub is to climb into the model.

Adults and children enjoyed the chance to climb into the model of the Deep Worker submersible.

In the kid's corner, children drew their ideas of what they might see in Stellwagen if they were a Deep Worker pilot. To see some of the drawings from the open house, please see the Stellwagen Bank kids gallery section of the Photo Gallery.

This little artist gets some help from mom.

Educator Workshops

Date: July 5, 1999
Time: 1-2pm, 2-3pm or 3-4pm
Where: Coast Guard platform in Boston, MA
Admission: Free admission, but reservations required at (781) 545-8026

This is an opportunity for teachers to learn about the expeditions so they can educate their students.

Educators from the Boston area will be invited to a one-hour introduction to the Sustainable Seas Expeditions.This is intended for high school science and technology teachers, but teachers of other grades are also welcome. Educators will be able to meet with Sustainable Seas Expeditions mission coordinators and NOAA's National Marine Sanctuary education staff. They also can see the research vessel FERREL and the Deep Worker submersibles. In addition, they will be able to pick up a copy of the new Sustainable Seas Expeditions resource/ curriculum book, explore the Sustainable Seas Expeditions Web pages, and find out how these and future materials can be used in the classroom.

Teacher Cruise

When: July 12, 1999

There will be an all-day Teacher Cruise to the Stellwagen Bank National Marine Sanctuary in support of the Sustainable Seas Expeditions. This part of the annual Harbor Explorations summer marine science workshop for educators. The teachers will travel out to the sanctuary on board the EnviroLab III. Once at the sanctuary, the teachers will gather plankton samples, tow a drop video camera, and observe cetacean behavior in the sanctuary. A ship-to-ship phone conversation with Dr. Sylvia Earle may be possible.

(top)

Teachers from the area will be able to spend the day visiting and learning about this 842 square mile sanctuary off the Massachusetts coast.

Summits

General Information

Date: July 9, 1999
Location: Gloucester, MA
Participants: Students from the American School for the Deaf
Theme: Underwater Acoustics

Whales communicating to each other is probably a large part of the underwater noises at the Stellwagen Bank National Marine Sanctuary.

Dr. Sylvia Earle will meet with the high school students/researchers from the American School for the Deaf to discuss the Sustainable Seas Expeditions and to discuss underwater acoustics. After the summit, the students will be heading out to the Stellwagen Bank National Marine Sanctuary to participate in studies of sound in the sanctuary. Students and teachers will be studying background noise levels and whale behaviors using hydrophone recordings and visual displays of data.

The American School for the Deaf (ASD) is the oldest school for deaf people in the United States and is also the birthplace of American Sign Language (ASL). The school offers a broad range of programs to meet the varied needs of deaf infants, children, youth and adults. One of the programs for high school students is the National Undersea Research Center's "Aquanaut" program, designed to encourage students to study oceanography.

(top)

About Sylvia Earle

Sylvia Earle
National Geographic Society

Marine biologist Sylvia Earle is Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion - oceans - especially serving as project director of Sustainable Seas Expeditions and writing three books for publication in 1999.

Named one of Time Magazine's "heroes for the planet" in 1998, Earle has pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She holds numerous diving records and is the author of more than 100 scientific and popular publications, including a 1995 book "Sea Change."

Earle was born August 30, 1935, in Gibbstown, NJ. She has a bachelor's degree from Florida State University and a master's and doctorate from Duke University as well as nine honorary doctorate degrees. She lives in Oakland, California.

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Post-Summit Summary

On July 9th, Dr. Sylvia Earle joined 2 students from the American School for the Deaf in studying the impacts of noise on whales in the Stellwagen Bank National Marine Sanctuary. Students from the school will begin a five-day expedition into the sanctuary to study impacts of noise pollution on whale behavior, determine levels of background noise in the sanctuary and look at day vs. night differences in noise in the sanctuary. The students are using a hydrophone to collect sound within a mile radius of the research vessel, MIMI. Specialized visualization software allows the students to "see" the sound on a computer screen on board the ship.

Dr. Sylvia Earle introduces herself to two students from the American School for the Deaf who will be doing acoustic studies in the sanctuary.

The research vessel, MIMI is famous for the video series and middle school curriculum entitled "Voyage of the MIMI."

On their way out to Stellwagen on the 9th, the MIMI reported being surrounded by humpback whales. One breached, others spouted and circled in to get a closer look. Several came within 50 ft of the MIMI. The students will be out in the sanctuary during most of the Sustainable Seas Expedition in Stellwagen and their studies will complement what the scientists are learning with the DeepWorker submersibles. This project is supported by NOAA's National Undersea Research Program.

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Resources

Newsletters and Posters

Stellwagen Soundings: News from the Stellwagen Bank National Marine Sanctuary
This 8 page newsletter is filled with timely articles about research,education and resource protection efforts ongoing in the sanctuary. Additional features highlight interesting scientific investigations or ecotourism topics. Free. Published 2-3 times per year.

Seafloor Topography of Stellwagen Bank

This full color poster provides a computer graphic image of the complex topography of the seafloor in Massachusetts Bay and Stellwagen Bank. Produced by the sanctuary from an image generated by the US Geological Survey (using computer visualization software and NOAA bathymetric data). 20"x30".

Books

Stellwagen Bank: A Guide to the Whales, Sea Birds and Marine Life of the Stellwagen Bank National Marine Sanctuary. Nathalie Ward/Center for Coastal Studies. 1995. Down East Books, Camden, ME. 232pp.
This publication was rated a "Hit-of-the-Week" by the Boston Globe. With more than 200 photos and illustrations, this spectacular book reveals the wealth of resources hidden in the waters of the sanctuary. Essays by resource users and researchers complement the descriptive text.

A Field Guide to Whales, Porpoises, and Seals from Cape Cod to Newfoundland. 4th Edition. Steven Katona, Valerie Rough and David T. Richardson. 1993. Smithsonian Institution Press, Washington, DC. 316pp.
The variety of species found in the North Atlantic are detailed in this authoritative text that combines numerous black and white photos and line drawings with information about whale behavior, migration patterns and identifying features. All of the sanctuary's cetacean species are covered in this book.

Marine Life of the North Atlantic: Canada to New England. A*ndrew J. Martinez. self published. 1994. ISBN: 0-9640131-0-X. 272pp.*
This photo guidebook, specializing in the rich diversity of invertebrate life in the North Atlantic, is an ideal tool for scuba divers and students of marine biology. Seaweeds and some marine fish are also covered.

Beneath the North Atlantic. Jonathan Bird. 1996. Tide-mark Press, Ltd., East Hartford, CT. 152pp.
This coffee table book is filled with amazing underwater photography as well as descriptive text that reveals the wonder of the North Atlantic to readers. The book is divided into sections based on biological phyla of the animal kingdom.

Fishes of the Gulf of Maine. Henry B. Bigelow and William C. Schroeder. Fishery Bulletin of the Fish and Wildlife Service, Volume 53, Fishery Bulletin 74. 1953. U.S. Government Printing Office, Washington, DC. 577pp.
This is the "Bible" of fish guidebooks for the region, still referenced after all these years. The text is jam packed with technical information about fish predator-prey relationships, migration patterns, life stages, and habits. Black and white illustrations accompany the text for each species.

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Videos

From Whaling to Watching: The Northern Right Whale. 1997. Stellwagen Bank National Marine Sanctuary, Gray's Reef National Marine Sanctuary and Georgia Department of Natural Resources. 20 minutes, color, VHS.
This video won best of category (non-broadcast) in the 1998 International Wildlife Film Festival. The video highlights the biology and behavior of the North Atlantic population of the northern right whale, and conservation efforts underway to protect this critically endangered species. There is a companion teacher guidebook of the same name by Anne Smrcina, SBNMS and Sarah Mitchell, GRNMS, 36pp.

Bounty of the Banks. Stellwagen Bank National Marine Sanctuary. 1997. 13 minutes, color, VHS.
Designed as a companion piece to an upcoming curriculum, this video also serves as a standalone film, focusing on human use of marine resources, particularly those of the Stellwagen Bank Sanctuary and elsewhere in the Gulf of Maine and northwest Atlantic Ocean. The video features Richard Wheeler, one of Time Magazine's Heroes of the Planet and star of the NOVA show "The Haunted Cry of a Long Gone Bird.

CD-Roms

A Guide to the Whales of the Northwestern Atlantic. Produced by WhaleNet. 1998.
Includes the complete index to humpback whale flukes in the North Atlantic as well as background information about species, individual sighting histories on individual whales, and other related data. See the WhaleNet home page for ordering information on this product.

The Food Bank: The Food Web at the Stellwagen Bank National Marine Sanctuary (to be completed by late 1999).
Produced by the Stellwagen Bank National Marine Sanctuary. Filled with hundreds of photographs and dozens of video clips, this product demonstrates the complicated nature of the food web in these temperate waters. The latest information on predator-prey relationships is included.

Web Sites

WhaleNet (http://whale.wheelock.edu)
From whale fluke identifications to scientific tagging, this site covers a wide range of

topics primarily related to whales, but also covering other marine species including endangered sea turtles and pinnipeds. Sections are specially designed for students, teachers, and the general public.

Journey North (http://www.learner.org/jnorth)
Winner of the 1999 Webby Award (known as the "Oscars of the Internet") in the Education Category, this site immerses more than 200,000 students into environmental science as they track the coming of spring through the migration patterns of butterflies, birds, and land and marine mammals, the budding of plants, changing daylight, and other clues in their local environment. For the past five years, the Stellwagen Bank Sanctuary has provided weekly humpback and right whale reports.

Exhibits

Storm Over Stellwagen -- Immersive Theater at the New England Aquarium.
This state-of-the-art exhibit recently opened to rave reviews. Audience members can participate in the flow of the show, answering pop quizzes and guiding the final outcome based on their management decisions for the Stellwagen Bank Sanctuary.

Creatures of the Bank: A photographic exploration into the biodiversity of the Gerry E. Studds Stellwagen Bank National Marine Sanctuary.
Produced by the sanctuary, on loan to the Nantucket Whaling Museum. Over 60 photos of organisms as small as bacteria and as large as fin whales illustrate the range and beauty of species in the sanctuary. Images were donated by numerous commercial and amateur underwater photographers.

For more information on how to obtain these resources, please contact:

Stellwagen Bank National Marine Sanctuary
175 Edward Foster Road
Scituate, MA 02066
tel: (781) 545-8026

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Gray's Reef National Marine Sanctuary

July 26 to August 6, 1999

Included on this pages are the education and outreach events and summits that took place during the two-week Sustainable Seas Expeditions dive at Gray's Reef National Marine Sanctuary. Following the events and summits are a list of resources with specific information about the sanctuary.

Events

Rivers to Reefs Reports

Where: WSAV-TV (NBC) and WSVH/WWIO Peach State Public Radio
Dates: July 27 and July 29 (more to follow)

In an effort to help the general public understand the connection of the land to the sea and the dependence of the health of our entire state to any of its particular parts, Gray's Reef National Marine Sanctuary is producing a series of reports. The series starts at the headwaters of the Altamaha River Watershed and continues out to Gray's Reef and beyond to the continental slope.

The reports are being produced in cooperation with Savannah's local NBC affiliate WSAV-TV. Reporter/Meteorologist Shay Ryan will report two installments during Gray's Reef Sustainable Seas Expeditions mission on July 27 and July 29 and an

indefinite number afterwards. The raw video footage will also be used to produce education programs and a documentary for broadcast on public television. The radio reports are produced through WSVH-WWIO Peach State Public Radio, Savannah's local affiliate of National Public Radio. The series will begin prior to the Sustainable Seas Expeditions and continue indefinitely.

Gray's Reef National Marine Sanctuary encompasses 17 square miles of rippled sand bottom punctuated with dazzling garden-like oases of premier live bottom habitats.

Ocean Festival

Where: River Street
When: Sunday August 1, 1999
Time: 12:00pm to 5:00 pm

The Ocean Fest will take place on River Street and aboard the NOAA Ship the Ferrel which will be docked at the site. DeepWorker 2000 will be featured with a display explaining Sustainable Seas Expeditions. Also on display will be our Gray's Reef National Marine Sanctuary photo and information exhibit as well as an exhibit from National Geographic Society. The Fest will have performances by local musicians, readings by local poets and display locally produced art. A working model of DeepWorker 2000 will be on hand for the general public to experience by sitting in it and working the controls. The Fest is designed to elevate the public's awareness of the oceans in general and Sustainable Seas Expeditions and Gray's Reef in particular.

The model of the Deep Worker and the Sustainable Seas Expeditions exhibit panels.

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Summits

General Information

Date: August 1, 1999 5:00pm
Participants: Students from the Student Ocean Council
Theme: Sustainable Seas Expeditions

Among other things, the students will talk with Dr. Earle about the habitat and living resources of Gray's Reef National Marine Sanctuary.

On Sunday August 1st at 5:00 PM Gray's Reef National Marine Sanctuary will conduct Sustainable Seas Expeditions Sanctuary Summit '99. The Summit will give local students the opportunity to listen to and ask questions of world renowned ocean scientist, Dr. Sylvia Earle, as well as other staff involved with the project. During the 1999 school year 17 local private and public high school students participated in Gray's Reef's Savannah Student Ocean Council. The students met monthly with professionals in ocean science related fields. Most of the sessions began with short presentations by the professionals about their work and ended with the presenters conducting hands-on activities they designed specifically for these sessions. The presenters represented professions ranging from research scientist to fish hatchery manager from marine educator to boat captain. These students will be the participants in the Student Summit '99.

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About Sylvia Earle

Sylvia Earle
National Geographic Society

Marine biologist Sylvia Earle is Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society

divisions on projects involving her passion - oceans - especially serving as project director of Sustainable Seas Expeditions and writing three books for publication in 1999.

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Earle was born August 30, 1935, in Gibbstown, NJ. She has a bachelor's degree from Florida State University and a master's and doctorate from Duke University as well as nine honorary doctorate degrees. She lives in Oakland, California.

Post-Summit Summary

Dr. Earle shared her personal experiences with whatever the students talked about and offered comments on how their interest might be turned into a long-term study.

Sunday August 1st was a scorcher indeed, and after five hours of unrelenting 105 F temperatures in the shade with no hint of a breeze the Gray's Reef Ocean Festival on River Street neared its end. A few of the students in the Sanctuary Student Ocean Council braved the heat and stuck with us through the afternoon helping out in the various tents set up to educate the general public about the oceans. As the day turned into evening and the festival wound down the temperatures seemed to climb even higher along with the anxiety that our guest speaker Dr. Sylvia Earle, Executive Director of Sustainable Seas Expeditions and Explorer in Residence for National Geographic Society, would not arrive in time for the planned student summit. Sylvia however came through while many of the students did not. Even though Sylvia was about an hour late due to a canceled flight which caused her to scramble to even

get to Savannah at all, she still came through to deliver a memorable message and to interact with the students who did brave the heat.

With her usual gracious aplomb looking cool and calm and refreshed despite her travel ordeal from the west coast, Sylvia gave the few students who gathered to hear her and be in her presence, her undivided attention. She earnestly asked each of the students what their interests were, listening intently and nodding her head in approval as they shared their interests in and fascinations with sharks and dolphins. Sylvia's effectiveness as a teacher and mentor comes from not only her ability to speak knowledgeably and eloquently about the many aspects of the oceans and its creatures but in listening to her audience. She chatted with each student directly giving them the "one on one" that is so integral in encouraging a young mind. She shared her personal experiences with whatever the students talked about and offered comments on how their interest might be turned into a long-term study. Sylvia also asked how they would use a submersible to research their subject. She listened intently as the students explained their ideas again nodding encouragement and giving good advice that even the adults strained to hear as well.

Sylvia's soft voice at times was no match for the noise of cars and boats traversing the river and the street, so we all enclosed the circle even tighter. Drips of sweat were trickling down our necks and backs but Sylvia's pearls of wisdom refreshed us and made us forget the noise and the heat. Her pearls were many with the best perhaps being that any great research starts with a dream and is accomplished by doing whatever it takes to make it happen. "The opportunity to study a particular topic most likely will not be thrown in your lap," she said, "so if you want something to happen, you have to get it on your own. It may take your own money, time and resources to get started, but in the end it will pay off." That of course applies to life in general. I think everyone that listened to Sylvia that afternoon was impressed with her unwavering conviction to leave this planet a little better than when she came into it. Her passion is the ocean, and some of that passion couldn't have helped splashing on to all of us.

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Resources

Educational Handbooks and Books

Coastal Waters
Salt marshes, tidal creeks, estuaries, and offshore reefs form a biologically rich

assemblage of marine environments. Coastal Waters is a condensed guide to the geology, natural history and ecology of the marine waters of coastal Georgia. Sapelo Island, centrally located on the coast of Georgia is highlighted and field trip information is included.

The Northern Right Whale: from Whaling to Watching
This is an educational module that includes a handbook, video and two-part poster, created by Will Hon depicting the migration route, size, and anatomy of the great whale. This handbook explores the life history of the most endangered large whale, the northern right whale, and our history with the whale from exploration to conservation. The handbook includes activities that students will thoroughly enjoy and discover how we as domineering species on the planet may navigate more carefully to protect the right whales future.

Gray's Reef and Stellwagen Bank National Marine Sanctuary are both located within the endangered whale's migration track. As a result the two sanctuaries have taken a strong interest in the marine mammal and have teamed-up to increase public awareness and education efforts concerning the conservation of the northern right whale. The education coordinators of both sanctuaries recently co-authored a curriculum guide and video entitled "The Northern Right Whale from Whaling to Watching." Sarah V. Mitchell, of Gray's Reef National Marine Sanctuary, designed the handbook and wrote the text with Ann Smrcina of Stellwagen Bank National Marine Sanctuary.

Tales of Whales, Turtles, Sharks, and Snails: an elementary level educational handbook.
The purpose of this handbook is to increase the awareness, knowledge and literacy of elementary students in marine-related subjects. It is written also for elementary teachers to use as a resource and guide to other environmental educational materials.

Gray's Reef National Marine Sanctuary: An Educational Handbook: middle school level handbook.
This is a middle school level handbook that introduces Gray's Reef National Marine Sanctuary, one of twelve National Marine Sanctuaries in the United States, and the only one in Georgia. It describes the geology and biology of Gray's Reef. In addition, Sanctuary management and regulations are discussed and the other National Marine Sanctuaries are described.

An Illustrated Field Guide to the Fishes of Gray's Reef National Marine Sanctuary by Matthew R. Gilligan, Ph.D
The field guide consists of illustrated manuals on the identification and general

biology of the fishes encountered at gray's Reef. The Field Guide is intended for use by students (high school and collage), non-specialist scientists, and sanctuary users who want more information about species of fish they may encounter in the sanctuary. It also serves as an important reference on the groups of fishes found at Gray's Reef.

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Books

A Guide to the Georgia Coast by the Georgia Conservancy, edited by Gwen McKee, 1985, ISBN No. 0-9614284-0-6.
This guide consists of descriptions to 40 historical and ecological sites and 8 coastal rivers. It presents an introduction to the Georgia Coast region- approximately 100 miles from South Carolina to Florida and 30 miles inland, including Gray's Reef National Marine Sanctuary.

Posters

Rivers to Reefs
"Rivers to Reefs" represents a journey across the major landforms and seascapes of southeastern U.S. coast. This poster will take you from the estuaries, salt marshes, maritime forest on the upland portion of the barrier island, beaches and dunes, coastal water, and to the reef communities.

Invertebrates of the Reef
The "Invertebrates of the Reef" poster depicts the different invertebrate residents and explains the different reef habitats and communities in Gray's Reef.

Northern Right Whale
This poster created by Will Hon depicts the anatomy and migration routes of a Northern Right Whale. This poster serves as a companion guide to the "The Northern Right Whale: From Whaling to Watching" educational handbook.

Web Sites

Great American Fish Count
http://www.fishcount.org

Marine Extension Service/ University of Georgia
http://www.marsci.uga.edu/EXT/MAREX.html

NOAA Coastal Service Center
http://www.csc.noaa.gov

Sapelo Island National Estuarine Research Reserve
http://inlet.geol.sc.edu/SAP/home.html

South Atlantic Fisheries
http://www.safmc.nmfs.gov/

Skidaway Institute of Oceanography
http://www.skio.peachnet.edu

Tybee Island Marine Science Center
http://www.tybeeisland.com/tourinfo/tybeemsc/tybeemsc.htm

Reef Environmental Education Foundation
http://www.reef.org/

Whale Net
http://whale.wheelock.edu/

For more information on how to obtain these resources, please contact:

Gray's Reef National Marine Sanctuary
10 Ocean Science Circle
Savannah, GA 31311
tel: (912) 598-2345

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Florida Keys National Marine Sanctuary

August 16 to August 29, 1999

Included on this pages are the education and outreach events that took place during the two-week Sustainable Seas Expeditions dive at Florida Keys National Marine Sanctuary. Following the events there is a list of resources with specific information about the sanctuary.

Events

Resources

Events

NOAA Ship Ferrel and DeepWorker Open House

Where: Mallory Square Pier, Key West, FL
Date: Sunday, August 22, 1999
Time: 11:00 AM - 3:00 PM

The Florida Keys National Marine Sanctuary will be hosting an open house of the NOAA ship Ferrel and the DeepWorker submersibles. Sanctuary staff, pilots, researchers and DeepWorker technicians will be on hand to answer questions and lead tours. There will be displays about the Sustainable Seas Expeditions and the Florida Keys National Marine Sanctuary. The open house is designed to elevate the public's awareness of the oceans in general, and the Sustainable Seas Expeditions and the Florida Keys in particular.

Mini Student Summit

Location: Florida Keys National Marine Sanctuary Lower Region Office
Key West, FL
Date: Sunday, August 22, 1999
Time: 10:00 AM - 2:00 PM

The open house will give people the opportunity to learn more about Florida Keys National Marine Sanctuary and the Sustainable Seas Expedition.

A mini-student summit will be held in conjunction with the open house of the NOAA Ship Ferrel and DeepWorker submersibles on August 22. Students and teachers from area high schools will meet with Florida Keys National Marine Sanctuary staff at the Sanctuary Lower Region Office. After meeting with the staff, the group will tour the NOAA ship Ferrel and speak with pilots and scientists about their recent explorations and research.

The goals for the day include:

•learn more about the Sustainable Seas Expeditions
• learn how the Sustainable Seas Expedition will affect the Florida Keys National Marine Sanctuary
• learn about the NOAA ship Ferrel and the DeepWorker technology
• assist with planning of the Student Summit to be held in September

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Student/Teacher At Sea Experience

A select group of teachers and students from area high schools will have the opportunity to observe the Sustainable Seas Expeditions aboard the NOAA ship Ferrel. After being shuttled to the NOAA Ship Ferrel in the morning, the students will spend the day watching firsthand how technology is being used to enhance research in the Florida Keys National Marine Sanctuary. The goal of the project is to promote oceans as a focus for public education, build the basis for a learning community that uses an interdisciplinary approach to explore ocean issues, and to develop the skills and knowledge to encourage active public participation in monitoring, conserving,

and sustaining ocean resources. It is hoped this experience will also aid the students and teachers in their preparation for the Student Summit to be held in September.

DeepWorker Model and Sustainable Seas Expeditions Display

Where: Marathon Airport, Marathon, FL
Mile Marker 49, Bayside
When: August 15 - August 21
Time: Sanctuary Staff will be present from 10 AM - 4 PM each day, however the display will be open for viewing during normal airport hours from 8 AM - 6 PM.

The open house will give people the opportunity to learn more about Florida Keys National Marine Sanctuary and the Sustainable Seas Expedition.

A static display of the DeepWorker and the Sustainable Seas Expeditions will be open to the public at the Marathon Airport. This will be a great opportunity for the public to learn more about the Expeditions, the Florida Keys National Marine Sanctuary, and the importance of the oceans.

The model of the Deep Worker and the Sustainable Seas Expeditions exhibit panels.

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Resources

Television Programs and Videos

Waterways
Over one hundred half-hour television episodes of Waterways explore the natural treasures of south Florida. Filmed on location, each episode includes interviews with local environmental experts who explain the various projects currently underway to

protect this unique ecosystem. Waterways is a cooperative effort between the Florida Keys National Marine Sanctuary, Environmental Protection Agency, and Everglades National Park.

Introduction to the Florida Keys National Marine Sanctuary
On the fifteenth anniversary of the Looe Key National Marine Sanctuary, Dr. Sylvia Earle, National Geographic Explorer in Residence, described the oceans as "a cornerstone of our life support." This seven minute long video features short segments about the history of marine protection in the Florida Keys, reasons for implementation of the Florida Keys National Marine Sanctuary in 1990, and current research, education, and volunteer programs.

Protecting Paradise Grounding Video
Boaters learn maritime "rules of the road" with this eight minute video that was developed for local rental boat companies. Navigational markers, use of mooring buoys, and basics of safe boating are explained and demonstrated, and the viewer is instructed in proper procedures for handling a grounded boat. A short course in "reading the water" - interpreting depth and bottom conditions from the color of the underwater cover (sand, seagrass, and coral) is included.

Maps and Brochures

Teall's Guide, Key Largo to Conch Key
Teall's Guide, Marathon to Key West
These fold-out maps, based on NOAA nautical charts, include the locations of Sanctuary Preservation Areas and Ecological Reserves, National Wildlife Refuges, National and State Parks. A large insert page offers a Marine Zoning Guide and an overview of the Florida Keys National Marine Sanctuary, including instructions for using a mooring buoy, and details about lobster regulations. Upper and Lower Keys versions are available.

Florida Keys National Marine Sanctuary brochure
This comprehensive fold-out brochure offers maps and information about the Florida Keys National Marine Sanctuary and other protected areas in the Florida Keys. It also includes a short history of geology and shipwrecks, describes the region's principal habitats, and lists regulated activities. The importance of the Everglades and the entire south Florida ecosystem to the health of the Keys' coral reefs is highlighted, along with a look at cooperative efforts now underway by various agencies seeking a sustainable south Florida.

Lower Florida Keys Region
Upper Florida Keys Region

Maps and information about Florida Keys reefs are included in these colorful brochures, with text in English and Spanish. Examples of navigational and regulatory markers are illustrated, and there is a list of public boat ramps and vessel pump-out facilities. The brochures also contain instructions on how to use a mooring buoy, tips for divers and snorkelers, advice for boaters and fishermen, and a summary of Sanctuary regulations. Upper and Lower Keys versions are available

Management Plan and Directory

Strategy for Stewardship - Florida Keys National Marine Sanctuary Final Management Plan: An Overview
What is the difference between Sanctuary Preservation Areas and Ecological Reserves? Where are they located? Why is water quality of critical concern in the Florida Keys? The answers to these and other questions may be found in this short summary of the Florida Keys National Marine Sanctuary's first five-year management plan. Channel Marking, Submerged Cultural Resources, Education, Enforcement, and Mooring Buoys are subjects of some of the Sanctuary's ten Action Plans. Learn about the important role volunteers play in the success of Sanctuary programs, and what you can do to help protect coral reefs of the Florida Keys.

The complete three-volume Florida Keys National Marine Sanctuary Final Management Plan/Environmental Impact Statement is also available. This tome is an excellent reference for those studying methods of marine resource management or for anyone who would like more insight into the workings of this unique protected area, home to the only living barrier reef off the coast of North America.

Florida Keys Environmental Education Resource Directory 1997
From summer camps to books, the Resource Directory lists details about organizations and their products. Find out about parks, education programs, and more with this comprehensive listing that offers information and resources on environmental education in or about the Florida Keys.

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Books

Florida Keys Environmental Story, published by Monroe County Environmental Education Advisory Council
A collection of stories about the fascinating environment, culture, and history of the Florida Keys, this book may be used as a research and learning tool or for pure reading pleasure. This is a splendid introduction for newcomers to the area, and includes more detailed information for those with special interests. The book is used

regularly by Keys school teachers, and is an appropriate gift or souvenir for anyone who is charmed by the magic of the Florida Keys. Available at most bookstores in the Florida Keys.

Posters and Decals

Florida's Coral Reef Ecosystem poster
Eight habitats of the Florida Keys ecosystem are highlighted in this two-sided, educational poster. Color illustrations detail communities from the tropical hardwood hammocks and mangroves to the seagrass flats and various reef formations. On the reverse, a species list is keyed to outlines of the same illustrations. Suitable for framing - and learning!

Florida Keys Safe Boating Tips Decal
Educating boaters about navigating the unique waters of the Florida Keys is an ongoing challenge. This sticker was designed as a handy on-board reminder about the meaning of reef markers, channel markers, regulatory, and information markers. It also includes instructions for minimizing damage should the boat run aground. The sticker is part of a boater safety program developed for boat rental businesses.

Web Sites

Tortugas 2000: Tortugas Ecological Reserve
http://fpac.fsu.edu/tortugas/index.html
This site explains what is special about the Tortugas region, how the ecological reserve will be established, and how you can be involved in the process. With links to the Tortugas 2000 Update newsletter and Tortugas 2000 Working Group page, the Tortugas 2000 site will keep you abreast of the latest efforts to protect the Florida Keys' westernmost reefs.

The Florida Marine Research Institute
http://www.fmri.usf.edu/coral/tax.thm
This page features a new taxonomic list of the stony corals (with pictures) observed by the Coral Reef / Hardbottom Monitoring Project in the Florida Keys National Marine Sanctuary. This U.S.E.P.A. funded monitoring project has been in existence since 1994, has collected over 12,000 stony coral species records, and has analyzed over one half million points during image analysis from framegrabbed Hi-8 video. This taxonomic list page is a digital version of our Coral Identification Guide used for training and Quality Control purposes. Principal Investigators on this project are Dr. Phil Dustan from University of Charleston, South Carolina, Dr. Jim Porter, University of Georgia, and Walt Jaap, Florida Marine Research Institute.

International Coral Reef NGO Directory
http://www.coral.org/NGO/index.html

The International Coral Reef NGO (Non-Governmental Organization or Not for Profit) Directory highlights the innovative and solution-oriented actions of dozens of organizations that are committed to improving the future of coral reefs. CORAL, The Coral Reef Alliance, maintains this page and offers memberships and other links to photographs and information on their homepage, www.coral.org.

For more information on how to obtain these resources, please contact:

Education Coordinator
Florida Keys National Marine Sanctuary
PO Box 1083
Key Largo, FL 33037
(305) 852-7717 ext. 30
mary.tagliareni@noaa.gov

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Flower Garden Banks National Marine Sanctuary

September 1 to September 13, 1999

Included on this pages are the education and outreach events that took place during the two-week Sustainable Seas Expeditions dive at Flower Garden Banks National Marine Sanctuary. Following the events there is a list of resources with specific information about the sanctuary.

Events

Resources

Events

Sanctuaries and Coastal Resources Day

Hosted by: Texas State Aquarium
Where: Corpus Christi, Texas.
Date: Aug 28

See a life-size model of the one-person submersible, DeepWorker. Talk to DeepWorkeer pilots, researchers, and Flower Garden Banks National Marine Sanctuary staff. Visit the Flower Gardens tank in the Texas State Aquarium to see demonstrations of the latest in scuba equipment. Chat with a variety of agency representatives involved with protecting and managing our coastal and ocean resources.

Sustainable Seas Expedition to the East Flower Garden Bank.

Where: Flower Garden Banks NMS
Date: Sept 1 - Sept 13

The first leg of the mission from September 1 - September 6 will include deep-water biological characterizations, exploration for potential brine seeps (in addition to the known seep), and observations of the annual mass coral spawn.

The second leg of the Sustainable Seas Expedition to the East Flower Garden Bank taking place from September 8 through September 13 will include exploration and data gathering at the known brine seep and hypersaline lake at 240 feet. It will also include and exploratory dive off the continental shelf to depths of 1,000 feet and greater.

(top)

Student Summit and Public Open House

Student Summit

Date: Tuesday, Sept. 7
Time: 9:00 am to 10:00 pm

Upper middle and high school students meet with Dr. Sylvia Earle to discuss current issues in the nation's marine protected areas, with a focus on the Flower Garden Banks National Marine Sanctuary. After discussions with Dr. Earle, selected students will present short descriptions of projects related to the Sanctuaries, proposed for completion during the school year. Lastly, representatives from various marine related organizations will discuss career opportunities and a representative from Texas A&M University at Galveston will tell students what they need to do now to prepare for college level studies in marine sciences.

Public Open House

Hosted by: U.S. Army Corps of Engineers with volunteer assistance from the Seaborne Challenge Corps
Time: 10:00 am - 2:00 pm

Keynote presentation by Dr. Sylvia Earle, followed by a book signing session. Other acitivities also taking place during the Open House include:

* touring the NOAA Ship FERREL,

* examining the DeepWorker submersibles, and

* touring the exhibits of other coastal organizations.

Live Internet Chat

Where: Public Open House
Date: Tuesday, September 7
T*ime:* 2:00 pm - 3:00 pm

Live internet broadcast of an on-line chat from the NOAA Ship FERREL with the FERREL crew, DeepWorker pilots & researchers, and Sanctuary personnel.

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Mini-Workshop

Hosted by: Moody Gardens,
Where: Galveston, Texas.
Date: September 11

Mini-workshop on the Sustainable Seas Expedition and the Flower Garden Banks NMS during the Texas Marine Educators Association Fall Conference

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Teacher Onboard

Where: NOAA Ship FERREL
Date: tentative

During 2-day VIP trip (during 2nd leg), there will be a teacher on board to observe the SSE mission diving on the Flower Garden Banks.

On-line Chat

Date: Sept 16

On-line chat with Sustainable Seas Expedition researchers and Sanctuary staff to discuss the outcomes of the mission that took place during the precious two weeks. Hear what the researchers and staff learned from this mission and what kinds of things they would like to do on the next SSE visit to the Sanctuary.

Resources

There are a variety of resources with information on the Flower Garden Banks National Marine Sanctuary for all levels of learning. Brochures, leaflets, posters, videos and reference lists addressing a number of topics are available. See **Educational Resrouces for the Flower Garden Banks National Marine Sanctuary** for all the details.

Kathy would like to become a pilot of the DeepWorker submersible in future years.

For more information on how to obtain these resources, please contact:

Shelley Du Puy
Interim Education Coordinator
Flower Garden Banks National Marine Sanctuary
1716 Briarcrest Dr.
Suite 603
Bryan, TX 77802
(409) 847-9296
shelley.dupuy@noaa.gov

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Educational Resources for the Flower Garden Banks National Marine Sanctuary

Title (Age Group)	Description	Available From	Address	Make Check Payable To	Cost
Printed Media					
Flower Garden Banks National Marine Sanctuary (9th grade up)	Color brochure with biological and regulatory information about the FGBNMS.	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Not applicable	Free
"The Flower Gardens: A Chronology of Research (9th grade up)	Compilation of references since 1937 (in draft form)	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Not applicable	Free
Flower Gardens Fact Sheet (5th grade up)	1 page leaflet with general information on the Sanctuary	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Not applicable	Free
Activity sheets (3 rd through 5th grade)	Packet of activity sheets on various topics related to the Flower Gardens, coral reefs and ocean resources	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Not applicable	Free

Flower Gardens Posters (9th grade up)	Two-sided color poster depicting biotic zones	Texas A&M Sea Grant College Program	1716 Briarcrest Dr. Suite 603 Bryan, TX 77802	Texas A&M University Sea Grant	$ 3.00
Reef Fish of the Flower Gardens and Stetson Bank National Marine Sanctuary (all ages, depending on how you use it)	100 common fish species of Flower Gardens & Stetson Bank. Includes color photos, life history, habitat and occurrence notations.	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Reef Environmental Education Foundation	$5.00/poster plus $3.00 postage per order (NOT per poster)
Video					
"The Flower Gardens" (9th grade up)	11.5 minute narrated video on the Flower Garden Banks	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Not applicable	single copies FREE while supplies last
"Our Favorite Home Video " (All ages)	7 minutes unnarrated	Flower Garden Banks National Marine Sanctuary	216 W. 26th St. Suite 104 Bryan, TX 77803	Not applicable	one per school, please
"Reef Romance" (9th grade up)	10 minute video on coral spawning	Texas A&M Sea Grant College Program	1716 Briarcrest Dr. Suite 603 Bryan, TX 77802	Texas A&M University Sea Grant	$ 5.00

"Gardens Under the Sea" **(9th grade and up)**	**Award winning 48 minute documentary on coral spawning & research activities at the Flower Garden Banks National Marine Sanctuary. Produced by KFDM-TV, Beaumont, TX.** **Comes with a worksheet for classroom use.** **OR** **Without the classroom worksheet.**	**Leave Only Bubbles, Inc 1-800-890-1034** **KFDM-TV Channel 6 Beaumont 409-892-6622**	**Leave Only Bubbles P.O. Box 2397 Key Largo, FL 33037** **6 Discovers c/o KFDM-TV PO Box 7128 Beaumont, TX 77726-7128**	**Leave Only Bubbles** **KFDM**	**$19.95** **+ postage & handling**

1. Prices include tax and shipping/handling unless otherwise noted.

SUSTAINABLE SEAS EXPEDITIONS
EDUCATION

SITE INDEX

The Education Program of the Sustainable Seas Expeditions

This section of the SSE Web site describes the goals and objectives of the SSE Education Program, provides access to educational materials, links to descriptions of professional development activities for teachers and education events for students, and offers information on informal educational media and activities. Also included is an archive of education events, summits and resources from the 1999 SSE field season.

The Olympic Coast National Marine Sanctuary serves as a living classroom for teachers and students.

Background: In April 1998, the National Geographic Society, in partnership with the National Oceanic and Atmospheric Administration (NOAA), launched the Sustainable Seas Expeditions to explore the U.S. National Marine Sanctuaries and promote the need for greater marine conservation. One of the SSE's primary goals is to provide people with rich educational experiences, both through the drama of underwater exploration itself and the compelling photographs and video footage that document these little-known areas. To achieve the objectives of increasing regional and national interest in the marine sanctuaries, while addressing the national need to

improve marine education for young and old alike, the National Geographic Society and NOAA established a team to develop educational activities and programs that involve many partners and collaborators.

The SSE education program has four primary elements:

SSE Education Program

Teacher Materials

Teacher Opportunities

Student Opportunities

(1) **Developing Teacher Materials**: SSE strives to provide high-quality marine science teaching materials that are linked to national standards in science and geography. One of the project's main goals is to provide teachers with the tools to bring new technologies, new knowledge and new learning opportunities to students.

Sanctuary Education Coordinator Julie Goodson and Park Service ranger Tom More share the history of Anacapa Island--one of the Channel Islands--before taking visitors on a hike.

(2) **Providing Professional Opportunities for Teachers**: SSE provides a multifaceted approach to teacher professional development. Programs such as Teacher-in-the-Sea and Teacher-at-Sea provide special opportunities for teachers to conduct research with SSE scientists. In addition, the SSE reaches out to a broader audience of teachers through a series of hands-on and virtual training workshops.

(3) **Developing Educational Opportunities for Students**: These include Student Summits, Students-at-Sea (direct participation in a mission), and Web chats and Web casts. Each sanctuary host several educational events during the course of an SSE mission.

(4) **Providing Informal Educational Activities**: Informal educational opportunities include exhibits, family activities, public programs, books, television programs, magazine articles and the Web. The National Geographic Society estimates that SSE has, during its first two years, potentially reached more than 200 million people through newspaper, radio and television coverage.

Ventura High School students toured the sanctuary aboard the National Park Service vessel, *Ocean Ranger,*during the SSE mission to the Channel Islands.

For More Information

Contact the **SSE Education Team** to learn more about the SSE

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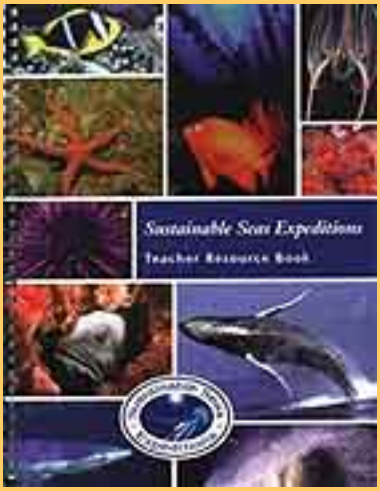
Teacher Materials

The Sustainable Seas Expeditions strive to provide high-quality marine science teaching materials that are linked to national standards in science and geography. One of the main goals of the SSE is to provide teachers with the tools to bring new technologies, new knowledge and new learning opportunities to students. These materials are available below.



Teacher Resource Book: The SSE Teacher Resource Book was produced to help teachers develop classroom activities and materials to highlight these exciting explorations. Based on the SSE's 1999 field season, the Teacher Resource Book includes background on NOAA's National Marine Sanctuaries--our nation's most important marine environments--and a look inside the project. Teachers will find detailed information about the *DeepWorker 2000*--the innovative submersible used to explore sanctuary depths--and an outline of the 1999 missions. Several activities developed by classroom teachers are offered for classroom instruction, e.g., planning a submersible research mission, designing a submersible vehicle, and mapping a marine sanctuary. The book also lists many additional resources: books, Web sites and other sources of information about the ocean and the sanctuaries. The Teacher Resource Book is targeted for grades 9-12 but can easily be adapted to other grade levels. **Download the *Sustainable Seas Expeditions Teacher Resource Book Unit 1 & 2***.

BRIDGE Sanctuary Data Tip: The National Marine Sanctuary Program partnered with the **BRIDGE**, an online Ocean Science Education Teacher Resource Center, to develop a "Data Tip" for several sanctuary regions. The BRIDGE produces "Data Tips of the Month," lesson plans that make online ocean science data sets and related activities easily accessible to teachers and students. The following Data Tips are now available:

SSE Education Program

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Student Opportunities

September 2000 - Southeast Region

Explore the habitats and associated fish communities of three sanctuaries (Gray's Reef, Florida Keys, and Flower Garden Banks), and use the FishBase and **REEF** databases to determine if fish species are similar or different between each site.

December 2000 - Northwest Region

Shipwrecks! Learn about shipwrecks in the northwest sanctuaries (Olympic Coast, Gulf of the Farallones, Cordell Bank, Monterey Bay, and Channel Islands) and how they can teach us important lessons on how currents, weather, technology and human error can combine in ways that can damage the environment. Plot the locations of shipwrecks and answer historical questions based on knowledge compiled in the West Coast Shipwreck Database.

April 2001 - Pacific Islands Region

E helu Kakou i na Kohola! (Let's Count Humpback Whales!) Humpback whales visit the Fagatele Bay National Marine Sanctuary, as well as the Hawaiian Islands Humpback Whale National Marine Sanctuary. The classroom activity examines the Kauai data from the annual whale count conducted at the Hawaiian Islands Humpback Whale National Marine Sanctuary.

National Geographic Classroom Ideas: The National Geographic Society has developed a series of educational materials that can be adopted into the classroom. The materials focus on several marine sanctuaries and have been customized for elementary (K-4), middle (5-8), and high school (9-12).

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Professional Opportunities for Teachers

The Sustainable Seas Expeditions provide a multifaceted approach to teacher professional development. SSE programs, such as **Teacher-in-the-Sea** and **Teacher-at-Sea**, provide special opportunities for teachers to conduct research with SSE scientists. In addition, SSE reaches out to a broader audience of teachers through a series of hands-on and virtual **training workshops**. Teachers who participate in these professional opportunities further the educational goals of the project by sharing their experiences with students, colleagues and administrators through lesson plans, presentations and educational conferences.

Teacher-in-the-Sea
The *Teacher-in-the-Sea*program debuted at the Monterey Bay National Marine Sanctuary in 1999. In this competitive program, a teacher is selected to train as a pilot of the *DeepWorker* submersible. The teacher participates directly in the SSE mission, collecting data, involving students and developing lesson plans for students and colleagues.

Michael Guardino, Teacher-in-the-Sea, from Carmel High School.

During the 1999 field season, Mike Guardino, a Carmel High School teacher, trained as a *DeepWorker* pilot for the SSE mission to the Monterey Bay National Marine Sanctuary. Mr. Guardino involved his students in his work by training them in scuba diving and marine research techniques. His students conducted a study that observed the size and abundance of rockfishes inside and outside of a marine reserve. Mr. Guardino extended the study into deeper water with the *DeepWorker* submersible. He described his participation in the **May 24 Web chat** and the **May 19 Mission log**. He plans to participate again this year when the SSE revisits Monterey Bay.

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Kathy Soave, Teacher at Sea

Teacher-at-Sea:
The *Teacher-at-Sea*program debuted at the Gulf of the Farallones National Marine Sanctuary in 1999. In this competitive program, a teacher is selected to participate on board a NOAA ship during the SSE mission. The teacher interacts with pilots and scientists and develops lesson plans and other educational materials.

During the 1999 field season, Kathy Soave, a high school teacher at the Branson School in the Bay area, participated as a Teacher-at-Sea aboard the NOAA Ship *McArthur*in the Gulf of the Farallones National Marine Sanctuary. She observed dive operations and participated in sanctuary research. As a result of her experience, she developed lesson plans for her students and developed an intertidal monitoring program at her school. To read about Ms. Soave's experience, read the **April 18 SSE mission log**.

Teacher Workshops
Teacher training workshops are single-day to multi-week professional development opportunities for teachers. During these workshops, teachers learn the importance and value of national marine sanctuaries, learn strategies for integrating ocean studies into science and geography courses, participate in field investigations, interact with the research community, learn scientific monitoring techniques, develop lesson plans, and refine presentation skills.

Geographic Information Systems (GIS) Workshop
July 12-14, 2000 -- Channel Islands National Marine Sanctuary

Twenty teachers and marine educators from across the nation came to Santa Barbara, California this past summer to participate in a geographic information systems (GIS) workshop. GIS is a powerful visualization tool used by marine resource managers to map locations of animals, ocean bottom topography, ocean currents, surface temperatures and more. Participants in the workshop learned how to use GIS and other emerging technologies to access SSE and marine sanctuary data for their classrooms. After a one-day introduction to ArcView Software, participants took an extended field trip to the Channel Islands National Marine Sanctuary aboard the *Spirit of Santa Barbara*.They collected water quality data and recorded marine mammal sightings, and captured images that were used to complete a project using GIS the next day in class.

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Workshop sponsors included NOAA, the National Geographic Society, the Center for Image Processing in Education, the University of California at Santa Barbara, the Environmental Systems Research Institute (ESRI), and the National Center for Geographic Information and Analysis. **Click here for the workshop summary.**

Project Ocean S.T.E.W.A.R.D. Virtual Teacher Workshop
October 9 to November 3, 2000 -- Online Virtual Event

There are 250 slots for teachers and educators who wish to participate in the Ocean STEWARD (Students and Teachers Empowered With Access to Real Data) virtual workshop. The goal of the workshop is to introduce teachers to, and educate them in, the process (questions) and products (data) of scientific investigation and exploration. Via the Web, workshop participants will engage in dialogue with scientists and educators about physical oceanography, geographic information systems, and habitat characterization as they relate to the national marine sanctuaries and Sustainable Seas Expeditions. They will create lesson plans related to these topics that will be shared on-line with others. Registration for this free workshop opens on September 18, 2000 and closes on October 8, 2000. To register, go to the **College of Exploration Web Site**. Workshop sponsors include NASA, NOAA, the National Geographic Society, University of Southern California Sea Grant Program and the College of Exploration. For more infromation, contact the **SSE Education Team**.

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May 24, 1999
Web Chat Summary

10:00 am to 11:00 am Pacific time (1:00 pm to 2:00 pm eastern time)
Teacher in the Sea

Introduction

During this chat we were joined by Mike Guardino, the Teacher In The Sea and Liz Love, Education Coordinator for MBNMS. Mike, his students, and Liz provide a glimpse of their work to help us learn more about MBNMS.

Mike is a high school teacher from Carmel High School close to Monterey Bay. Mike and his students are involved in an extensive study of Monterey Bay and the role of the sanctuary in preserving this special marine environment. Mike is a trained DeepWorker Pilot and made a dive during the MBNMS expedition. His students took several scuba dives as part of their involvement in the project. They will compare the data that they gathered to observe the impact of no-take zones on marine life preservation.

In December of last year, Mike Guardino was selected by the Sustainable Seas Expeditions as the first pilot for NOAA's National Marine Sanctuaries "Teacher in the Sea" Program. Mike has taken both the beginning and advanced training courses to become a DeepWorker 2000 Pilot. Mike and 16 of his students, who have been trained to scuba dive, in his expedition investigation. He will make two DeepWorker dives at 150 ft. Each of his students will conduct a minimum of 5 dives to scuba depths.

Mike will use his DeepWorker time to conduct a video survey of bottom topography and organisms in and out of a no-take zone. The results are to be compared with existing bathymetric charts of Carmel Submarine Canyon to yield an accurate description of the bottom topography and benthic organisms of the region. Correlation of marine life with various benthic habitat types will be made in Pt. Lobos Reserve near the Pinnacles outside of Bluefish Cove. This area is within the boundaries of the Point Lobos Reserve and is relatively free from commercial and recreational take of fishes and invertebrates. A similar dive will be made outside of the park to gather

data from an area that experiences more harvest pressure.

To learn more about the Monterey Bay National Marine Sanctuary, visit these two NOAA Web sites:
www.sanctuaries.nos.noaa.gov/oms/omsmonterey/omsmonterey.html
and
http://bonita.mbnms.nos.noaa.gov/

To learn more about the Great American Fish Count visit this Web site:
http://www.fishcount.org/

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Highlights

We were joined in the chat room by Liz Love, MBNMS Education Coordinator, Mike Guardino the "Teacher In The Sea" and 18 of his diver/researcher students. While Mike answered some of the questions about the project and the DeepWorker dives, most of the chat featured his students' interaction with others from around the country.

As the Teacher In The Sea project focused on "no-take marine reserves," Liz helped create a better understanding of how complex the issue is and what it means: "There are many different meanings for a marine reserve depending on who you are talking to or what marine protected area you are referring to. In the most strict sense, it's an area that is off-limits to most human activities, particularly the taking of marine animals."

Liz and Mike also discussed the importance of student involvement in SSE and other marine research. The objective will be to grow this aspect of the project in future years.

As the students described their project, everyone in the chat room was inspired to be a part of this experience. As Allison, a student diver/researcher commented, "every dive is exciting, but for me probably the most exciting dive I had was when I was able to see a leopard shark. The whole experience is just exhilarating. Its' almost like traveling to another planet minus the space travel."

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Web Chat Transcript

Laura Francis - Welcome to the Chat room for our discussion with Mike Guardino, NOAA's first Teacher-in-the-Sea, and students from his marine research course. Liz Love, Education Coordinator from NOAA's Monterey Bay National Marine Sanctuary will also join us. We are going to get started in about 5 minutes, so get your questions ready...

Laura Francis - Good morning everyone, we have Liz Love, Mike Guardino and his students logged on and ready to answer your questions. We are all set to get started with the chat. Mike and students, do you want to give everyone a brief description of your research project?

Mike Guardino/Teacher in the Sea - As part of my duties as Teacher in the Sea I recruited 18 students from four local high schools to conduct a research project on scuba. After certifying the students we learned the names of 160 local marine organisms and scientific sampling techniques such as transects and quadrants. The students were curious about the use of Marine Protected areas for fisheries management. They conducted 200 scuba dives in and around Pt. Lobos Reserve in Carmel, California.

Tim Haag/Mission Park - Mike: we're still working on receiving all the comments. Great to 'see' you. Tim

Nickolas - Yes, Mission Park is here.

Thomas - This is Thomas from Mission Park school. What was going through your minds?

Q1: Nickolas - Hello, Can you see the lasers on the machine

A1: Mike Guardino/Teacher in the Sea - We used lasers on the video camera we carried and the DeepWorker submarine is also fitted for their use.

Q2: Jackson/Woodside Middle School - Is your project over now that the Monterey mission is finished?

A2: Jason - No not really, the project will be going on for the next four years or so.

Q3: Tim - When the article said that this could be an ongoing project for the students, what do you foresee the students doing in the future?

A3: Mike Guardino/Teacher in the Sea - I will continue to certify new students in scuba and have them conduct research in No-Take Marine Protected Areas. We are also looking at putting a student in the DeepWorker. Most of our students are here right now so why not ask them directly?

Q4: Jackson/Woodside Middle School - Is your project over now that the Monterey mission is finished?

A4: Liz Love/Monterey Sanctuary - From my perspective, I certainly hope that Mike and his students continue their research work, both using SCUBA and the DeepWorker Submersible as a way of collecting data. I would like to see even more students become directly involved in the project next year.

Q5: Rhonda/Woodside Middle School - What will you do with the data you gathered during the Teacher In The Sea project?

A5: Ali - We were invited to MBARI in July to present our research project! It will also be posted on the SSE web site.

Q6: Mrs. Paker/Woodside Middle School - Will Monterey Bay have more teachers in the sea next year? Are there other similar projects in the area?

A6: Liz Love/Monterey Sanctuary - I hope we have the opportunity to train at least one more teacher next year. I think Mike's involvement has showed how valuable it is to have a teacher involved directly with DeepWorker operations.

I just read the second part of your question. We are currently working with a UCSC scientist to obtain funding to initiate a student monitoring project to collect data in rocky inter-tidal areas.

Q7: Mrs. Paker/Woodside Middle School - Will Monterey Bay have more teachers in the sea next year? Are there other similar projects in the area?

A7: Mike Guardino/Teacher in the Sea - Monterey will have more Teachers in the

Sea and the other 11 National Marine Sanctuaries will too. There is a lot of marine research being conducted in MBNMS through Moss Landing Marine Labs, MBARI, The Monterey Bay Aquarium, Hopkins Marine Station, and Long Lab.

Q8: Thomas - I guess its pretty neat going down and seeing all those species. What was the most exciting thing about going down?

A8: Alison - Well every dive is exciting, but for me probably the most exciting dive I had was when I was able to see a leopard shark. The whole experience is just exhilarating. It's almost like traveling to another planet minus the space travel.

Q9: Karen/Seattle Wa - Was it fun being on the McArthur?

A9: Paul - I've never spent much time on a boat before, but I was entirely amazed at the size of the ship and at all of the technology onboard. I also got a chance to profess my love to Sylvia Earl's daughter anonymously in a book in the galley. It was great!

Q10: Lisa/KR Smith - The second graders would like to know if you have seen any marine mammals on your dive today. What other marine organisms have you seen?

A10: Michele - On our dives we were fortunate enough to see many different marine mammals. Following us on our dives were harbor seals, and we often saw sea otters.

Q11: Mrs. Paker/Woodside Middle School - Liz, are you also a pilot of the DeepWorker? Are you conducting other SSE related education projects next year?

A11: Liz Love/Monterey Sanctuary - No. I did not train to be a pilot and will gladly give up this opportunity every year in order for a teacher or a student to have the chance instead! Sanctuary Education staff coordinated the half-day student summit where Mike and his students presented their research project. We invited other students and teachers from the region to the summit and focused on the theme of no-take marine reserves. We'd like to continue holding these kinds of events in the future.

Q12: Max/Bel Aire - Hey Mike and Students! My kids want to know what it was like doing research underwater, and more importantly, did you get to miss any class to go diving?

A12: Nikki - It was difficult to do research under water. We had to be able to write on under water paper and be able to recognize different organisms while moving. Also, we had to be able to distinguish between a juvenile and an adult fish. This was a class we were given credit for, so when we did miss class for diving it was a good reason.

Q13: Lisa/KR Smith - Hi, Mike and Student Divers. We are a class of second graders in San Jose and we're studying about marine mammals right now. That is why we asked if you had seen any marine mammals. Many of the second graders would like to be student divers some day and wonder what they need to learn to be able to do that.

A13a: Mike Guardino/Teacher in the Sea - You need to be 12 years old in order to be certified as a scuba diver. It also helps to be a good swimmer and to be comfortable in the ocean.

A13b: Liz Love/Monterey Sanctuary - Being comfortable in the water is the most important thing - you don't necessarily have to be a strong swimmer. I would suggest leaning how to snorkel or skin dive first. If you enjoy snorkeling, then learn how to scuba dive. My most exciting moments in the water have been snorkeling. I've been

Right next to whale sharks, dolphins, a humpback whale mother and her calf, and a marlin, all with just a mask, snorkel and fins!

Q14: Thomas - What was the preparing like?

A14: Mike Guardino/Teacher in the Sea - I had to learn to pilot the DeepWorker Submarine by studying the operations book and conducting training dives in confined water as well as in the ocean. I even lost 25 pounds to fit in the sub better but couldn't do anything about my height (6'2").

Q15: Ms. Patterson/Bel Aire School - Hi Mike! This is Liz at Bel Aire and some of my fourth graders. Hope all is well with you! We have many questions for you and your students. What is the strangest thing you have seen? What is the longest time you have been in the water? How deep have you gone? What is the most interesting creature you have seen? Any scary moments? How deep can the sub go? Do you like going in the sub? Is it scary down there? What kind of communication do you have

with the surface? Have you ever lost communication? Do your ears pop on the way down? Is it cold down there? How do you stay warm? What about oxygen and carbon dioxide build up?

A15: Mike Guardino/Teacher in the Sea - Hello Liz!!! Great questions! I saw a large pelagic cnidarian. I was under water for almost two hours at 120 feet. There was nothing scary but piloting the sub can be a bother while trying to collect data. I have never lost communication with the surface (YET). The sub is very warm due to the chemical reaction that removes carbon dioxide from the cabin. Hello Max.

Q16: Mrs. Jackson/Woodside - Liz and everyone - can you share with us your definition of a no-take marine reserve?

A16: Liz Love/Monterey Sanctuary - Great question and that's one that's hard to answer as their are many different meanings for a marine reserve depending on who you are talking to or what marine protected area you a referring to. In the most strict sense, it's an area that is off-limits to most human activities, particularly the taking of marine animals.

Q17: Lisa Johnson/KR Smith - Almost everyone in the class can swim--in swimming pools! They have a way to go to be comfortable in the ocean, so luckily they have time. How deep are you diving today? What do you do for light?

A17: Emily - We dove as deep as 70 ft. For light we took flashlights. After having the experience of diving a few times you become more comfortable with the ocean.

Q18: Thomas - How long were you under (estimate)?

A18: Ben - Our dives were roughly 30 to 45 minutes long. This is highly based upon getting cold or running out of air.

Q19: Ms. Patterson/Bel Aire School - If they make Monterey Bay an protected area where you have a no-take policy what will happen to the aquarium and what will this mean for research?

A19a: Mike Guardino/Teacher in the Sea - The Aquarium does more to protect the MBNMS than anyone! They need to collect organisms for display but these critters serve to educate and inspire us all to conserve what we have. Marine Protected Areas

are small places within a Sanctuary that are used to manage fisheries.

A19b: Liz Love/Monterey Sanctuary - Another great question. A recent effort to designate a small portion of the bay off-limits to fishing and collecting wasn't very successful. The area proposed (off Cannery Row) is an area that's heavily used by people both

Recreationally and commercially. It's doubtful that the entire bay would ever be designated a no-take area.

Lisa Johnson/KR Smith - We all congratulate you for going on these dives. Thanks for sharing your experiences with us. My kids would like to meet you also. I look forward to hearing more detail and seeing pictures this summer at MBARI.

Q20: Max Bel Aire - So Mike and Students, my kids want to know if you guys can come up here and visit us sometime! How many students are there right now? Has anything gone wrong on any of your research dives? And lastly, was the diving ever hard for the students (cold, scary, etc)? Thanks for doing all of this you guys, we're going to log off soon... (Math test!) but we'll keep in touch! Max and kids!

A20: Jennifer - Yeah, we'd love to visit you guys sometime and tell you about our experiences underwater. There are 18 students here right now. Nothing has

Really ever gone wrong on our dives, except sometimes the sea conditions weren't very good, and it was hard to see underwater. I never found diving scary - it's one of my favorite past times!

Q21: Mrs. Jackson/Woodside - Liz and everyone - can you share with us your definition of a no-take marine reserve?

A21: Chad - A "no take" marine reserve is exactly as it sounds. Simply It is a place were no life can be removed for any reason. That means no fishing or collecting.

Q22: Rhonda/Woodside Middle School - What did you and your students learn so far?

A22a: Kyle - we learned how to dive. then during our research we learned the

differences between the organisms in and out of the no-take zones.

A22b: Gabe - Besides learning the various marine organisms, we learned that there is a significant difference in populations of marine fish between the no-take zones and the non protect areas. However invertebrate populations are the same indicating that the low fish populations were due to human interaction.

Laura Francis - We just have a couple of minutes left, so we are going to let our experts try to answer the last few questions. Thank you all for joining us today and for the great questions-sounds like we have some future scuba divers and DeepWorker pilots out there. Check back in about a week at:

http://www.sustainableseas.noaa.gov/aboutsse/liveevents/liveevents.html

to see footage of Mike and his students conducting their research and interviews with students. Also remember to log on to the next video uplink from NOAA's Channel Islands National Marine Sanctuary from 11-12:15 pacific time on Thursday, May 27 from the same live events page listed above.

Q23: Thomas - Did it make you tired from all the preparing and work?

A23: Paul- Not just the work, but the dissolved nitrogen that accumulates in the bloodstream during a dive makes it almost impossible for me to stay awake after a dive. My parents actually told me I had to cancel some of my dives because I was too tired to do my homework... but I didn't :-)

Mrs. Jackson/Woodside - Thanks to all that answered our questions. We will watch for your results as SSE continues.

Q24: Ms. Patterson/Bel Aire School - A few last questions. How fast does the sub travel? How do you name new species? What do you hear under the water? Have you ever named an animal? Thank you for talking with us and THANKS for all the work you are doing! Hope to see you soon Mike. Liz

A24: Mike Guardino/Teacher in the Sea - The DW travels about 4 kmp. Organisms are usually named for some aspect of their structure but they may also be named after scientists. The scientific name is the genus and species of an organism: the sea otter is *Enhydra lutris*.

Q25: Jackson/Woodside Middle School - What will you do different next year?

A25: Mike Guardino/Teacher in the Sea - I hope to get donations of scuba gear so that we can continue to offer this program in the future!!!

Q26: Nickolas - Hello, Can you see the lasers on the machine

A26: Mike Guardino/Teacher in the Sea - We used lasers on the video camera we carried and the DeepWorker submarine is also fitted for their use.

Laura Francis - Thanks everyone for joining us today and for the great questions. Hope to chat with you all again next time...

Mike- Better late than never. Sorry it took me awhile to register. First of all, congrats from your old high school chemistry teacher. I am extremely proud of you and your accomplishments. You will be inspiring many future scientists with this kind of adventure.

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WEB CHATS

1999

Meet Dr. Sylvia Earle (summary)

Cordell Bank (summary)

Amazing Ocean Research (summary)

Teacher in the Sea (summary)

Understanding Fishery Issues (summary)

Charting the Sea Floor (summary)

Stellwagen Bank (completed)

Gray's Reef (summary)

Live Events

Return to the current Live Events page

Communicating the adventures and discoveries of the Sustainable Seas Expeditions as they are happening is one of the principal objectives of this Web site. Direct interaction with expedition participants is an important component of that communication. Over the course of the expeditions, we will host a series of about fifteen interactive events.

Two types of events are planned. The first is a Web chat. This is an interactive Internet discussion in which participants pose questions or offer comments to expedition scientists or educators. Generally, the Web chats will have specific topics (e.g., Charting the Sea Floor), but several are more open-ended (e.g., Meet Dr. Sylvia Earle).

Interactive broadcasts are the second type. These are live video uplinks directly from the expedition vessel. These broadcasts also will include interactive questions and comments from viewers.

Active participation in these events requires prior registration. However, no registration is required to observe the events as they happen. Each event will be archived as a permanent record available to the general public.

These events are sponsored by Oceanographic Program in the Earth Sciences (OPES) of the National Aeronautics and Space Administration (NASA). They have been organized, and will be hosted and managed as a partnership between NASA's Quest Project and NOAA's National Marine Sanctuaries Program.

Following is a listing of the of the events with

VIDEO UPLINKS

1999

Monterey Bay (summary)

Channel Islands (summary)

Gray's Reef (summary)

Florida Keys (summary)

Flower Gardens (summary)

Florida Keys (summary)

Flower Gardens (summary)

links to a brief description, the time of the event, and access procedures for registration, participation, and observation.

1999

April 26 **(Web chat)**, *Meet Dr. Sylvia Earle, Chief Scientist of the Sustainable Seas Expeditions*
May 6 **(Web chat)**, *Exploring the Cordell Bank National Marine Sanctuary*
May 14 **(Web chat)**, *Amazing Ocean Research Technologies*
May 18 **(Video Broadcast)**, *Monterey Bay National Marine Sanctuary / Prickly Shark Ecology: The Process of Observation and Analysis*
May 24 **(Web chat)**, *Teacher In The Sea*
May 27 **(Video Broadcast)**, *Channel Islands National Marine Sanctuary / Great American Fish Count*
June 3 **(Web chat)**, *Understanding Fishery Issues*
July 1 **(Web chat)**, *Charting the Sea Floor*
July 13 **(Web chat)**, *Stellwagen Bank National Marine Sanctuary: Welcome to Stellwagen Bank*
July 28 **(Video Broadcast)**, *Gray's Reef National Marine Sanctuary (GRNMS): Technologies Used by SSE and GRNMS*
August 9 **(Web chat)**, *Gray's Reef National Marine Sanctuary (GRNMS): Rivers to Reef*
August 20 **(Video Broadcast)**, *Florida Keys National Marine Sanctuary (FKNMS): Preserving the Beauty of the Keys*
September 2 **(Web chat)**, *Florida Keys National Marine Sanctuary (FKNMS): 1999 SSE Mission Overview/Preserving the Keys*
September 7 **(Video Broadcast)**, *Flower Gardens National Marine Sanctuary (FGNMS): Coral Spawning and Deep Water Habitats*
September 16 **(Web chat)**, *Flower Gardens National Marine Sanctuary (FGNMS): 1999 SSE Mission Overview*

For Further Information

For information on the live events of the Sustainable Seas Expeditions, contact:

Ms. Laura Francis
Sustainable Seas Expeditions
Education Coordinator
NOAA's Channel Islands National Marine Sanctuary
113 Harbor Way
Santa Barbara, California 93109
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For more information on NASA's Oceanographic Program in the Earth Sciences, or NASA's Quest Project, contact:

Ms. Andrea McCurdy
Internet Event Producer
NASA Quest
Ames Research Center
MS:T28-H
Moffett Field, CA 94035

andream@quest.arc.nasa.gov

or visit these NASA Web sites:

Earth Sciences: www.earth.nasa.gov
Quest Project: quest.arc.nasa.gov

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April 26, 1999
Web Chat Summary

10:30 am to 11:30 am Pacific time (1:30 to 2:30 pm eastern time)
Meet Sylvia Earle, Chief Scientist of Sustainable Seas Expeditions

Dr. Sylvia Earle

Introduction

The Sustainable Seas Expeditions is a five-year project of deep-water exploration and public education in NOAA's National Marine Sanctuaries. During this hour chat you will have the opportunity to meet and interact with Dr. Sylvia Earle, Project Director and Ms. Francesca Cava, Project Manager.

As Chief Scientist for the Sustainable Seas Expeditions, Dr. Earle will be integrally involved in all of the research missions being conducted at each sanctuary. She brings to the Expeditions a life-long career of ocean exploration and a commitment to helping each of us better understand the role of the oceans in sustaining a healthy planet. You will also meet the Project Manager for the expeditions, Ms. Francesca Cava who is responsible for expedition planning, day-to-day operations, logistics for the DeepWorker submersibles and encouraging new partnerships with other marine institutions. She has had an extensive career in marine research, management and policy.

Sylvia and Francesca joined the chat from Bodega Bay, California where they attended a sanctuary summit for local high school students, one of the expedition's educational initiatives. Sylvia, sanctuary staff, and the students at the summit discussed the upcoming exploration of the Cordell Bank National Marine Sanctuary and ideas for student projects for next year's expedition.

Click **here** to view the video or **here** for audio only of 'The 1998 Year of the Ocean Student Summit with Dr. Sylvia Earle, Explorer-In-Residence, The National Geographic Society'.

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Highlights

Ms. Francesca Cava and Dr. Sylvia Earle shared many facts about the ocean and the impact that we are having on this natural environment. They shared that a primary goal of the Sustainable Seas Expeditions is to raise public awareness of the importance of preserving the oceans. Sylvia observed that, "The sea is the cornerstone of our life support system. When we damage the health of the ocean, we are compromising our own future. But with knowing comes caring, and with caring there is hope that we'll find an enduring place for ourselves among the natural systems that sustain us."

There was considerable discussion of the DeepWorker and its role in expedition research. As Francesca described, "I made my first submersible dive last fall in Monterey where we started our dive training. Its truly one of the most exciting experiences of my life, being in the ocean without being cold or wet and staying down much longer than possible with scuba."

Both experts gave advice on what each of us can do to help the oceans. Sylvia called everyone to action, "learn everything you can about the ocean; share what you know. Make an effort to go see the sea for yourself. Learn to dive. Take someone younger than you to an aquarium. Also, take someone older -- get them excited about doing something positive to take care of the ocean that takes care of us all."

Andrea McCurdy
Web Chat Coordinator

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Web Chat Transcript

Dr. Sylvia Earle, SSE Project Director and Francesca Cava, SSE Project Manager

Laura Francis- Dr. Sylvia Earle and Francesca Cava have arrived and we are going to start the chat in a couple of minutes.

Laura Francis- We are underway and accepting questions For Dr. Sylvia Earle ,

Project Director and Francesca Cava, Project Manager for Sustainable Seas Expeditions.

Q1: Jason- Where did the idea for the DeepWorker come from?

A1: Francesca Cava- The idea of using the DeepWorker came about from several directions. First, from Sylvia Earle's desire to bring the mysteries and importance of the national marine sanctuaries to everyone through exploration beyond scuba depth. At the same time, new technology, the DeepWorker, made it possible for the first time for one person to dive to depths of 2000 feet. The important new dimension of the DeepWorker was its size. Relatively speaking, its much smaller than other subs, and therefore easier and cheaper to launch and recover. One of its predecessors, for example, DeepRover weighs 12,000 pounds, while the DeepWorker, only weighs about 2,500 pounds. Just as importantly, the National Geographic Society, NOAA and the Goldman Fund also made the resources available to make these expeditions possible. So it might be fair to say this whole event happened because one person had a dream, one company made the technology possible and several organizations pledged the resources to make the entire project possible.

Q2: Jessica- For Sylvia and Francesca - when did you do your first dive? What was it like?

A2: Francesca Cava- I made my first submersible dive last fall in Monterey where we started our dive training. Its truly one of the most exciting experiences of my life, being in the ocean without being cold or wet and staying down much longer than possible with scuba. Sea lions also thought I was pretty interesting as they began to come up to the sub dome and blow bubbles in my face while checking me out.

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Q3: Alana- I know that one person alone can do their part to save the oceans, how can we influence others besides ourselves to help save the oceans also?

A3: Francesca Cava- One way to get others interested in the ocean is to show how it is important to them. You can do that by explaining that without the ocean there would be no life. Or that the ocean holds over 97% of life on earth. You can also show people what is there. Once someone knows what is in the ocean and what we may be doing to affect that system, they will begin to care about what's happening in the ocean. In Santa Barbara, where I live, for example, more and more people are caring about the ocean since beaches have been closed down because of increases in pollution. Now the ocean is affecting them and they are beginning to take more

notice.

Q4: Mellie- Francesca, How long can you stay down in DeepRover? Is a dive in DeepRover considered a saturation dive?

A4: Francesca Cava- Theoretically you can stay down in the DeepWorker for about 106 hours, but I'm not sure you would want to since quarters are very tight and there are no bathrooms aboard. Normally, a dive is anywhere from two to six hours, although some have pushed it to 12 hours or so. Since you are kept at one atmosphere in the sub, there is no decompression needed and therefore this is not considered a saturation dive. This answer applies both to the DeepWorker and DeepRover even though they are two different subs.

Q5: Mark- Why didn't they make the DeepWorker a two person submersible?

A5: Francesca Cava- Actually there are two person DeepWorkers as well as one person DeepWorkers. The reason for the one-person sub is that it is so easy to use you don't need a separate pilot. This makes it less expensive to operate and much easier for anyone to use the sub as they need to and when they need to. It also makes the sub easier to launch and recover off a ship since it is smaller and lighter.

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Q6: Diana- What will happen at the end of the five year expedition?

A6: Francesca Cava- First, we hope that although this expedition was planned for five years that it doesn't end in five years. The ultimate goal of the expedition is to inspire in all of us the thirst to know more and understand how the ocean is changing. Our findings on the sub will not answer all the questions in five years, but open the door for others to continue on with ocean exploration and research.

Q7: Mr. Choate- What would you say to our class about saving the oceans? Many of us have never visited an ocean coast.

A7: Francesca Cava- If I could say one thing to your classroom about saving the ocean is that now they have the opportunity to do something that would really make a difference. For the first time in history what we are doing on land whether near the ocean or not is affecting the ocean in an unprecedented way. We are taking more out

of the ocean and putting more in the ocean than ever before and these actions are now having enormous impacts. If we don't start to understand these impacts and changes our actions now, we may see changes in the ocean that we can't reverse.

Q8: Kyle- Do you think that the Sustainable Seas Expeditions will promote the establishment of new National Marine Sanctuaries?

A8: Francesca Cava- Yes, I hope that once people see what sanctuaries mean they will begin to understand why we need them. One way you can think about it is to think about where you live. Before there were houses it was easy to designate areas as parks, but after people began to use the land, it was harder to go back and make natural areas to preserve what is there. The same thing applies to the ocean. We need to set aside areas today to preserve them for tomorrow. So far we have allocated less than 1 % of the US ocean areas as national marine sanctuaries. Whole areas of the ocean are still missing, say Alaska, for example.

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Q9: Mr.Choate- What would you say to our class about saving the oceans? Many of us have never visited an ocean coast.

A9: Sylvia Earle- Knowing about the ocean is the first step toward taking care of it. More has been learned about the sea during the past half century than during all preceding human history, yet less than 5% of the oceans have been truly explored. If everyone recognized that the sea is the cornerstone of earth's life support system - - generating oxygen, absorbing carbon dioxide, driving climate and weather, shaping planetary chemistry, providing 97% of the biosphere (living space) -- more care would be taken not to harm the way the ocean works. Trouble comes from many directions. What people put into the ocean, either deliberately or inadvertently, causes many of the problems we now face. Everyone can help reduce the use of excess fertilizers, pesticides, herbicides, etc., that flow into the sea via groundwater as well as through streams and rivers. Toxic algal blooms are among the consequences of allowing too much runoff from lawns, golf courses, farms and fields. What we are taking our of the ocean is another source of problems. Many people think of fish as a commodity -- something to eat, rather than in the broadest sense, as vital components of the ocean ecosystems. True, too, of lobsters, shrimp, clams, etc. -- They are all wildlife, to be equated with birds and others creatures on the land. If we start thinking about fish the way we began some years ago to think about birds, there might be a stunning change in what appears in our supermarkets and on our plates. That is, we eat birds, of course -- chickens, turkey, ducks and sometimes geese -- but most birds are valued for other reasons and are protected. Most of the birds eaten by people are cultivated; most of the fish are not. If people realized that it may take 100,000 pounds of plants at the end of a long and complex food web to make a pound of ten year old tuna, as compared to about 2 pounds of plants to make

a pound of chicken or catfish, they might not be so eager to munch tuna sandwiches or salads or sushi . . . and if they did, they should do so with great respect. Many fish that appear now in markets take decades to mature and may live to be older than your grandparents. Orange roughy, a deep sea fish caught mostly around New Zealand and Australia, takes 30 years to mature and may live to be 150 years old. Monkfish and the so-called "Chilean Sea Bass" are common today on menus around the world but will certainly not be there for long. They, too, live a long time, reproduce slowly and are vulnerable to the industrialized methods of capturing wildlife from the sea that are now employed. The methods used are another source of problems -- both because of destruction of the habitat where the targeted species live, and because many creatures are captured and killed in the process of obtaining those desired. For example, 5 to 10 pounds of "by-catch" -- starfish, juvenile fish of many species, crabs, sponges, corals, sand dollars, and numerous other creatures -- are scooped up in the process of taking a pound of shrimp. People who want to make a difference can choose not to eat fish that are more important swimming alive in the ocean than swimming in lemon slices and butter. So -- learn everything you can about the ocean; share what you know. Make an effort to go see the sea for yourself. Learn to dive. Take someone younger than you to an aquarium. Also, take someone older -- get them excited about doing something positive to take care of the ocean that takes care of us all.

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Q10: Mr.Choate- What was the most important thing about your own education that resulted in your great concern for the oceans?

A10: Francesca Cava- Luckily for me I lived in many places when I grew up. I lived in Europe, the Orient and the US. Perhaps it was the contrast in these areas that made me aware of how different parts of the world were - some areas were very crowded with people, like the Philippines, whereas others like Alaska were relatively untouched. This wasn't formal education, but it led to decisions in my life on what to focus on as I chose areas to learn about and ultimately led to my decision to start to work at NOAA. After starting my work at NOAA, I came to realize how much more I needed to learn about the ocean. Unfortunately, there weren't as many formalized education opportunities about the ocean as when I was in school and most of my education has been on the job.

Q11: Jessica- For Sylvia and Francesca - when did you do your first dive? What was it like?

A11: Sylvia Earle- My first dive took place years ago in Florida. My brother, a next door neighbor and I borrowed a copper diving helmet of the sort that sponge divers use, along with an air compressor and some lead weights, and went to the Weekiwatchee River to see the fish on their own terms. It was hard to believe that I

could actually breath underwater, but once I got used to it, I really enjoyed watching the fish, including a large gar that seemed intent on watching me. The following year I used scuba for the first time and since then, have dived thousands of times in many parts of the world. Right now, I am excited about using a new diving system, "DeepWorker" -- a one person submersible that maintains surface pressure throughout its full depth range, down to 2000 feet. I have used other one person subs to as much as 3300 feet -- and can tell you, it's fantastic to be able to descend through sunlit waters into increasing darkness -- with small, medium, and sometimes very large creatures for company. Many are bioluminescent -- It is like falling into a galaxy of stars created by the sparkle, flash and glow of creatures who generate their own light, like fireflies.

Laura Francis- Dan Howard, Assistant Manager of NOAA's Cordell Bank National Marine Sanctuary has just joined us. Dan is also a DeepWorker Pilot and has been out on the NOAA ship McARTHUR for the last ten days. He is looking forward to answering your questions.

Q12: Tom- Sylvia, Are you alarmed by the rate at which some fisheries are being depleted? How much of this is from pollution or unknown impacts worldwide rather than overfishing?

A12: Sylvia Earle- Am I alarmed about the swift, sharp decline in numerous marine species? Absolutely! I believe that future generations will look back on us with horror for not taking action sooner to stabilize the natural ocean systems that are the cornerstone of Earth's life support system. While pollution and other factors are implicated in the collapse of cod, swordfish, many kinds of tuna, flounder and more than a hundred other marine organisms, there is no doubt that taking too many fish using brutally destructive techniques is far and away the most direct and serious cause.

Q13: Kyle- What percentage of a fishery must be designated a No-Take Zone in order for it to be an effective method of management?

A13: Dan Howard- The percentage would really depend on the species of fish and their reproductive strategy. For example, a species like rainbow surfperch give birth to live young who remain in the same area as their parents. With this type of reproduction, you could protect a well defined area known to be surfperch habitat. Rockfish on the other hand, exude 8mm larvae that float freely as plankton in oceanic currents for the first month or so of their life. The dispersal of rockfish young and the unpredictability of where they go, make determining the size of no take zones very difficult. Biologists are currently conducting research to try and answer that very

question. In an area like the Gulf of the Farallones that is habitat for species with both strategies another layer of complexity is added.

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Q14: Ali- I am currently participating as a Student in the Sea by collecting data on SCUBA with The Teacher in the Sea in the Monterey Bay sanctuary. Will students ever be trained as DeepWorker pilots?
A14: Francesca Cava- Ali, its interesting that you asked this question because its one we are currently grappling with. Since the expeditions are 5 years we have the opportunity to do more in the future - and perhaps we could start a Student at Sea program. We'd like to! But what we need to know to get a Student in the Sea program working is what would our goal be, what would the student want to do, how long should it be, etc. I'd be very interested in hearing what your input would be on this question.

Q15: Ali- What advice do you have for a senior in high school that wants to pursue marine biology as a future career?

A15: Dan Howard- Hi Ali, my advice would be to volunteer somewhere in the next few years while you are attending college. Find a place near school or do something in the summer. This will give you an opportunity to see if it's something you really want to do and also give the people a chance to get to know you. It's easier to hire someone if you know what their work habits are.

Q16: Mike- Do you plan to explore the Monterey Submarine Canyon while you are in the Monterey Bay sanctuary ?

A16: Francesca Cava- Mike, we do plan to explore parts of the Monterey Submarine Canyon, but of course, will be limited to the safe working depth of the sub - 2,000 feet. Another operational consideration is that the sub should only operate in water depths that the sub is capable of diving in. Therefore, if we know the canyon falls off deeper than 2000 feet in some places, even though we can go to 2000 feet we must stay clear of that area just in case there is an accident.

Q17: Ali- Have you discovered anything out of the ordinary during the Sustainable Seas research that has already been conducted? If so what?

A17: Dan Howard- What we are finding out in this first few days it that the DeepWorker appears to be a very good tool for conducting research underwater. It was not known if one person could operate the sub and collect data at the same time.

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Q18: Kyle- What percentage of a fishery must be designated a No-Take Zone in order for it to be an effective method of management?

A18: Sylvia Earle- Many are debating the issue of how large a "no take" area must be, but I personally think we're asking the wrong question. Rather, we should say, "Demonstrate first that what you are taking and where you are taking and how you are taking and how much you are taking and when you are taking is not disrupting these populations" -- then decisions can be made about how large an area can be devoted to the enterprise. We need to shift the burden of proof concerning the whole business of hunting wildlife in the sea on an industrial scale. A more direct answer to your question is that 20% of the ocean is being seriously recommended by some for "no take" designation. Presently, however, a small fraction of one per cent has been designated for any kind of protection -- and less than 1% of that for "no take."

Q19: Charles Young at Palm Beach Day School- JACQUES COUSTEAU once predicted that the oceans are dying. Can I tell my students that we have turned the corner and that they are no longer declining in condition and are now steadily improving?

A19: Sylvia Earle- I wish I could say yes, but I cannot. The sea continues to suffer from the combined impact of what we are putting in -- excess fertilizers and biocides and more from farms, fields, lawns, golf courses -- and what we are taking out. Nearly 100 million tons of wildlife are being taken from the sea every year, and the effort to remove more is increasing, despite collapse of more than 100 species once thought to be so abundant that little could be done to reduce their numbers. But there is real cause for hope. The first step toward solving problems is to recognize that they exist, and there is growing awareness that the oceans now are in trouble. The most important corollary to that is -- "and therefore, so are we." The sea is the cornerstone of our life support system. When we damage the health of the ocean, we are compromising our own future. But with knowing comes caring, and with caring there is hope that we'll find an enduring place for ourselves among the natural systems that sustain us.

Mellie - Thank you Francesca, Dr. Earle and Dan. This has been excellent. Can't wait for the next chat on May 6th to learn about Cordell Bank National Marine Sanctuary.

Laura Francis- Thank you all for joining us on the first chat of the Sustainable Seas Expeditions Project. A special thanks to Dr. Sylvia Earle, Francesca Cava and Dan Howard for taking time to answer your questions. Join us again on May 6th to talk with Dan Howard for a discussion about Sustainable Seas Expeditions in NOAA's Cordell Bank National Marine Sanctuary. Visit the live events web site for SSE -

http://sustainableseas.noaa.gov/aboutsse/liveevents/liveevents.html

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May 6, 1999
Web Chat Summary

10:00 am to 11:00 am Pacific time (1:00 to 2:00 eastern time)
Exploring the Cordell Bank National Marine Sanctuary

Introduction

Mr. Dan Howard, assistant manager of the Cordell Bank National Marine Sanctuary, hosts this chat to review the findings and new discoveries of the first expedition. As the mission coordinator for the sanctuary, Dan is a trained DeepWorker Pilot and has participated first-hand the Sustainable Seas Expeditions investigations conducted at this site.

Dan Howard

About 39 miles (45 nautical miles) northwest of the Golden Gate Bridge, at the edge of the continental shelf, Cordell Bank rises from the sea floor. Most of the water around the bank is about 200 feet deep. Along a few of its ridges and pinnacles, this seamount rises to within 120 feet of the ocean surface. Here nutrient rich upwellings of ocean waters and the bank's underwater topography create one of the most biologically productive areas on the West Coast. Cordell Bank has been identified as one of the most critical and fragile fisheries habitats in California

During the first year's expedition, researchers will survey Cordell Bank and assess habitats, algae, invertebrate, and fish populations. A second objective will be to investigate fishing impacts on the bank. The missions will help inventory and characterize sanctuary resources by describing community structure at Cordell Bank and establish monitoring sites and transects for baseline and long term studies.

To learn more about the Cordell Bank National Marine Sanctuary, please visit this NOAA web site:

www.sanctuaries.nos.noaa.gov/oms/omscordell/omscordell.html

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Highlights

On May 6, 1999, we chatted with Dan Howard, Assistant Manager of the Cordell Bank National Marine Sanctuary. Dan had just returned from the McArthur where he had been part of the mission team for the first two expeditions.

When asked how it felt to be back onshore he replied, "Mixed emotions really. Being at sea you get into a different mode of operation. The only focus is the days dive activities with no other distractions except whales breaching and seabirds flying by. But it's good to get back to my family."

During the chat Dan talked about his many adventures studying the Marine Sanctuaries. He told a short story about an adventure he once had while doing white shark research, "I've helped the biologists at the Farallon Islands with their white shark research. When they attack an elephant seal, we sped out in a small boat to film them. I've never seen one while diving which is fine with me!"

There were also many questions about the DeepWorker and the unique role it will play in marine research. One question was about whether or not SSE planned to use the submersible to do live captures of the habitat. Dan told participants, "I'm sure DeepWorker could do live captures but we would need to rig some type of device to so it. We have a manipulator arm, have many design ideas for live capture. We could measure the animals and then let them go."

(top) RETURN

Web Chat Transcript

Dan Howard, Assistant Manager of Cordell Bank National Marine Sanctuary

Laura Francis- Dan Howard has arrived. He has just returned from the first two Sustainable Seas Expeditions in NOAA's Gulf of the Farallones and Cordell Bank National Marine Sanctuaries.

Laura Francis - Dan just got off the ship at 11:00pm last night - How does it feel to be back on land after 3 weeks on a ship? Mike and others who have joined, please tell

us what city and or school you are from in your handle.

Dan Howard- Mixed emotions really. Being at sea you get into a different mode of operation. The only focus is the day's dive activities with no other distractions except whales breaching and seabirds flying by. But it's good to get back to my family.

Q1: Kellie - As I have not yet had the opportunity to see DeepWorker, could you tell me what capibilities it has.

A1: Dan Howard - Hi Kellie, The DeepWorker is like an underwater go-cart. We can go to 2000 feet and stay down for 80 hours in an emergency. Most of our dives will be about 2 hours.

Q2: Ashley, 5th Grade, Montessori School of Corona - Dan, is your job what you always wanted to be, if not what was it?

A2: Dan Howard -Hi Ashley, I always knew I wanted to do something that involved working outdoors. Since I grew up near the coast in California, marine biology was kind of a natural choice for me.

(top)

Q3: Ashley, 5th Grade, Montessori School of Corona - How long have you been an assistant manager?

A3: Dan Howard -It's been 5 years now. Time flies when you're having fun.

Q4: Kellie - Can DeepWorker do live captures? Is that something this project (Sustainable Seas) is interested in?

A4: Dan Howard - I'm sure DeepWorker could do live captures but we would need to rig some type of device to so it. We have a manipulator arm, have many design ideas for live capture. We could measure the animals and then let them go. Send me your ideas.

Q5: Jason, 5th Grade, Montessori School of Corona - Why do you always have to

get along with the other workers?

A5: Dan Howard - Jason, when you're living on a boat with 20 other people, it's very important to try and get along. There is no place to hide except the bathroom or head as it's called on a ship.

Q6: Jason, 5th Grade, Montessori School of Corona - For your job have you got to met anyone important, like the President?

A6: Dan Howard - As a matter of fact the president likes jogging by our office so I have met him. I've also had a chance to meet Sylvia Earle who is the leader of our expedition from National Geographic.

Q7: Rhonda, Lincoln Elementary, Springfield - What did you learn during the first two missions?

A7: Dan Howard - I learned that no one can fool mother nature. We tried dancing and chants but the wind still blew so hard it was hard to work sometimes.

(top)

Q8: Yash, 4th Grade, Montessori School of Corona - Have you ever been in a scuba or seen anything dangerous?

A8: Dan Howard - Hi Adam, I've been scuba diving for 20 years and have only seen a couple sharks. They were just as scared of me as I was of them. The closest I came to getting hurt was when I picked up a poisonous cone snail in Hawaii and didn't know it could hurt me.

Q9: Mellie, Atholton Elementary School - Dan, will DeepWorker be used in the Florida Keys National Marine Sanctuary?

A9: Dan Howard - The DeepWorker will be in Florida in August. Make sure you go and check it out. I bet they'll have an open house where you can go see the subs.

Q10: Yash, 4th Grade, Montessori School of Corona - Are you comfortable

working with animals that can kill you?

A10: Dan Howard - Most animals don't eat people on purpose so I hope they don't make a mistake while I'm in the water.

Q11: Neeraj, 4th Grade, Montessori School of Corona- Have you ever seen a great white shark in person?

A11: Dan Howard - I've helped the biologists at the Farallon Islands with their white shark research. When they attacked an elephant seal, we sped out in a small boat to film them from the boat. I've never seen one while diving which is fine with me!

Q12: Kellie -To expound on Ashley's question, could you fill us in on your educational backround.

A12: Dan Howard - I graduated from Humboldt State with a degree in fisheries biology.

Q13: Yash, 4th Grade, Montessori School of Corona - Have you seen an animal that you never seen but you thought someone else had probably seen it?

A13: Dan Howard - We hope to discover new plants and animals using the DeepWorker subs. The subs can go much deeper than divers so maybe we'll see something that's never been seen before.

(top)

Q14: Kellie How well have these expeditions met the objective of assessing populations? Fishing impacts? I realize that not many expeditions have been done to date, but how does it look?

A14: Dan Howard - We've finished two expeditions so far and the DeepWorker subs are a great tool for assessing populations in deep water. We have great vision in the dome and we have video cameras mounted on the front of the sub to record everything we see.

Q15: Landon and Amber, 5th Grade, Montessori School of Corona - Do you think there are over two million animals in the ocean?

A15: Dan Howard - Yes, the ocean is full of animals but many of them are so small you need a microscope to see them.

Q16: Ashley, 5th Grade, Montessori School of Corona - Have you ever touched a whale? If so how did it feel? Were you excited?

A16: Dan Howard - No, I've never touched a live whale and we need to be careful not to bother them when they are in the ocean.

Q17: Landon and Amber, 5th Grade, Montessori School of Corona - How does the submarine get in the water?

A17: Dan Howard - We launch the sub from a 175 foot boat called the McArthur. We lift it from an A-frame with a cable, then lower the subs into the water as the A-frame tilts back.

Q18: Ashley, 5th Grade, Montessori School of Corona - Can you estimate how many krills and shrimps there are in the ocean? How close have you ever came to a whale or dolphin?

A18: Dan Howard - Estimating how many krill are in the Gulf of the Farallones is one of the projects we are currently working on. Their numbers really change from one year to the next depending on how much food is available

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Q19: Mellie, Atholton Elementary School - Thanks for letting us know DeepWorker is coming to the Florida Keys National Marine Sanctuary in August. How will it be transported from sanctuary to sanctuary? Will it be deployed from the McARTHUR?

A19: Dan Howard - The DeepWorkers will be driven on a truck from the west coast to the east coast. They will be deployed from a couple different NOAA vessels once they get there, but the McARTHUR stays on the west coast.

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Q20: Landon and Amber, 5th Grade, Montessori School of Corona - How does it feel to be an assistant manager of NOAA's Cordell Bank National Marine Sanctuary, Dan? What do you do?

A20: Dan Howard - It feels pretty good most of the time. My favorite part is working outside especially on an exciting project like the Sustainable Seas Expedition.

Q21: Ashley, 5th Grade, Montessori School of Corona - Have you ever worked on anything except what you do now?

A21: Dan Howard- I studied kelp beds and fish for about 15 years before I started working at the sanctuary.

Q22: Jose - Could you tell me how the sanctuary program uses the "Enviroment Hat" as part of its annual sampling program?

A22: Dan Howard - The Environment Hat was developed in the late 70's to sample the upper layers of the water column. The wide brim and deep recess were far superior to early samplers and kept the animals in very good condition.

Q23: Thomas, Lincoln Elementary, Springfield - Are there any shipwrecks in your sanctuary?

A23: Dan Howard - The San Agustin sits somewhere in Drakes Bay and is the first documented shipwreck in California. It sank during a storm in 1595.

Q24: Ashley, 5th Grade, Montessori School of Corona -Have you saved a whale? Are there such things as mermaids? If so have you seen one? Are you going to take a dive with Carmam High school? What is Channel island?

A24: Dan Howard - I've been involved in a couple of whale rescues but I'm still waiting to see my first mermaid. Any ideas where I might find one?

Laura Francis - Well, that wraps up today's chat. A special thanks to Dan Howard for sharing his experiences with the Sustainable Seas Expeditions, and to all of the folks out there who asked some fantastic questions. Please join us on May 14 for the next chat on "Amazing Ocean Research Technologies" with Francesca Cava, Sustainable Seas Expeditions Project Manager and other ocean experts. In the meantime, you may want to check out the NOAA ship McArthur web page to see images from the crew of the Expeditions -

http://www.pmc.noaa.gov/mcarthur/.

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May 14, 1999
Web Chat Summary

10:00 am to 11:00 am Pacific time (1:00 pm to 2:00 pm eastern time)
Amazing Ocean Research Technologies

Introduction

Ms. Francesca Cava, as the SSE Project Manager, is responsible for the day-to-day operations and logistics for the DeepWorker submersibles. Andy Shepard is with NOAA's National Undersea Research Program. During this chat Francesca and Andy provided an overview of the various technologies used in marine exploration, monitoring and research. They shared the unique role of many different types of tools, including Remotely Operated Vehicles (ROVs) used for conducting undersea investigations.

Francesca will join us in the chat room from the McARTHUR, while Andy will join us from his NOAA office in Maryland. They provide an overview of the various technologies used in marine exploration, monitoring and research, and will share with you the important role of these tools in undersea investigations. The DeepWorker 2000 a technology developed for the SSE project that allows researchers to personally explore ocean depths to 2,000 feet below the surface. The discussion will also review the role of remotely operated vehicles used to conduct robotic exploration in areas of the ocean that could not otherwise be explored. Finally, these two marine experts will highlight how these technologies are helping managers gain a better understanding of the important habitats and key species in our national marine sanctuaries and how they can be used to help develop permanent field monitoring stations at each of the sanctuary sites.

Come talk with Francesca and gain a personal understanding of these fascinating technologies.

To learn more about DeepWorker, click **here**.

To learn more about the use of remotely operated vehicles, see:

http://www.mbari.org/rd/tiburon/index.html

To learn more about NOAA's National Undersea Research Program, see: http://www.nurp.noaa.gov/

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Highlights

During this discussion with Francesca Cava, SSE Project Manager and Andy Shepard with NOAA's National Undersea Research Program, the DeepWorker was discussed in great detail. Andy was located in Silver Springs, Maryland, while Francesca joined the chat room from onboard the ship McARTHUR as it conducted the SSE mission to explore the Monterey Bay National Marine Sanctuary. The discussion was primarily focused on the DeepWorker and the benefits and innovations that it brings to underwater research.

The DeepWorker offers some of the best visibility yet experienced in a submersible. As Francesca noted, "You are surrounded by a big plastic dome which almost disappears when you go into the water." This unobstructed field of view, coupled with the sub's great maneuverability, offers the researcher/pilot near-SCUBA experiences in depths that divers can never reach.

In addition, the DeepWorker is built from mostly off-the-shelf technology, allowing its designers to work with best of class materials and navigation techniques. As a result the SSE program can more readily train scientists and others to dive without the need for a dedicated pilot. This change has created a significant cost reduction, and thus enables SSE to introduce the submersible experience to more people. As Andy observed, "about 2/3 of the pilots are scientists. The others include educators and environmental managers."

Both Francesca and Andy encourage all of you chatting to keep pursuing your own ideas for marine exploration and understanding as this is considered the key to future innovations!

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Web Chat Transcript

Laura Francis- Welcome to the "Amazing Ocean Research Technology" chat session. Francesca Cava, Sustainable Seas Expeditions Project Manager will be joining us this morning from the NOAA Ship McARTHUR and Andrew Shepard with NOAA's National Undersea Research Program will be joining us from Silver Spring, MD. We will get started in about 5 minutes...

Laura Francis - Hi students, welcome to the chat we should be able to get some answers to your questions in just a minute...

Q1: Liz and 4th grade - Hi, my students have many questions and I will type them in. Please let me know if there are too many, too fast, etc. How much did it cost to build the sub? How long did it take to make? What is the most unusual animal/fish you have seen? How fast does it go? What clothing do the scientists wear in the sub? Was the sub fun to make? How long has the longest trip under water been?

A1: Andy Shepard - Hi, Andy Shepard from the National Undersea Research Program. DeepWorker costs about $500,000. It may only take a year to build one but this sub is the product of twenty years of development. The air cleaning system (scrubs out carbon dioxide) was on one person suits from the 1970s. The most unusual critter I have ever seen myself was a cirrate octopus. It floats in the water column in deep water, more than 1000 feet deep. It is shaped like a bell and it has what look like ears on its head that flap to propel it. Its arms are webbed together like a ducks foot and inside the bell each arm has hundreds of little arms that capture food and move it to the mouth. It floats peacefully. Inside the DeepWorker we can wear shorts but only for a couple of hours. Sooner or later the sub will approach the water temperature which is often less than 50 degrees in deep water. Longest trip underwater so far has not been long because we are training. It can stay down for hours.

Q2: Laura Francis - Welcome to the web chat. We are just getting the connection set up with the ship. Francesca, How is the weather out there?

A2: Francesca Cava - Laura, Hello there! We have great weather out here just off of Santa Cruz. For the first time, less than 10 knots of wind, no fog, no swell. Perfect conditions for launch and recovery of the subs. Unfortunately, we are having trouble with the camera system and we're trying to fix those right now.

Laura Francis - Thanks for being patient everyone. We are trying a new system from the ship and seem to have everything up and running now. Francesca and Andy are ready for more questions.

Q3: Liz and 4th grade - Hi, My class and I have many questions? How many square feet is it? Do those who go down ever feel claustrophobic? How many people have gone down in it? How deep have you been so far? How deep do you want to go? Is it scary to go down? How much did it costs to build? What was the scariest animal or fish have you seen? What is the biggest animal you have seen in the ocean? What is the smallest animal/ fish have you seen? How long can you go down for? What do you do if you need to use a restroom? How many dives can be made in a day? Can you dive in the middle of the night? Is there any difference between the life you see during a day dive and a night dive? What time of day do you usually dive?

A3: Francesca Cava - Liz, Piloting the subs is great fun. For the first time you can be in the ocean, warm and dry with 360 degree visibility. You don't have the time constraints you have as a scuba diver - usually you run out of air after about an hour. With the subs, you can stay for 2-6 hours at a time and really get a chance to check things out. Liz, Luckily when you are in the sub, you are surrounded by a big plastic dome that almost disappears when you go in the water - so you are not claustrophobic. We have trained over 60 people as DeepWorker pilots and already over a dozen have been diving on the Expedition. Another benefit of the sub is that you can dive at night, and we have. Then you see another whole world down there then you would see in the day - different kinds of fish, different kinds of behavior, etc.

Q4: Liz and 4th grade - Hi, My class and I have many questions? How many square feet is it? Do those who go down ever feel claustrophobic? How many people have gone down in it? How deep have you been so far? How deep do you want to go? Is it scary to go down? How much did it costs to build? What was the scariest animal or fish have you seen? What is the biggest animal you have seen in the ocean? What is the smallest animal/ fish have you seen? How long can you go down for? What do you do if you need to use a restroom? How many dives can be made in a day? Can you dive in the middle of the night? Is there any difference between the life you see during a day dive and a night dive? What time of day do you usually dive?

A4: Andy Shepard - No more sugar for Liz and her class. I'll try to answer some of your questions. The DeepWorkers are the size of an airline seat and very comfortable. The glass dome helps you feel like you are in the open so you don't feel claustrophobic. We have not gone deep yet, maybe 150 feet but these subs are designed to go to 2000 feet. Scariest animal-- none, once you are underwater with them. A rest room? Good question. . .next one? No, there are few rules before you go on a long sub dive-- always go to the bathroom before you leave the deck and always bring your "safety" bottle. A small sub like DeepWorker can make many dives each day but needs to have its batteries charged after about 4 hours of running. We will dive at night if conditions are right (calm seas). Life at night is very different then what we see in the day. Just like fish gain shelter by hiding under rocks, they also live at different times of day for protection. We usually dive during the daylight because it

is easier to see, both underwater and when we are launching and recovering the subs.

Q5: Charly/Hawaii Prep Academy - How is this technology more innovative than any other submersible in existence today?

A5: Francesca Cava - Charly, In some ways the technology is not just more innovative, but it has had the benefit of all the previous discoveries allowing us to take the best of what has already been done. That way we have been able to make the sub smaller and lighter, a big advantage in the launch and recovery procedure. Also, over the years, much of the technology has become simpler to operate and now we can test our concept that we can quickly train scientists and others to dive without the need of a dedicated pilot. Again, having one less person makes our operation easier and less expensive.

Laura Francis - Those of you that are out there observing the chat, please go ahead and post your questions.

Q6: Charly/Hawaii Prep Academy - How is this technology more innovative than any other submersible in existence today?

A6: Andy Shepard - Charly, DeepWorkers are different from other one-person subs in some big and little ways. They are smaller and more maneuverable than the DeepRover subs of the 1980s. Some of these changes are made possible by technology (light stronger thruster motors) and some by engineering innovations of Nuytco engineers, such as the foot pedals that do all the driving. The subs may serve two people in the future, although I do not know when. Essentially it would be like creating a pop-bead chain-- two spheres will be mated together.

Q7: Charly/ Hawaii Prep Academy - Will the DeepWorker ever be able to accommodate two people for research and educational projects?

A7: Francesca Cava - Charly, There are two versions of the sub; one that allows for 1-person and the second that allows for two people. However, even the 1-person sub can be used for both education and research. In fact, next Tuesday our project will have a teacher, Mike Guardino from Carmel High School diving. He has been working with several students to design and take part in his dive project.

Q8: Juliette/Topanga Canyon - What exactly (research-wise) are these submersibles doing? Where are they exploring and is anyone in the water right now?

A8: Andy Shepard - Francesca will probably handle this one best. They are exploring the National Marine Sanctuaries and the only comment I want to make is that these areas are often in the kinds of ocean scapes that must be explored and visited to understand them-- places like coral reefs and ship wrecks.

Q9: Juliette/Topanga Canyon - What exactly (research-wise) are these submersibles doing? Where are they exploring and is anyone in the water right now?

A9: Francesca Cava - Juliette, I am now on the NOAA ship McARTHUR in the plot room answering you questions and Bill Duoros, Superintendent of the Monterey sanctuary is in the water making a check-out dive right here off Santa Cruz. Bill has several projects he hopes to take on including a better understanding of just what lives in the sanctuary he is trying to protect and to determine first hand what is its health.

Q10: Liz and 4th grade - Are most of the people using DeepWorker researchers? How many educators/ others?

A10: Andy Shepard - I do not have the numbers, but I would guess about 2/3 of the pilots are scientists. The others include educators and environmental managers

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Q11: Liz and 4th grade - Can you eat down there? Are you too excited by what you are seeing? Have there ever been any close calls (water leaking, electrical problems, etc.) What kind of training do you have?

A11: Andy Shepard - Liz-- I thought maybe you guys were into food. Sure you can eat, but you are usually way too excited and involved in being a fish to think about anything else. When I think of "close call" in this business, I think of a life-threatening situation. There has not been such an event with the DeepWorkers. There has been a few minor incidents-- for example, Bill Douros who is on the ship with Francesca, had some electrical problems which I heard he handled quite well. In fact, one atmosphere submersible diving is the safest way "to fly" underwater.

Q12: Eric Mendelsohn - Are researchers the market for this sub? Is the hope that

it'll be used in commerce (oil drilling?) in the future?

A12: Andy Shepard - Eric, The first customers for these subs were an oil field company. They often use the one-person suits to work on oil rigs. But past suits were designed to stand up in and they had a tether attached. The DeepWorkers are far more comfortable and have no connection to the surface.

Q13: Eric Mendelsohn - Are researchers the market for this sub? Is the hope that it'll be used in commerce (oil drilling?) in the future?

A13: Francesca Cava- These submersibles were developed for a wide-range of use for using them in the oil industry to research and education. In fact our project, is trying to bring untraditional uses and people into the subs, like Tim Friend who is a writer for USA Today or our Teacher-in-the-Sea, Mike Guardino. The main intent is to show that with the right kind of training almost anyone can use these subs.

Q14: Eric Mendelsohn - Are researchers the market for this sub? Is the hope that it'll be used in commerce (oil drilling?) in the future?

A14: Laura Francis - Eric, please see question 13 for the answer to this question - thanks!

Q15: Ms. Patterson/Bel Aire School - What materials is the sub made out of? Will lay people be able to use equipment like this in the future?

A15: Francesca Cava - The sub has a titanium hull and a acrylic dome, most of the components on the sub are made of off-the-shelf equipment. At this time, we are inviting many different people to dive the sub. We are hoping this will make others interested in learning to be pilots also.

Q16: Charly/Hawaii Prep Academy - When enclosed in a sub, how does one extract the carbon dioxide that they would exhale? Is it based off of a rebreather?

A16: Andy Shepard - Charly- good question about carbon dioxide. We have to be careful to ensure the air inside the sub stays about like it is on the surface-- 20% oxygen and very little carbon dioxide (<1%). But, when we breathe, we use up oxygen and expel CO2. We use scrubbers to absorb the CO2 and we have oxygen tanks to leak in the required amount of oxygen. The scrubbers have a dry pebbly

mixture in them called sodasorb-- don't ask me to give you the chemical reaction right now (I will later if you are interested).

Q17: Charly/Hawaii Prep Academy - When enclosed in a sub, how does one extract the carbon dioxide that they would exhale? Is it based off of a rebreather?

A17: Francesca Cava - Inside the sub we have a system called a scrubber filled with small beads called Sodasorb. Sodasorb is used to remove the carbon dioxide from the air as its circulated from the sub through the scrubber fan.

Q18: Eric Mendelsohn - I assume that the various thrusters make a lot of vibrations in the water. Do you often stop the thrusters and drift, hoping that fish and other shy creatures will come out from hiding?

A18: Francesca Cava - The thrusters don't make a lot of noise in the water, however they do make some noise. One way we handle the noise is to take the submersible and sit on the bottom and that allows us to observe the fish without making a lot of noise.

Q19: Ms. Patterson/Bel Aire School - What materials is the sub made out of? Will lay people be able to use equipment like this in the future?

A19: Andy Shepard - Ms Paterson, The subs are made out of a variety of materials from water to plastic. The most important parts are the stainless steel sphere and the acrylic dome. The newer subs will, as Francesca noted have titanium spheres. Titanium is just as strong but much lighter than steel (also more expensive). The Alvin submersible has a titanium sphere.

Q20: Eric Mendelsohn - If electrical power is lost, is there a foolproof mechanical way of emptying the ballast tanks and making the sub return to the surface?

A20: Francesca Cava - If the electrical power is lost, there is an emergency back-up power that still allows the pilot to operate the communications and life supports. However you can use the soft or hard ballast in a controlled ascent.

Q21: David - How hard is it for a pilot to fly the DeepWorker and do research at the same time?

A21: Francesca Cava - David, This is a very interesting question and one that we are trying to answer. Some people have found it possible to do both piloting and observations at the same time, but obviously it gets easier with more practice. The subs have been designed to be as simple as possible to allow the scientists to do their work in the same way that they have learned to do scientific work as scuba divers, only now you have different equipment to monitor and can stay dry.

Q22: Ms. Patterson/Bel Aire School - Thank You for taking the time to talk to us. We enjoyed the chat but must go to Espanol. Thanks and good luck!

A22: Laura Francis - Adios. Thanks for joining us today!

Q23: Eric Mendelsohn - If electrical power is lost, is there a foolproof mechanical way of emptying the ballast tanks and making the sub return to the surface?

A23: Andy Shepard - Eric, The thrusters on DeepWorker are quieter than many other subs in part because they are small. However, we often have to float quietly in order to make useful observations. The emergency ballast system consists of first pumping air into a open space under the whole. If this does not work, there is a lead weight that can be released (I could not find # of pounds right away, I think its around 250 lbs.)

Q24: Ms. Patterson/Bel Aire School - Thank You for taking the time to talk to us. We enjoyed the chat but must go to Espanol. Thanks and good luck!

A24: Francesca Cava - Mrs. Patterson, Thanks for joining us and come back for our next chat on May 24th. Also, you might be interested in our May 18th live video event and chat live from the NOAA ship McARTHUR.

Q25: Eric Mendelsohn - If you certify DeepWorker to 2000 feet, I imagine it is designed to withstand significantly greater pressure. What is the safety margin chosen by your engineers?

A25: Francesca Cava - Eric, You are absolutely correct that when we certify the subs or any of the equipment used with the sub we always certify to a much higher

level. For example, the crane that is used to lift the sub must be rated over 4 times the weight of the sub, so we need a 10,000 pound crane to lift the 2,500 pound sub. By requiring more excessive ratings we can better guarantee that we always keep our operations in the best window of safety possible.

Q26: David - How hard is it for a pilot to fly the DeepWorker and do research at the same time?

A26: Andy Shepard - David, One of the scientist's biggest worries about using one person subs was having the minds free to do science. Past one-person vehicles required lots of attention to drive. I think the most unique feature of the DeepWorkers that allows the scientist to focus on their research is the propulsion System -- your feet control all thruster movements of the sub. After a few hours of training, most pilots are flying around tight corners and stopping on a dime. This first year of SSE, we will test the subs to see how they handle many scientific tasks such as camera surveys and collecting samples.

Q27: Eric Mendelsohn - If you certify DeepWorker to 2000 feet, I imagine it is designed to withstand significantly greater pressure. What is the safety margin chosen by your engineers?

A27: Andy Shepard - Eric, The subs are certified by the American Bureau of Shipping and required. I do not have the safety factor in hand but you are right in assuming that they can withstand more than the operating depth. Usually the crush depth is at least two times the rated operating depth.

Q28: Juliette/Topanga Canyon - What kind of background would I need to learn how to build subs and other ocean exploratory technology?

A28: Andy Shepard - Ralph and Juliette, What does it take to be an ocean explorer? Like anything, dedication. The training and education you need depends on what field you choose. If you choose to be a scientist, which is how I started out, stay in school. A graduate degree is preferred. If you want to be a technician, then still stay in school but maybe for not as long. There is a program called MATE (Marine Advanced Technology and Education, search for their web site) and they can direct you to community colleges with ocean technology degrees.

Q29: David - Are these dives the first time anyone has been to these areas?

A29: Francesca Cava - David, The Monterey Sanctuary is bigger than the state of Connecticut, so although a lot of work has been done out here, there are still many places left to explore and we will be going to some of those. Its amazing when you think of it, but less than 3 per cent of the ocean has been explored at all - we certainly have a lot of work ahead of us.

Q30: David - Are these dives the first time anyone has been to these areas?

A30: Andy Shepard - David, The SSE dives will be concentrated in the National Marine Sanctuaries. In some cases they will be the first submersible dives in some of the Sanctuaries. Other Sanctuaries have been at least partially explored by programs like the National Undersea Research Program. Many of the Sanctuary staff are trained divers. One Sanctuary I know of often uses an underwater robot to survey their site. The science program devised for SSE is designed to build on past work and fill in holes.

Q31: Juliette/Topanga Canyon - What kind of background would I need to learn how to build subs and other ocean exploratory technology?

A31: Francesca Cava - Juliette, Most people in the sub building business start as engineers and this would be a good background for you. Although, we've also found that a multidisciplinary background is a big help so that you know both the engineering side and have a working knowledge of what the people using the subs are trying to accomplish.

Andy Shepard - Thank you to everyone, I have to go to a meeting to discuss how we can use undersea technology to determine how fishing gear impacts the seafloor. Happy diving!

Laura Francis - Francesca and Andy are working on the last couple of questions. Thank you all for chatting with us today. Please join us again on May 18 for a live video uplink to learn about Prickly Shark Ecology and May 24 to talk with Sustainable Seas Expeditions "Teacher in the Sea", Mike Guardino. Both of these events can be accessed through the Sustainable Seas Expeditions home page under live events (http://sustainableseas.noaa.gov)

Juliette/Topanga Canyon - Thank you for all of your helpful information. You guys are great and I am looking forward to logging on again during the next webchat or live uplink. Bye!

Charly/Hawaii Prep Academy - Thank you Andy and Francesca.

Francesca Cava - Thank you everyone for joining us. We hope to hear from you again as we continue our Expeditions. Come and see us if you have a chance at our June 5th Open House in Santa Barbara. Bye for now.

Eric Mendelsohn - Thank you for taking the time to chat with us interested lay people!

Ms. Patterson/Bel Aire School - Thank You for taking the time to talk to us. We enjoyed the chat but must go to Espanol. Thanks and good luck!

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June 3, 1999
Web Chat Summary

11:00 am to 12:00 am Pacific time (2:00 pm to 3:00 pm eastern time)
Rebroadcast of May 27 Live Video Event :
Channel Islands National Marine Sanctuary and the Great American Fish Count

Introduction

We continued the fish count at CINMS by encouraging chat participants to review the **video archive** from the event off of Anacapa Island. During this chat Ed Cassano, Laura Francis, and Julie Goodson were joined by Kate Faulkner from the Channel Islands National Park. Our chatters learned more about the Channel Islands, the SSE mission and the Great American Fish Count (GAFC.)

The Great American Fish Count (GAFC) was started in 1992 by Gary Davis at the Channel Islands National Park (CINP) as a way to encourage sport divers to report fish sightings. Fifty divers participated in the first GAFC at Anacapa Island. The primary goals of the GAFC were to: 1) raise public awareness about trends in fish populations, 2) provide information on fish populations, 3) provide a sustainable non extractive diving activity, and 4) improve fish population assessment techniques. The event is focused around a discrete time frame in July in order to get as many divers as possible involved, and attract media attention. The hope is to have divers become interested enough in fish monitoring to map and adopt sites that could then be visited year-round.

To help us better understand the impact of the Fish Count on the marine environment we were joined Kate Faulkner from the Channel Islands National Park. The Park is home to a wide variety of nationally and internationally significant natural and cultural resources. Over 2,000 species of plants and animals can be found within the park. However only four mammals are endemic to the islands. One hundred and forty-five of these species are unique to the islands and found nowhere else in the world. Marine life ranges from microscopic plankton to the endangered blue whale, the largest animal to live on earth. Archeological and cultural resources span a period of

more than 10,000 years. The park consists of 249,353 acres, half of which are under the ocean, and include the islands of San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara.

To learn more about the Channel Islands National Marine Sanctuary, visit these two NOAA Web sites:
www.sanctuaries.nos.noaa.gov/oms/omschannel/omschannel.html
and
http://www.cinms.nos.noaa.gov/

Click on either of the links below to view the archived broadcast from Anacapa Island. From Anacapa, Ed Cassano, Manager at CINMS, will take you underwater to demonstrate how the fish count is conducted and explain what is learned during this project.

Small image archive (< 56k) | **Large image archive** (> 56k)

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Highlights

For this chat we had Ed Cassano, CINMS manager, Laura Francis, SSE Education Coordinator, Julie Goodson, CINMS education and outreach coordinator, and Kate Faulkner, a Marine Resource Specialist from the Channel Islands National Park, all online answering questions. The chat topic was a continuation of the May 27 event which featured the importance of the Great American Fish Count (GAFC). We had the added benefit of offering, online, for all to view, the pre-recorded Fish Count event conducted from Anacapa Island and the McARTHUR the week prior.

Much of this chat focused on how a fish count is conducted and its unique role that it plays in helping us understand fish habitat at SCUBA depths. Laura shared that to conduct the fish count they "use an underwater slate - a waterproof fish ID card and pencil - and count the fish from underwater." Ed went on discuss the importance of this volunteer activity. "Long term monitoring helps us evaluate the relative abundance of species - this along with other data will provide important information to resource managers. This non-disruptive type of monitoring allows for an understanding without the more traditional forms of observations." Julie added, "The Great American Fish Count data base certainly shows annual trends in kelp forest and reef community fishes."

The impact on the recent El Niño fish populations was also of great concern to the chatters. As Kate explained, "I am not aware of new species found. However, I know that there was an expansion of species more typical of warm water moving further north during the El Niño period. It will be interesting to see if this changes this year

with the colder waters."

Overall, this was a very busy chat as we had many experts online for this hour all very excited about what we are learning about fish habitat in the Channel Islands National Park and Marine Sanctuary.

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Web Chat Transcript

Andrea/NASA Chat Host - Welcome to the chat room for the rescheduled May 27 web cast. We plan to have you review the Great American Fish Count that we recorded on the 27th. You are welcome to ask questions of the content experts and hosts for the event: Ed Cassano - CINMS Manager, Laura Francis - SSE Education Coordinator, Julie Goodson - CINMS Education and Outreach. Thank you for joining us - Enjoy!

Andrea/NASA Chat Host - A reminder to all that join us - please review the online clip at: **http://quest.arc.nasa.gov/ltc/sse** - you will see the Fish Count in process and be able to ask questions from here to the experts that were on Anacapa and in the water last week at this very time!

Q1: Camp Internet - We look forward to today's re-broadcast. We've been holding daily chat sessions since the SSE Team came to Santa Barbara. We are especially eager to know if students will take part in the DeepWorker dives during future SSE visits? The Channel Islands region has a web site up for the Student Summit Team at http://www.rain.org/sse

A1: Andrea/NASA Chat Host - We look forward to today's re-broadcast. We've been holding daily chat sessions since the SSE Team came to Santa Barbara. We are especially eager to know if students will take part in the DeepWorker dives during future SSE visits? The Channel Islands region has a web site up for the Student Summit Team at http://www.rain.org/sse Welcome Campers! Good to have you online this morning - I was just "over" at your site!

Andrea/NASA Chat Host - For all that are new to the CINMS - you may want to read the online biography of Ed Cassano - the courtesy of RAIN and the Student Summit team - http://www.rain.org/sse/journals/summit_journal/3.html -- I invite the team to point us to other features that they would like to share.

Timothy - Andrea - we just put up a link from Camp Internet's chatroom to the registration web for todays NASA re-broadcast. As kids come into that chatroom they'll be given an automatic link to the registration web.

Laura Francis - Greetings!! Julie Goodson and I are here and we are getting Ed Cassano, CINMS Sanctuary Manager, online From the NOAA Ship McArthur right now. We will get started with the chat in just a few minutes...

Q2: Kate Faulkner - Kate Faulkner from Channel Islands National Park is online.

A2: Andrea/NASA Chat Host - Welcome Kate - we are expecting our team shortly. Ed is onboard the McARTHUR this morning and may be on his way. Well Ed is here now!

Ed Cassano/CINMS Manager - With me on the Mac are several folks - Dr. Guy Cochran - PI for ground-truth research in the DeepWorker, and mapping habitat / Sara Fangman - Research Coordinator and DeepWorker pilot / Ian Griffith - Dive Supervisor / Donna Schroeder - specialist in Rock Fish or ichthyology / Dana Wilkes - SSE Operations Manager.

Julie Goodson/SSE Expert - Hello, I'm finally online

Q3: Camp Internet - We look forward to today's re-broadcast. We've been holding daily chat sessions since the SSE Team came to Santa Barbara. We are especially eager to know if students will take part in the DeepWorker dives during future SSE visits? The Channel Islands region has a web site up for the Student Summit Team at http://www.rain.org/sse

A3: Julie Goodson/SSE Expert - Yes! We are planning to involve students in future SSE dives next year at the Channel Islands National Marine Sanctuary. In fact, the CINMS Student Summit Team will be implementing a research project for next year's expedition.

Q4: Camp Internet - We look forward to today's re-broadcast. We've been holding daily chat sessions since the SSE Team came to Santa Barbara. We are especially eager to know if students will take part in the DeepWorker dives during future SSE visits? The Channel Islands region has a web site up for the Student Summit Team at

http://www.rain.org/sse

A4: Ed Cassano/CINMS Manager - Given appropriate certification CINMS are very interested in working with students. The idea would be to start now - and working the SCUBA component.

Q5: Kate Faulkner -Kate Faulkner from Channel Islands National Park is online.

A5: Laura Francis - Welcome Kate! Glad to have you online. Kate is an expert on the marine resources in the Channel Islands National Park. Kate - please feel free to answer any questions related to park resources.

Q6: Camp Internet - Has anyone working with GAFC found signs of new species in the channel over the past year?

A6: Kate Faulkner - I am not aware of new species found. However, I know that there was an expansion of species more typical of warm waters (for example: Guadalupe Cardinal fish) moving further north during the El Nino period. I will be interesting to see if this changes this year with the colder waters.

Q7: Camp Internet - Has anyone working with GAFC found signs of new species in the channel over the past year?

A7: Julie Goodson/SSE Expert - That is a good question. I know that global weather phenomena like the El Niño occur, warmer tropical species work their way farther up the California coastline following the influx of warm water to the region. Simultaneously fish of this region not well suited to warm water temperatures move further offshore or go deeper.

Q8: Marcy - Ed - please tell us about your underwater submersible experiences so far .. what depths did you go to, and what was seen ? The students have been asking at what point it goes completely dark as you descend...

A8: Ed Cassano/CINMS Manager - I have gone 113 ft - and made three mission dives - the third was a habitat characterization - I had great visibility - I was joined by a Friendly Torpedo Electric Ray - during the live event dive I saw Black Sea Bass. The significance of seeing a Black Sea Bass - they were fished almost to the point of extinction - we don't know much about them - in 1992 there was a good year of

survivorship for the babies - so now we are seeing them come back &endash; all the way down to Mexico. This shows that protection does make a difference - they typically live at depths of about 130ft, just at SCUBA depth - we hope the DeepWorker will help us understand their true habitat. -We have not gone so deep as to not see light - Donna says at about 300 ft it will be dark (Donna has spent a great deal of time in other submersibles.)

Andrea/NASA Chat Host - Please ask your questions of Ed, Laura and Julie - If you have any questions about the others onboard the Mac please feel free to ask them now.

Q9: Marcy - Another student question that has been coming up is about the giant squid - at what depths do they live?

A9: Kate Faulkner - Great question. The giant squid live so deep that they have never been seen in the wild. They are sometimes found dead or found in whales stomachs. They probably live below 5,000 feet.

Q10: Sean - Water temps in Southern California have been 3-4 degrees below normal this spring. Has this affected your area and the fish populations/species that you see? Can this offset the El Niño effect?

A10: Kate Faulkner - There are lots of rockfish juveniles -- they like the cold water.

Q11: Marcy - Another student question that has been coming up is about the giant squid - at what depths do they live?

A11: Ed Cassano/CINMS Manager - At about 3000 ft.

Q12: Zule - How fast can the submerisible descend/ascend?

A12: Ed Cassano/CINMS Manager - At 100 ft a minute - you don't have to worry about the rate - the issue becomes possible obstructions above and below the DeepWorker.

Q13: Sean - Water temps in so cal have been 3-4 degrees below normal this spring. Has this affected your area and the fish populations/species that you see? Can this offset the El Nino effect?

A13: Ed Cassano/CINMS Manager - Donna answering: The colder water favors the more Northern species and in the CINMS the transition zone - warm years favor the Giant Sea Bass, Kelp Bass and Brittle Stars - cooler years favor Rock Fish and Giant Kelp.

Q14: Sean - Water temps in so cal have been 3-4 degrees below normal this spring. Has this affected your area and the fish populations/species that you see? Can this offset the El Nino effect?

A14: Julie Goodson/SSE Expert - Yes it has. The greatest result of the cooler water temperatures is the re-growth of the giant kelp. In fact if you drive down highway 101 around Rincon you will see a thick kelp canopy forming. I haven't seen the kelp canopy so thick in a long time.

Q15: Eddie - Kate-How many square miles of land do you control

A15: Kate Faulkner - There are five islands included in the park and the surrounding 1 nautical mile of marine waters. Total acreage is 250,000 acres (evenly divided between land and water). 172 miles of coastline.

Brother Lou - Ed, just getting ready to view you in sub. congrats on a great mission!!!!!

Marcy - Kate - thanks for coming onto the chat today via the Camp Internet gate - we are directing students over here to ask more questions. They are really fascinated by the giant squid, and learned in a chat with Milton Love and Paul Scott (UCSB / SBMNH) that a tentacle had been found that is now at the Museum.

Q16: Bike Boy - So what will happen to all the species that have taken advantage of the cooler water to extend their range? Will they die?

A16: Kate Faulkner - There are a number of species that do not do well with warm

water conditions (El Nino). Seal and sea lions prefer cold water because there are more fish available close to shore and in shallower waters. The shift in water temperatures is not so rapid that individuals will be killed. Generally, their reproductive success is lessened, so subsequent generations aren't produced or are smaller. However, this is balanced by other species that prefer the new temperatures.

Q17: Twyla - Julie did you count any Sheepheads for your studies?

A17: Julie Goodson/SSE Expert - Yes we did count CA sheepheads as part of the GAFC last Thursday. We identified both male and female sheepheads in the Anacapa Reserve.

Q18: Brother Lou - Ed, just getting ready to view you in sub. congrats on a great mission!!!!!

A18: Ed Cassano/CINMS Manager - Hey Brother Lou it was a great trip! My best to everyone!

Q19: Regina Diana/Orogrande - Julie are you counting any of the Half Moons?

A19: Julie Goodson/SSE Expert - We didn't see any halfmoons during the LIVE uplink at Anacapa Landing. However I do think the other divers participating in the GAFC that day counted Halfmoons during their surveys.

Sean - I made two trips down US 1 in May and I have to concur with Julie, the kelp is flourishing!

Q20: Bike Boy - So what will happen to all the species that have taken advantage of the cooler water to extend their range? Will they die?

A20: Ed Cassano/CINMS Manager - Donna answering: The colder species can tolerate the warm water - so they should be fine.

Q21: Morgana 1st grade - How many fish have you counted so far?

A21: Laura Francis - We counted over 15 species of fish on that dive including Sheephead, Opaleye, Kelp Bass and Garibaldi.

Q22: Morgana 1st grade - Are the majority of fish vegetarian?

A22: Julie Goodson/SSE Expert - Many fish are grazers. A quick way to tell if a fish is a grazer (feeding on algae and small shrimps, crabs) is by the size of their mouth. Grazers tend to have a smaller mouth and may lack teeth all together.

Q23: Eddie - Kate-Do you control any ocean?

A23: Kate Faulkner - Eddie - No. We don't control the ocean. However there is marine water in the park and we enforce California Fish & Game regulations.

Q24: Morgana 1st grade - How many fish have you counted so far?

A24: Ed Cassano/CINMS Manager - Donna answering: We have counted thousands. The Giant Sea Bass - we have seen the most young rock fish than we had seen in over 20 years.

Q25: Twyla - Kate,how close have you been close to a seal or sealion?

A25: Kate Faulkner - Occasionally, when diving or snorkeling, a seal or sea lion will come up to me. When they are on land, I keep a large distance from the animals so that I don't disturb them when they are resting. Check out this web site: http://nmml01.afsc.noaa.gov/El_Nino/ Great information on the seals and sea lions of the Channel Islands.

Q26: Jason Sarah - Kate, Is it a lot of work to control parts of the ocean?

A26: Kate Faulkner - To Jason Sarah: Protecting the marine environment is very difficult. It is a hard place to understand because of the difficulty of diving to great depth (that is why the submersible is so nice). Also, there are a lot of people and we

like to eat the fish. This causes conflicts with sustaining the marine environment.

Q27: Camp Internet - Will the GAFC have much impact on the Fisheries planning?

A27: Ed Cassano/CINMS Manager - The impact is all about awareness of our underwater neighborhood - GAFC raises awareness of a place that we are not too familiar with . Long term monitoring with resource managers - helps evaluate the relative abundance of species - this along with other data will provide important information to resource mangers. This non-intrusive type of monitoring allows for an understanding without the more traditional/intrusive forms of observation. Thus the GAFC gives access to information that we have not had.

Q28: Davida - Laura - Did you ever get tangled in the communication line?

A28: Laura Francis - I never got entangled, but I did have to be constantly aware of where it was and we couldn't get too close to the sub because we didn't want to risk entanglement.

Q29: Camp Internet - Will the GAFC have much impact on the Fisheries planning?

A29: Julie Goodson/SSE Expert - The GAFC data base certainly shows annual trends in kelp forest and reef community fishes. The fact that the survey always takes place during the first two weeks in July provides a benchmark to species present during the summer months. However there are many other factors that managers use to determine that status of fisheries off our coast

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Camp Internet - We're having a great time viewing the video re-broadcast while the chat is going on. Especially having Dr. Earle talking via the video in the background while we type into the chat room.

Q30: Christian Galeana - Kate, Did El Niño hurt any kind of plants or animals?

A30: Kate Faulkner - El Niño is a tough time for species that depend on cold, nutrient rich waters. When the water is warm, it holds less nutrients. Seals and sea lions (especially the pups) have difficulty finding food during El NIno's. Lots of fish

move further offshore or to deeper water.

Q31: Lou Cassano - How long does it take the giant kelp to grow to these lengths??

A31: Julie Goodson/SSE Expert - Giant kelp can grow up to 2 feet per day under ideal conditions where the sunlight is just right, the nutrient levels are good and the water temperatures are cool.

Q32: Marcy - Laura - we were able to watch you live on screen at the National Park last week during the fish count dive - is it being rebroadcast today ? If so, Andrea, can you please give the students instructions on how to see the video and participate in the chat ?

A32: Andrea/NASA Chat Host - To all that need information on how to access the video - from the web site: **http://quest.arc.nasa.gov/ltc/sse** - you can click on the RealMedia link. However, first you will need to have downloaded the RealPlayer - You can do this by going to: **http://www.real.com** -- look for information on the FREE player. The process will ask you a few questions - and based on the computer you are using you will need to follow those specific instructions. For those of you not successful today - the video file will remain online for you to review in the future.

Q33: Regina - Julie, are you counting Calico bass?

A33: Julie Goodson/SSE Expert - We did see some calico bass, also called kelp bass on the dive at Anacapa. I think we saw 5 or 6 of them.

Q34: Marcy - We heard on Catalina that the Garibaldi is the California State Fish - can you confirm this ? And it was plentiful at Lovers Cove there, but how common is it in the northern waters around the Sanctuary ?

A34: Ed Cassano/CINMS Manager - Golden Trout is the State Fish - the Garibaldi is the State Marine Fish - they are common at the Southern end of the Channel Islands - but not so in the Northern area - this is one of the few examples of this.

Q35: Kim - How long has Channel Island been a nationally protected sanctuary? Is

there any indication of enlarging the sanctuary area or incorporating other areas nationally in the future?

A35: Julie Goodson/SSE Expert - The Channel Islands National Marine Sanctuary was established in 1980. There have been discussions about expanding the boundaries of the Sanctuary further into Santa Barbara Channel

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Q36: Cousin Thing - What's the outer wall thickness of the sub?

A36: Ed Cassano/CINMS Manager - In the training subs that we are using now, the thickness of the hull is 3/8 Inch. In the subs capable of going down 2000 feet, the thickness will be 1/2 inch. The acrylic dome is 2 inches thick.

Q37: Eddie - Kate-Have you ever been to the Wrigley Center, my class and I stayed the night there three weeks ago?

A37: Kate Faulkner - Eddie: Is the Wrigley center on Catalina? I have visited that island and the Wrigley Botanical Gardens.

Q38: Trinica - Julie what kind of instruments do you use to count the fish?

A38: Laura Francis - We use an underwater slate, waterproof fish id card and pencil to count fish underwater.

Q39: Regina - Julie,are you counting any Geralbaldies?

A3: Julie Goodson/SSE Expert - We did count the Garibaldi during our LIVE underwater uplink at Anacapa Landing on May 27. I'm positive that the other volunteer divers participating in the fish census that day also counted Garibaldi as well.

Q40: Lou - Ed, are you back on the land for this chat?

A40: Ed Cassano/CINMS Manager - No I am currently on the NOAA ship McARTHUR on the back side of Santa Cruz island in 120 ft of water. Weather

conditions have forced us to abandon our primary and secondary dive sites. We hope to dive this hour. We will be doing site characterization by tracking the sub using video and audio. Dr. Guy Cochran is going to be the pilot for our dive today. We will be back in Santa Barbara at 4:00 Friday afternoon - this will end the seagoing part of the expedition.

SSE Web Team - Kim: For more information on the National Marine Sanctuary Program, visit: **http://www.sanctuaries.nos.noaa.gov**

Q41: Camp Internet - Is there a shared information / data gathering process going on between NASA and NOAA as part of the SSE project? Are you gathering data into a single database or many databases?

A41: Kate Faulkner - At the park we use MSAccess. It is excellent as a database. It can be time consuming to use. MS Excel is a little easier to use and produces graphs easily.

Q42: Sean - Do you collect any information on food sources, ie. Zoo plankton, etc?

A42: Ed Cassano/CINMS Manager - We're doing oceanography - looking at the structure of the water column - we're taking water samples to measure the productivity of these areas.

Q43: Kim - How long has Channel Island been a nationally protected sanctuary? Is there any indication of enlarging the sanctuary area or incorporating other areas nationally in the future?

A43: Ed Cassano/CINMS Manager - Currently the CINMS is undergoing a management plan review - based on this the boundaries may change.

Q44: Camp Internet - Is there a shared information / data gathering process going on between NASA and NOAA as part of the SSE project? Are you gathering data into a single database or many databases?

A44: Julie Goodson/SSE Expert - Fortunately, there is sharing of data between

different agencies. For instance, NASA supplies great satellite images that we can use and we provide GIS information back to NASA.

Q45: Michael - Kate, has there been a decrease of Blue Whales around the islands because of El Niño?

A45: Kate Faulkner - Michael, we don't have real good counts of the Blue Whales. However, the Blues were seen in the Channel before, during, and after the El Nino. Island staff have been reporting Blues and Humpbacks off San Miguel Island recently. As far as I know, Blue Whale numbers have been steady in recent years. I have heard estimates of 200 Blues or so in the Channel. I don't know how accurate this is. The Sanctuary has done some work with Blues and may have better numbers.

Q46: Lou - Very cool, the DeepWorker, broadcast over the Internet. Thanks for making this happen! How big an area did you cover in the deep water transect?

A46: Ed Cassano/CINMS Manager - Because of the constraints on time to meet the divers - we only covered an area of 200 meters. Generally, we have laid out transects of .5 mile - .75 mile. Primarily looking at the habitat of different fish throughout.

Q47: Eddie - Julie-Where are you located?

A47: Julie Goodson/SSE Expert - We're located in both Santa Barbara Harbor in Santa Barbara and in Channel Islands Harbor in Oxnard.

Ms. Glenn - Thank You very much for your time and many answers to the class's question. Signing off;) Ms. Glenn's class

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Q48: Marcy - Ed - what types of weather problems cause a site to be avoided for a submersible dive ? And are you live via satellite or cellular for this chat?

A48: Ed Cassano/CINMS Manager - I am on cellular phone dictating to Andrea in Oregon and she is typing my answers into the chat room.

Q49: Marcy - The Camp Internet crew has been told by many scientists that kelp can grow up to 2 feet a day, and that if you are patient, you can actually sit still long enough to see it grow... this is pretty amazing ! We are wondering if kelp grows worldwide ? The GIS maps our students have been shown by Bill Bushing show it along the Americas and in the Pacific, but not much anywhere else in the world. Was it once more common in other places ?

A49: Ed Cassano/CINMS Manager - Kelp is found throughout the world - there are different species. During El Nino years - Kelp can be impacted. We saw this in the Channel Islands - it is coming back as we hope and expect.

Q50: Christian Mikey - Kate, do you control an island?

A50: Kate Faulkner - The five northern Channel Islands are in the National Park

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Q51: Regina - Julie, how big were the Calico bass you saw?

A51: Julie Goodson/SSE Expert - The Calico Bass we saw averaged lengths between 12 and 16 inches.

Ed Cassano/CINMS Manager - I am getting ready to go back - in parting I would like to say that we have found that a focused project with a strong mission component achieves many of the goals of the national sanctuary program. The DeepWorker has performed flawlessly and will be an excellent tool for helping us understand resources. Channel Islands is a unique place we have a National Park &endash; its cooperation and resource management skills are very important to the Great American Fish Count. Their underwater uplink program is unique &endash; and adds to the benefits of having a sanctuary and a park in one of the nation's most unique areas. Now we will sign off from the NOAA ship McARTHUR (BrotherLou - expect a call when I return home!)

Q52: Kim - How did you become interested in studying the oceans? Do you have a degree in marine science or oceanography? What are the job prospects for future marine scientists?

A52: Laura Francis - I first became interested in studying the oceans when I was in

6th grade on a field trip to Anacapa Island. I went snorkeling for the first time and was hooked. I have a Masters Degree in Deep Sea Biology. I think that the job prospects are going to get better in this field as people become more concerned about caring for the oceans. You will have to work hard and be persistent, but it will be well worth it to do a job you love!

Kate Faulkner - I have to sign off also. It has been fun talking with you. I hope that you get a chance to visit the islands and marine waters.

Andrea/NASA Chat Host - Kate - Thanks for joining us today - we hope you enjoyed the chat and we can do more of the same in the future.

Lou - The maneuverability of the Deepworker was amazing to see, looks like you could turn it on a dime. Thanks to the Entire Team for making this happen. Safe back to port.

Marcy - Thanks to everyone with SSE - CINMS / National Geo/ NPS and NASA Quest for making these public interactive sessions available. Our classrooms have been online both weeks interacting with scientists and learning about the goals of the SSE. See you all at the mission landing on Saturday June 5th and the public is invited (Santa Barbara Harbor, events start at 10am).

Q53: Kim - How did you become interested in studying the oceans? Do you have a degree in marine science or oceanography? What are the job prospects for future marine scientists?

A53: Julie Goodson/SSE Expert - I've always been interested in the ocean since I was a little girl. I went ahead and studied marine biology at UC Santa Barbara and have worked to develop educational programs about the ocean ever since. I think there are many opportunities out there in this field. It is hard work at times - but it is also worth it. Just get into it!

Q54: Silvia - We're on the NASA web site. That makes for a great connection between research in space and research under the water. Does that connection get talked about within the agencies much?

A54: Andrea/NASA Chat Host - There are many connections between ocean and space research. One of the primary objectives of the collaboration between SSE/NOAA and NASA is to recognize the importance of penetrating our oceans - as most of NASA's ocean research is concerned with surface data. We also hope to work together one day to use information, such as what is collected during the SSE missions, to help

better interpret the data seen from observation satellites. We have enjoyed the collaboration, the SSE explorations are a wonderful look at yet another other-world aspect of life on planet Earth!

Laura Francis - Thanks everyone for joining us today for a very busy and informative chat session. Whew! it was hard to keep up with all the great questions! Please join us again for another chat on July 1st from NOAA's Olympic Coast National Marine Sanctuary. Also, please fill out the chat survey, so we can make sure these events meet your needs and interest. For the survey, please go to **http://quest.arc.nasa.gov/qchats/qchat-surveys**

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July 1, 1999

10:00 am to 11:00 am Pacific time (1:00 pm to 2:00 pm eastern time)
NOAA's Olympic Coast National Marine Sanctuary (OCNMS): Charting the Sea Floor

Introduction

Carol Bernthal, sanctuary manager, Bob Steelquist, education coordinator and Ed Bowlby, science coordinator from NOAA's OCNMS host a discussion on the research conducted during the first expedition. The focus of the chat is the role of charting the sea floor in exploring rare habitats and species in the deep sea and assessing the impacts of varying degrees of commercial fishing.

The Olympic Coast National Marine Sanctuary spans 3,310-square miles of marine waters off the rugged Olympic Peninsula coastline. The sanctuary averages 38 miles seaward, covering much of the continental shelf and protecting habitat for one of the most diverse marine mammal faunas in North America and a critical link in the Pacific flyway. The sanctuary boasts a rich mix of cultures, preserved in contemporary lives of members of Quinault, Hoh, Quileute, and Maka tribes.

Little is known about fisheries issues in the deep sea environment, yet commercial fishing is one of the most significant activities taking place in the Olympic Coast sanctuary. The Washington Department of Fish and Wildlife and the National Marine Fisheries Service have already begun work to map trawlable and untrawlable habitats and estimate fish densities within them. Expedition studies will expand on this work. Initially, fish attraction and avoidance experiments will test the validity of undersea video fish counts. Fish and invertebrate populations will also be surveyed in the area that has been previously mapped. Differences in habitat complexity and benthic macroinvertebrate species composition will be assessed in other areas of the sanctuary. Investigators hope to delineate control, lightly trawled, and heavily trawled sites within the study area for comparison.

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Highlights

I trust you will enjoy this archive of the chat with Carol Bernthal, OCNMS Manager, Ed Bowlby, Research Coordinator and Bob Steelquist, OCNMS Education Coordinator. Just one day after the Olympic Coast Expedition, they gave some great insight into what was learned and process by which they sought to accomplished their goals.

They talked about what they learned during the mission and what surprised them the most. Bob commented: "I was surprised by the beauty of the upper 100 feet of water in the open ocean. As you descend or ascend through this layer, your are surrounded by a luminescent green, like being bathed in an eerie beautiful light. I called it "the green room."

Carol added that several things surprised her:

1. finding wolf eels in a bottom that was flat and deeper than normally would be expected (you usually find them hanging out in rocks);
2. the reaction of fish to the submersibles-they didn't seem bothered by them at all;
3. the high density of crushed shells further offshore;
4. the lack of sea urchins in areas we expected to find them, which tells us that the prey base for predators such as sea otters is fairly geographically limited.

All three felt they had learned a great deal about how best to use the DeepWorker and what that challenges are to working with this research tool. You will read about the changes that they would suggest when using the DeepWorker. They found that launch and recovery from the ship is among the most challenging aspects of using the DeepWorker. Bob also commented that "The DeepWorker design is very elegant. Certainly tools can be added that give it additional capabilities, but I think we need to be thinking about modifying some of our research practices to fit DeepWorker. For example, if we research elk or sea otters, biologists spend long hours observing these animals in-situ. This kind of observation is now feasible with submersibles. I hope we move in that direction -- the kind that requires trained human eyes to gather data."

You will also read how access to the DeepWorker allowed the OCNMS team to extend their observations of certain transects. Ed described one such instance: "I participated in our subtidal diver surveys, so it was a rare treat to see how the habitat changed with depth. Our diver surveys showed extensive canopy and understory kelp beds, and associated fish and macroinvertebrate communities. But as the sub extended these transects to deeper waters, the habitat changed dramatically to gradual sloping gravel and shell fragment bottom, dominated by sea stars, sea cucumbers, and the occasional rock fish near a few rock outcroppings. The algae community, that so characterized the inner waters, was noticeably absent in the deeper areas."

So read on and discover in more detail what was learned during this last SSE mission on the west coast for the 1999 season!

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Web Chat Transcript

Andrea/NASA Chat Host - Welcome to the chat room for the discussion with the members of the Olympic Coast National Marine Sanctuary in Port Angeles, Washington, USA. You are welcome to leave your questions before the chat begins - however, you will not be able to see your question until a moderator has had a chance to review it and add it to the chat room. Thanks for joining us

Laura Francis - Greetings. We have Carol Bernthal, OCNMS Manager, Ed Bowlby, Research Coordinator and Bob Steelquist, OCNMS Education Coordinator all online and ready to answer your questions about the recent Olympic Coast Sanctuary Expedition. Let the chatting begin....

Why don't Carol, Ed and Bob say hello and tell us about your expedition...What types of things did you see and learn?

Bob Steelquist/OCNMS Education Coordinator - On my dives, I visited rocky reef structures at 159 and 279 feet of depth respectively. These habitats are rich with rockfish, many species of seastars and many smaller organisms attached to the rocks. What struck me about these places was that, just like on land, ecological communities in the sea are very diverse -- sandy bottoms and rocky reefs can be right next to each other yet host very different lifeforms.

Carol Bernthal/OCNMS Manager - Hello from the Port Angeles, Washington, home office of the Olympic Coast National Marine Sanctuary. One of the things we learned on this, the first submersible visit to our Sanctuary, is that it is very challenging to do research on the outer coast. We had to contend with weather, mechanical break downs, and the learning curve for new submersible pilots and the ship operators. Despite these obstacles, we were able to do about 10 dives, which yielded interesting video footage of several offshore reefs, and the marine wildlife that lives there.

Ed Bowlby/Research Coordinator - Hello Everyone. We completed our expedition yesterday and are still catching up on sleep. Ocean research projects try to make the most use of ship and personnel time, so we all put in long hours, both day and night. Of course we get occasional treats, like unusual sightings of sea critters or beautiful underwater formations, that make the hours worth it. Thus life at sea can be long and arduous, but rarely boring.

(top)

Q1: Joan Tex - How do you actually perform a fish count?

A1: Ed Bowlby/Research Coordinator - For this year, we actually didn't count fish, but were trying to determine if the sub would act as an attraction or avoidance to fish behavior. If either behavior was encountered, that would bias counts made from subs. That is critical information to know if subs are used for future fish counts.

Although my dives didn't involve a fish counting methodology, carrying out that kind of research can be tricky. Some fish are attracted to the submersible, some are repelled. In designing your research project you have to be very careful to account for these factors. One of our projects, planned by Tom Jagielo and Annette Hoffmann of Washington Department of Fish and Wildlife was designed to observe how DeepWorker affected fish. Unfortunately the dives involved using two subs at once and we were never able to launch the two subs and get them together to perform the experiment. New science in a new environment using new tools doesn't always go according to plan.

Q2: Stephanie/Univ. of Washington - The mission log said you used the submersible to extend some underwater transects started by people using scuba. How did things change as you extended the transect and moved deeper?

A2: Ed Bowlby/Research Coordinator - I participated in our subtidal diver surveys, so it was a rare treat to see how the habitat changed with depth. Our diver surveys showed extensive canopy and understory kelp beds, and associated fish and macroinvertebrate communities. But as the sub extended these transects to deeper waters, the habitat changed dramatically to gradual sloping gravel and shell fragment bottom, dominated by sea stars, sea cucumbers, and the occasional rock fish near a few rock outcroppings. The algae community, that so characterized the inner waters, was noticeably absent in the deeper areas.

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Q3: Jenny - What did you learn that surprised you the most?

A3a: Ed Bowlby/Research Coordinator - I was surprised by the beauty of the upper 100 feet of water in the open ocean. As you descend or ascend through this layer, your are surrounded by a luminescent green, like being bathed in an eerie beautiful light. I called it "the green room." When you come up from the depths, you enter this area slowly. Gradually you start to see the underside of the sea's surface with light being refracted off the waves. It was very beautiful.

A3b: Carol Bernthal/OCNMS Manager - Some of the things that were surprising were 1) finding wolf eels in a bottom that was flat and deeper than normally would be expected (you usually find them hanging out in rocks); 2) the reaction of fish to the submersibles-they didn't see bothered by them at all; 3) the high density of crushed shells further offshore; 4) the lack of sea urchins in areas we expected to find them, which tells us that the prey base for predators such as sea otters is fairly geographically limited.

A3c: Bob Steelquist/OCNMS Education Coordinator - I seemed to scare schools of rockfish. I had one large ratfish that would just not go away, it kept positioning itself near the lights. Every time I moved, it came back. During training off the dock at the Seattle Aquarium I kept encountering schools of small sand lance. I would thrust up toward them from below. I could tell when they were reacting by the way individuals would begin to "twitch," as though trying to distract me. Ordinarily the entire schools swam in unison. In the presence of a large predator (me) this new behavior was successful in making me look at individuals. As this occurred, the school gradually dissipated.

Q4: Jenny - I was reading the logs and was surprise to learn that both submersibles and ROVs were aboard your R/V. Do all of the missions use both? What are the limits of the ROVs? When do you decide to use an ROV vs. the submersibles?

A4: Ed Bowlby/Research Coordinator - Good questions. Although our prime objective was conducting sub dives, we also wanted to test use of the ROV as another survey tool. Sometimes we cannot launch the sub due to weather or sea state conditions, then we turn to the ROV, since it can sometimes be launched when the sub cannot. This maximizes our use of ship time. Also if we are trying to survey an area that may have entanglements (e.g. discarded fishnets on rocky reefs), we may choose to send the ROV down first to assess the safety of the situation. Sub entanglement is a hazard we always try to avoid. Besides the sub and ROV, we also conducted night operations with ship board bottom grabs, another tool to characterize seafloor communities.

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Q5: Eric the Halibut - So how could you assess whether the sub attracted or repelled fish? Wouldn't you first have to quantify the fish in the area without the sub, but whatever you use to do that may well impact the fish as well.. Heisenberg uncertainty principle at its best..

A5a: Bob Steelquist/OCNMS Education Coordinator - Right on with Heisenberg. Tom and Annette's design called for using two subs. One would go to a location and settle down, letting the fish become accustomed to it. The sub 2 would then run a transect at 90 degrees, approaching sub 1. Video on both subs would be running. Sub

2 would see what it saw. Sub 1 would see what Sub 2 was supposed to see. Unfortunately, we couldn't carry out the experiment. Annette and Tom are hoping that SSE can try again in Florida Keys.

A5b: Ed Bowlby/Research Coordinator - Good points. Although we were not successful this first year in assessing that question, we (that is Tom Jagielo and Annette Hoffmann, sub pilots with Washington Dept. of Fish and Wildlife) were trying to use a two-sub experiment. One sub would find a fish aggregation area, park itself, and let the fish acclimate to its presence. Then the second (mobile) sub would cruise near the first, allowing the stationary sub to record fish behaviors related to the mobile sub. Of course, the presence of the first sub is still a contributing factor, one that has to be acknowledged. Also the same type of experiment was planned for a stationary sub and the mobile ROV. These will have to be repeated in future years.

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Q6: Marine Man - Did you get a chance to compare transects from areas that had been commercially fished with those that have not?

A6a: Carol Bernthal/OCNMS Manager - From fishing logs we had identified areas that had been heavily and lightly trawled in about 300 feet of water. Our intent was to send the submersible down to these areas, observe the seafloor and take note of the differences in biological communities between the two areas. Unfortunately, these areas were about 20 miles offshore and due to a number of mechanical problems with the ship and weather, we were unable to complete the project dives. We hope to repeat this study on the return trip of SSE, hopefully within the next two years

A6b: Ed Bowlby/Research Coordinator - Unfortunately, due to a combination of ship engine problems and uncooperative weather, we were not able to dive on sites we had selected for the heavy vs. lightly trawled areas. We still plan on investigating this with SSE in the future, as well as partnerships with other organizations and other tools.

Q7: Stephanie/Univ. of Washington - The weather here in western Washington state has been crummy for a couple of weeks now. How did the weather affect your dives? Does it affect the submersible once it is in the water?

A7a: Bob Steelquist/OCNMS Education Coordinator - Hi Steph. Swells offshore made it extremely dangerous to crane the subs off the ship. Annette had one dive scrubbed as she was in the water yet still connected to the crane. Dive supervisor and deck chief felt they might be able to get her off, but not sure they could get her back aboard. Sounded like the right call to me. Underwater there isn't much difference. In fact, dive procedures call for the sub to dive to bottom if its necessary to sit out bad conditions. Bobbing in DeepWorker on rough seas for very long makes for very

queasy pilots.

A7b: Ed Bowlby/Research Coordinator - The critical factor is launch/recovery. Once below the surface, the sub is fine, but safety factors dictate conservative windows we will allow the sub to operate. Hence the backup of using the ROV or other tools, such as shipboard bottom grabs.

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Q8: Jenny - When do will the DeepWorkers return to your coast? Will they also be used during different seasons to assess seasonal differences in the ecosystems? Or do you try to pick a window that generally has the best weather? How is the Deep Worker transmitted between sites?

A8a: Bob Steelquist/OCNMS Education Coordinator - Future OCNMS dives are in the cards, but we aren't sure just when. We hope in two years. This year's schedule was set based on logistical considerations and the difficulty of getting up the west coast, down the east coast and to the gulf all within the general field season. We think that a July window would be better. (Based on today's weather, maybe not so!) Deepworkers are very portable. They went out on trucks yesterday, one to Boston for start of Stellwagen's projects, one to Key West for pilot training.

A8b: Ed Bowlby/Research Coordinator - Although SSE will not visit the Olympic Coast site next year, the subs may return in the year 2001. We have limitations on what time of year they visit since we have a nationwide program, both east and west coasts, so we all have to be somewhat flexible on scheduling. This year we experienced more weather related problems than we have had during other NOAA sponsored research cruises, roughly the same time of year. And to answer your question of transport, the two subs are currently be driven cross-country for our east coast sanctuary sites. They are also small enough they could be transported in cargo-type aircraft.

Q9: Jenny - I read about the bottom grabs, but am not familiar with what they are or how they work. How much of the bottom do you sample? How often do you sample? Do you get (slow) animals too or just substrate?

A9: Ed Bowlby/Research Coordinator - There are several types of bottom grabs, but the basic principal is the same. Send down a heavy box-like device that once it hits the seafloor, it will scoop out (grab) a small (say gallon or two) of seafloor. Once this is retrieved, sub samples are taken for sediment size characterization, and the rest is screened to assess for macroinvertebrates.

(top)

Q10: Eric the Halibut - Does anyone have any permanent video monitoring stations on the sea floor of Sanctuaries? A remote "fish blind"?

A10a: Bob Steelquist/OCNMS Education Coordinator - Aquarius (in the Keys) might qualify as a fish blind, but otherwise, I don't think so. I like the idea of a "reefcam" too -- might make an interesting cable show, take five normal rockfish and put them in a reef together and every week check in on their lives.

A10b: Ed Bowlby/Research Coordinator - Our site has 'permanent' sub-tidal video transects at about a dozen sites. They are conducted by scuba divers using underwater scooters, transecting pre-selected sites. Unfortunately we cannot afford to visit these sites every year, but sample them every 4-5 years. Just two weeks prior to SSE arrival, a dive team was surveying, and we continued their survey efforts at two sites, one out to 300 ft. of water.

Laura Francis- These are all great questions (I'm learning a lot myself!). Are there some other chatters out there that would like to ask questions. Now is your opportunity to find out about this exciting expedition while it is still fresh and "hot off the ship"?

Hi Jenny, glad you are online. We do hope to expand the "teacher-in-the-sea" program to other sanctuary sites in the next couple of years. It is in the SSE education proposal for next year. I will definitely keep you posted. We are also planning to have Sanctuary pilots do some student-driven research projects.

Q11: Jenny - What is Aquarius? Where is it at?

A11: Laura Francis - Aquarius is an underwater research station operated by NOAA in the Florida Keys. Sylvia Earle and other scientists use it for two-week stays in relatively shallow (scuba range) water.

(top)

Q12: Jenny - Hey Laura. Trish is also here, but in an "observe only" mode. I've been forwarding her questions too. This is pretty neat. Does this chat become part of the SSE record? Can we access it or other chat sessions later?

A12: Laura Francis - Yes. This chat session and all others will be archived and can be accessed on the SSE web site at: **http://sustainableseas.noaa.gov/aboutsse/liveevents/liveevents.html**.

For all you other chatters out there, Jenny and Trish were part of a SSE Teacher workshop in NOAA's Gray's Reef National Marine Sanctuary last week. We will be doing another teacher workshop in the Olympic coast NMS Aug 8-13.

Christine was another Teacher in our Gray's Reef workshop and she has had the opportunity to go down in the Delta submersible in the Stellwagen Bank NMS. She shared some of the video from her dive in our workshop. It was very cool!

Q13: Christine - Yes, but my submersible dive cannot be anything like piloting a submersible in a kelp forest. It would be a completely different habitat and opportunity.

A13: Laura Francis - True. Every habitat is different and being a pilot is much different than being an observer, but both experiences are great, nonetheless. Glad you were able to log on, Christine. Maybe you can join us on the Stellwagen chat and share some of your experiences from your sub dive...

(top)

Q14: Jenny - I noticed that there were scientists flying up from all over to join the expedition. How do you get selected to join the expedition or to be a submersible pilot? Are there any more plans to train other teachers to be pilots (like Mike G. from Carmel)?

A14a: Ed Bowlby/Research Coordinator - We solicit research proposals from scientists to conduct research in the OCNMS. In some cases, we had scientists who were not trained as pilots, but used the other pilots to accomplish the work. In the case of educators being trained as pilots at our site, we were fortunate to have Bob Steelquist, who is our Education Coordinator, trained as a pilot.

A14b: Bob Steelquist/OCNMS Education Coordinator - My goal as education coordinator at OCNMS for long-term SSE projects is to act as the pilot/technician on student and teacher designed projects in the Sanctuary. Pilot spots are scarce and so I'd like to enable students and teachers to use DeepWorker as Principal Investigators. It is very early to start thinking about our next projects, but that's the direction I'd like to move toward.

Q15: Eric the Halibut - How about initiating an "interested-bystander-with-no-qualifications-in-the-sea" program? :-)

A15a: Ed Bowlby/Research Coordinator - Actually we did have a number of

student volunteers on our cruise. They helped with night operations (bottom grab samples), entering the dive logs into a computer, and other miscellaneous tasks. So, send us your name and we will see how we can plug you in!

A15b: Laura Francis - It would be fun wouldn't it! You are not the first person to ask that question. We hope to provide a window to these fragile undersea environments through the video collected during the expeditions so that people like you can vicariously participate with us on these voyages.

A15c: Bob Steelquist/OCNMS Education Coordinator - Based on your questions, I think you are overqualified for the position you described. Our goal is to make ocean science and exploration available to innocent bystanders. If not directly as pilots, then at least through education projects, information exchanges and other means. Perhaps the next generation will see DeepWorkers in suburban garages, as common as jet skis are now. For now, the fact that your are networked with us and asking good questions is great. Thanks for tuning in.

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Q16: Stephanie/Univ. of Washingtona - Were you doing oceanographic studies from the ship as well as using the submersible? Do you have some ideas about why there is a the high density of crushed shells further offshore? How would the crushed shells affect what organisms are found in this area?

A16: Ed Bowlby/Research Coordinator - One of the drawbacks of using the Navy ship Discovery Bay, was that it is not equipped for oceanographic collections. We did install a winch so we could collect bottom grabs. Mary Sue Brancato, a sanctuary pilot, and a team of volunteers attempted to collect bottom samples at night, when the subs were not being used. We had hoped to sample at sites that 30 years before had been sampled for macroinvertebrate community associations. However, we were only able to collect at a couple of sites before ship engine problems forced us off the coast. We may try to re-sample along the near shore sites off our small research boat, but will have to wait for another ship opportunity to resume the offshore sampling effort. Also the sanctuary had previously sponsored oceanographic cruises from NOAA ships and we hope to continue this effort in the future with various agency and university partners.

Q17: Heidi - What sort of modifications would you suggest could you make to an ROV or submersible to aid in your research?

A17a: Bob Steelquist/OCNMS Education Coordinator - The DeepWorker design is very elegant. Certainly tools can be added that give it additional capabilities, but I think we need to be thinking about modifying some of our research practices to fit DeepWorker. For example, if we research elk or sea otters, biologists spend long

hours observing these animals in-situ. This kind of observation is now feasible with submersibles. I hope we move in that direction -- the kind that requires trained human eyes to gather data.

A17b: Ed Bowlby/Research Coordinator - We tested the ROV with a weighted arrangement that allowed more use in higher current areas. This appeared to work fairly well but certainly could be improved. For the sub, the critical link is launch/recovery windows. For our open coast, new techniques must be found to launch during typical sea swell and local wind conditions. Additional suggestions: We hope that in the future that the DeepWorkers will be equipped with two robotic arms, one dedicated to the video/camera arrangement as this year, and the other as an arm capable of collecting samples, such as push-cores, water samples, etc.

(top)

Q18: Jenny - Someone mentioned early on that there were very few urchins when they continued the transects out past scuba depths. Why aren't there many urchins there? Lack of kelp?

A18: Ed Bowlby/Research Coordinator - - We are beginning to look into this and don't have a ready response as yet. These were in high current areas, which may be a contributing factor. Science cannot always provide quick responses since we have to examine all the contributing factors. Stay tuned.

Laura Francis - It is time to start wrapping up the chat. Thanks to all the participants and experts. The experts will try to answer the remaining questions. The next chat is from the Stellwagen Bank NMS on July 13 from 1-2pm East coast Time. We will also be doing a web cast/underwater uplink from the Gray's Reef NMS on July 28 from 1-2pm Eastern time. Check in at the SSE web site to register for these upcoming events! Glad you all could join us!

Bob Steelquist/OCNMS Education Coordinator - Thanks everyone! Bob

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Q19: Jenny - What kinds of fish are attracted to the submersible? scared away from it? Does the same thing happen if an ROV is used?

A19: Ed Bowlby/Research Coordinator - These were the sort of tests we hoped to conduct but were unable to this first year. But we hope we'll have opportunity in a couple of years to re-examine those questions with SSE's sub and ROV.

Jenny - Thanks! I learned a lot!

Carol Bernthal/OCNMS Manager - Thanks for all your great questions, hope we were able to answer a few and maybe stimulate additional thinking. We certainly have not yet totally assimilated all we learned on this cruise, so it's a project in progress.

Heidi - Thank You very much for your time Best of luck with your research.

Laura Francis - Please make sure to fill out your evaluations of the chat. This will help us improve future chats!

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July 13, 1999

10:00 am - 11:00 am Pacific time (1:00 pm - 2:00 pm eastern time)
Stellwagen Bank National Marine Sanctuary (SBNMS): Welcome to Stellwagen Bank

Introduction

During this chat you will meet with mission coordinators Peter Auster and Anne Smrcina, as they report from the Sustainable Seas Expedition to the Stellwagen Bank National Marine Sanctuary. Stellwagen Bank, an underwater plateau at the mouth of Massachusetts Bay, serves an important role in the ecosystem of the region, channeling waters and creating upwelling currents that power the multi-layered, productive food web. Not only is the water rich in plankton, but the seafloor is rich in habitat variety.

This year's DeepWorker dives are concentrating on deep, boulder reefs -- similar to tropical coral reefs -- just deeper, darker, and colder. But there is great beauty here. And there are some ugly beasts too. The rocks of these reefs are covered by organisms -- tunicates, bryozoans, sponges, mollusks, echinoderms, and crustaceans. Hiding among the nooks and crevices are important commercial fish species, as well as other species that have not yet attracted public attention.

The expedition to Stellwagen Bank has also incorporated other researchers who are further exploring the biodiversity of the region. Students from the American School for the Deaf (high school) and their teachers are studying sound in the sanctuary, particularly whale sounds as they relate to whale behavior and background noise levels. They are using the sailing vessel MIMI, famed from the Voyage of the MIMI curriculum and video series, as their research platform. Other researchers are looking at whales from other platforms including surface ships and an airship (the Hood blimp). Scientists from the Marine Biological Laboratory are studying microbial (microscopic) biodiversity, while teachers and a researcher from the National Marine Fisheries Service are directing their attention to the zooplankton species.

You are invited to direct questions to: Peter Auster, research coordinator of the sanctuary and science director of the National Undersea Research Center at the

University of Connecticut (and DeepWorker pilot), and/or Anne Smrcina, education coordinator of the sanctuary, acting on-site interim manager, and dive team coordinator. Questions to the ASD students on board MIMI will be forwarded to them.

Stellwagen Bank was designated as a sanctuary in November 1992. The sanctuary surrounds the entire Stellwagen Bank, a glacially deposited topographic feature lying in 65 ft. to 100 ft. of water. The sanctuary also includes the areas to the north of the Bank known as Tillies Bank and Tillies Basin, as well as the southernmost end of Jeffries Ledge. The seaward side of the Bank drops off rapidly to over 600 feet. Stellwagen Bank is the most prominent submarine feature in Massachusetts Bay, stretching for nearly 20 miles between northern Cape Cod and Cape Ann, Massachusetts.

Commercial fishing is the most economically important activity on the bank, though whale watching has grown steadily since 1976 due to the regional access and concentration of cetacean species. Current commercial whale watch activities involve more than half a million visitors to the Bank annually. Recreational activities, tourism, research, and commercial shipping are other important human uses. Seven historic shipwrecks have been identified within or adjacent to the boundaries, including the recently discovered and historically significant wreck of the steamship Portland that sunk in 1898. A heavily used vessel traffic separation lane transports more than 2700 commercial vessels in and out of Boston annually.

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SUSTAINABLE SEAS EXPEDITIONS
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SITE INDEX

August 9, 1999

1:00 pm - 2:00 pm eastern time (10:00 am - 11:00 am Pacific time)
Gray's Reef National Marine Sanctuary (GRNMS): Rivers to Reef

Introduction

Join us from Gray's Reef National Marine Sanctuary. Reed Bohne, GRNMS sanctuary Manager will host this event. You will talk with several scientists that conduct their research in Gray's Reef and ask them questions on topics ranging from the Loggerhead Turtle to archeological findings near the reef. You will also be given a live underwater tour of the Reef by Cathy Sakas, sanctuary education coordinator. During this tour Cathy will meet up with her GRNMS colleague Alex Score, sanctuary information systems coordinator, who will be piloting the DeepWorker.

On Monday August 9th at 1PM E.S.T. the pilots of the DeepWorker 2000 from Gray's Reef National Marine Sanctuary will be available to answer questions concerning their just completed mission for Sustainable Seas Expeditions. The participating pilots will be Alessandra (Alex) Score, Bruce Cowden, Cathy Sakas, Tom Potts, and Sarah Mitchell . The respective projects conducted by the pilots were: comparison of inner shelf reef invertebrates with those of the deeper outer shelf reefs; exploration of the inner shelf reef and deeper outer shelf reefs for fossils; day-night comparison of reef activity; fish population characterizations for the inner shelf reefs and deeper outer shelf reefs; and loggerhead sea turtle use of the reefs. The main focus of the chat will be the *Rivers to Reefs*theme that emphasizes the interconnection of Gray's Reef to inland Georgia as well as further offshore to the continental slope. The conduit connecting land to sea and rivers to reefs are the six fresh water rivers and their watersheds that drain on to the Georgia coast. The Altamaha River Watershed most directly influences Gray's Reef and is therefore the one in which we are the most interested. Join in the chat and learn about our individual projects and about *Rivers to Reefs*.

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Highlights

During the chat with the Gray's Reef National Marine Sanctuary (GRNMS) manager and sanctuary staff/pilots we learned a great deal about how the sanctuary works to preserve Gray's Reef and work with other partners to look after the health of this special ocean environment.

Reed Bohne, GRNMS Manager, shared how Gray's Reef works with other groups to study and preserve the reef. "The information we collect is shared with all coastal authorities and the public. Most of our studies are conducted with the help of other academic institutions and governmental offices so the data is widely shared.... As a group we are working with the Fisheries Council, Coast Guard, State, local and non-profit groups. The ocean is, as you know an incredible, dynamic environment and to work effectively in this environment it requires strong partnerships bringing a spirit of cooperation to the issues relating to the oceans."

The monitoring collaboration was also discussed by Ralph Rogers, GRNMS Research Coordinator for the SSE mission. While responding to a questions about the endangered Right Whale he shared, "The Right Whales are not in this area now. They spend the summer months much farther north feeding. We work with the Right Whales during the winter months during calving season. Last winter we worked with New England Aquarium and NMFS tracking a mother and calf pair to observe their behavior during this critical time."

Bruce Cowden, GRNMS Boat Operations Manager and Alex Score, Information Systems Specialist at GRNMS also discussed research done to help endangered species. When asked if they could share more about the recovery of the Loggerhead species, "Loggerhead sea turtles are on the threatened species list and do not appear to be in as much trouble as many other sea turtles, such as leatherbacks. There is data that suggests that maybe the Northern population of loggerheads, which include loggerheads North of Florida, are more endangered then the Southern population. With collaboration to coastal sea turtle research and offshore work we hopefully will be able to answer that question one day."

Cathy Sakas, Education Specialist at GRNMS discussed the role of the sanctuary since its designation by President Jimmy Carter in January 1981. She suggested that there may be a growing issue with the coral in Gray's Reef , but the sanctuary is generally a healthy environment, "Over the past few months we have noticed some changes in coloration in the Oculina coral. The normal brown color of some of this hard coral is turning white. Other than that the reef looks to be in terrific health and is a real pleasure to dive on and explore."

Cathy continued by discussing what it was like to explore Gray's Reef from the submersible, "The creatures didn't seem to mind the subs at all and even seem to come to the sub especially during the night dive when the camera lights were on. I had a very large male hammerhead shark come in for a look, and he actually hit the dome of the sub."

Tom Pott, visiting scientist at Gray's Reef, gave some inspirational insight into why he became a marine biologist and what it meant to be able to use the submersible to conduct underwater observations. "Many studies have been done to document how certain fish species move off the reef to feed, hunker down under cover for protection, and to actively search for food... To actually see this in motion was exciting and witnessing "ecology in action" rather than reading about it in a scientific paper reinforced why I chose to go into marine biology as a profession... nothing beats just looking around. That's the advantage of working in a sub... you actually get to be on the bottom and observe. We're all experienced scuba divers, but to go down without the limitations of scuba and relax was refreshing. Plus, I had a chance to see a new deep ledge. It was like an alien seascape."

Read on and you will learn even more from the exciting team at Gray's Reef!

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Transcript

Laura Francis/SSE education - Welcome to the chat room for the Rivers to Reef chat with the folks at Gray's Reef National Marine Sanctuary. You are welcome to leave your questions here before the chat begins. You will not be able to see your question until a moderator has had a chance to review it and add it to the chat room. Thank you for joining us!

Laura Francis/SSE education - Welcome to the chat room. We are ready to get started. We have a whole crew of experts ready to answer your questions. We have Alex Score, Bruce Cowdan, Ralph Rogers, Reed Bohne, Tom Potts, Cathy Sakas and Sarah Mitchell all from the Gray's Reef NMS.

Ralph Rogers /GRNMS - Hello, we at Gray's Reef are online and ready for your question!

Trish Jenny/NMEA Conf - Hi Laura. This is Trish and Jenny. I think we just signed on from the NMEA Conference. We are sitting in front of the SSE Exhibit. . . the Deep Worker Model is behind us!!!

Reed Bohne/GRNMS - Welcome everyone. This is Reed Bohne at Gray's Reef and we're glad you've joined us for the Web Chat. We have just completed a very successful Sustainable Seas Expedition and have the DeepWorker pilots on line to answer you questions. We were most fortunate with the weather and virtually every dive planned was conducted. Lets begin

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Q1: Sarah - Hi Laura, This is Sarah, I'm excited to be here on line. Jenny and Trish are with me!!

A1: Laura Francis/SSE education - It is Great to have all of you online! Trish and Jenny participated in a Sustainable Seas Teacher Workshop at the Gray's Reef NMS in June.

Alex and Bruce/GRNMS/pilot - Hello, Both Bruce Cowden and Alex Score are here joining you from North Georgia Mountains amongst the famous Bartram trails. We were both pilots during the SSE missions at Gray's Reef. Bruce was searching for fossils and I was investigating invertebrates. It was an incredible mission.

Cathy/GRNMS pilot - Hello, I am Cathy Sakas here in the Gray's Reef office.

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Q2: Trish Jenny/NMEA Conf- Did Bruce find any cool fossils? How did the fish react to the Submersibles? Did you get to try the experiments with the fish blind? How did the fish react to the Submersibles?

A2: Tom Pott/GRNMS Pilot - Many of the fish, such as black sea bass and amberjack, were attracted by the sub. It probably was the result of a combination of factors: lights, noise, and prop wash uncovering food for the fish. Other fish, such as some of the large groupers, were clearly agitated by the sub and did their best to stay hidden or away from the "action."

Laura Francis/SSE education - I'm in Forks, Washington at a Sustainable Seas Expeditions Teacher Workshop at the Olympic Coast NMS with 15 teachers from different sanctuary communities around the country. We have one teacher who flew in from American Samoa to participate!

Q3: Ben - I had heard that some scientists and explorers had located Pacific sharks capable of surviving deep waters without movement. This is contrary to the notion most sharks need movement in order to pass water over their gills. Is there a correlation between this and the discovery of sharks with multiple gills or prehistoric features? Do you expect to encounter some of these species in your expeditions? Thank you for considering my question.

A3: Tom Pott/GRNMS Pilot - Ben, You posed a pretty tough question that I, unfortunately, cannot answer. However, I don't imagine that we'll encounter any new shark species since the continental shelf off Georgia keeps water depths relatively shallow. These areas are substantially fished and uncovering any new species would be a tremendous find.

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Q4: Rachel/Philadelphia - What was the purpose of the Sustainable Seas Expeditions in general and specifically at Gray's Reef?

A4: Reed Bohne/GRNMS - Rachel The Sustainable Seas expedition for Gray's Reef has been an incredible opportunity for research and public outreach. The DeepWorker Submersible offers an unprecedented opportunity for observation of the reef and its inhabitants. With the sub we are not limited to the tradition 60 minutes at 60 feet as on SCUBA. In addition it has allowed us to explore at depths beyond the safe limits for SCUBA such at the Sapelo Scarp reef where we dove for hours examining this deepwater Gulf Stream-influenced habitat. We will be analyzing the scientific data from the cruise and be in a better position soon to relay the value from that perspective, but all initial accounts by the pilots are very positive. The DeepWorker submersible has also generated an enormous amount of public interest as well. There is no better spokesperson for the conservation of the marine world that Dr. Sylvia Earle. When you combine the innovative technology of the DeepWorker with the eloquence of Dr Earle, you know it will strike a chord with the interested public. We view SSE as the starting gate for our efforts to begin reassessment and revision of the Gray's Reef management Plan. It will be a two-year process and involve everyone interested in the conservation of marine habitat off the coast. SSE is an unparalleled kick off for this most. At Gray's Reef we were looking at the following areas, fish populations, invertebrate community structure, turtle habitat, geo-archaeology and day/ night changes. We think all the dives associated with the project will help enormously

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Q5: TrishJenny/NMEA Conf - How did the diversity change when you dove the ledges outside Gray's Reef in deeper water? Did you find the boulders? How deep was it? Were the same types of organisms found?

A5: Alex and Bruce/GRNMS/pilot - The deeper ledges were in about 180-200 feet deep. The ledges were about 6 to 10 feet in relief and the invertebrates and fish diversity showed a mixture of tropical and temperate species. More amber jacks and angel fishes. The ledge extended over an area of 3 miles.

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Q6: Brian - Did any of you collect data on the loggerheads during your dives?

A6: Alex and Bruce/GRNMS/pilot - I came upon a large female loggerhead sleeping in the sand flat about 1 mile away from the reef. Alex saw a previously tagged turtle with cohort reflector tags twice during a dive near by the capture site. We gathered video and location data.

Q7: Maureen/scubadiver - How long has Gray's Reef been a sanctuary? Has there been any documented decline/improvement in the reef since designation? How deep did you dive and how did the benthic community react to the explorer's presence?

A7: Cathy/GRNMS pilot - Gray's Reef has been a national marine sanctuary since January 1981 when then President Jimmy Carter designated it as such. Over the past few months we have noticed some changes in coloration in the Oculina coral. The normal brown color of some of this hard coral is turning white. Other than that the reef looks to be in terrific health and is a real pleasure to dive on and explore. We dove on three different areas at 70, 130 and 195 feet. These depths represent the inner, middle and outer shelf reefs. The creatures didn't seem to mind the subs at all and even seem to come to the sub especially during the night dive when the camera lights were on. I had a very large male hammerhead shark come in for a look, and he actually hit the dome of the sub.

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Q8: Brian - Did any of you collect data on the loggerheads during your dives?

A8: Sarah/GRNMS pilot - Hello Brian, searching for sea turtles was one of the research projects planned for SSE off of the coast of Georgia. Bruce and other pilots observed sea turtles and we will compile all of the sightings and determine how best to proceed with the project of investigating sea turtle density at GRNMS.

Q9: TrishJenny/NMEA Conf - We fish offshore at the 40 mile bottom off Cumberland. It seems as though this is a rocky substrate, too. How far south does the reef (or reef-like areas) run along the GA / FL coast?

A9: Alex and Bruce/GRNMS/pilot - There is live bottom ledges found from North of Cape Hatteras, NC to South of Cape Canaveral, FL. The specific ledge we dove was the Sapelo Scarp. This feature runs north to south about 5 miles long.

Q10: Rachel/Philadelphia - How old is the oldest fossil found at Gray's Reef?

A10: Alex and Bruce/GRNMS/pilot - So far from the fossils we have collected the oldest is mammal fossil, a bison leg bone, dated 10, 000 years old, Bruce

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Q11: TrishJenny/NMEA Conf - How will you process the data from this expedition so that it can be used in the classroom? or can this data be useful to classroom teachers?

A11: Cathy/GRNMS pilot - Trish and Jenny, The data we have garnered from the missions will be used in existing school programs when we talk about Gray's Reef in the context that it is connected to inland areas as well as coastal all the way to the continental slope. There are many species of fish and invertebrates that use the inner coastal waters for spawning and as nurseries and then as adults use the off shore reefs for food and as habitat. We'll most likely develop one or two new programs characterizing the theme of "Rivers to Reefs" to make the connection of Georgia's inland counties to the continental slope.

Q12: Ben - Hmm.... maybe I have been watching too many NOVA programs on TV :). A simpler question : Will any of your research be forwarded to the local coastal authorities for safeguarding of the reef marine life?

A12: Reed Bohne/GRNMS - Ben You can't watch too many NOVA programs. The information we collect is shared with all coastal authorities and the public. Most of our studies are conducted with the help of other academic institutions and governmental offices so the data is widely shared. Our approach at the sanctuary is specifically to encompass an area beyond the boundaries of Gray's Reef. This is our Rivers to Reefs theme, which involves authorities all along the major river watersheds and offshore to the continental shelf break. As a group we are working with the Fisheries Council, Coast Guard, State, local and non-profit groups. The ocean is, as you know an incredible, dynamic environment and to work effectively in this environment it requires strong partnerships bringing a spirit of cooperation to the issues relating to the oceans

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Q13: Brian - How do these deep reefs like the Sapelo Scarp differ from typical shallow-water reefs? How much sunlight do they get at those depths?

A13: Alex and Bruce/GRNMS/pilot - The shallower reefs are definitely different

from the deeper Sapelo Scarp reefs. From previous studies it seems that the Sapelo Scarp is Miocene Epoch. The inner shore reefs are younger from the Pliocene, between 10,000 to 20,000 years ago. We still haven't quantified the data from this trip but it seems as if the deeper reefs support more tropical species then the shallower reefs. The water clarity at the deeper sites seemed to allow about the same light penetration as Gray's Reef. There seemed to be larger and more abundant predatory fish in the deeper sites.

Q14: TrishJenny/NMEA Conf - Bruce, did you find any evidence of human hunters on the fossiled bison leg bone? Would you expect to find this kind of evidence?

A14: Alex and Bruce/GRNMS/pilot - There is no evidence to date but that is one of the indications we would be looking for.

Q15: TrishJenny/NMEA Conf - Sarah -- did you find any male sea turtles? were they tagged? Is there any way you can use the submersibles in your satellite tagging efforts?

A15: Sarah/GRNMS/pilot - Alex and Bruce both sighted sea turtles while flying the Deep Worker offshore Georgia. It is often difficult to determine if the individual is a male or female unless the characteristic long tail of the male is observed. Satellite tagging must be done onboard a boat to get the attachment secure and in the best location on the turtle's top shell.

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Q16: Keith/Atlanta - When will you get to work with the DeepWorker again?

A16: Reed Bohne/GRNMS - Keith We would like to see it back tomorrow, but we just bid the NOAA Ship FERREL and the Deepworker subs farewell this morning on their way to the Florida Keys. The expedition at the Keys will be tremendously exciting and everyone can continue to track the SSE mission through the website. All the Sanctuaries and the SSE team will be getting together in the fall to plot our strategies for next year. The SSE project is a five year program but for logistical reasons it won't get to all the sanctuaries this year. Those that weren't included this year will have top priority next year and in all likelihood SSE will not be back next year to all the sites visited in 99. We hope of course to see SSE next year or the year after and we'll be making our pitch, but for now we'll just have to stay tuned for the schedule

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Q17: TrishJenny/NMEA Conf - How do you assess changes in night/day activities? Do you count fish? Record behaviors? Look at distribution? Something else? Do you rely mostly on video taped accounts or also collect data in real time? What were your initial observations?

A17a: Tom Pott/GRNMSPilot - Diurnal activity changes are monitored most effectively with your own eyes. Many studies have been done to document how certain fish species move off the reef to feed (such as tomtates and other grunts), hunker down under cover for protection (angelfish), and to actively search for food (bigeyes, moray eels, groupers). But to actually see this in motion was exciting and witnessing "ecology in action" rather than reading about it in a scientific paper reinforced why I chose to go into marine biology as a profession. Do you count fish? We use a few different proven methods to count fish. Some are very difficult to conduct, but yield statistically strong results. Others are a lot easier (and fun) to conduct, but may not be as statistically strong. Record behaviors? Absolutely. Look at distribution? Yes. This is critical to get a sense of what's happening on and off the reef and why. Do you rely mostly on videotape accounts or also collect data in real time? Both. videotape is great because you can walk away from your sub dive with a record of what you saw. Plus, it gives you a way to better quantify the area you're looking at. This is important when addressing questions of species and individual abundance. However, nothing beats just looking around. That's the advantage of working in a sub...you actually get to be on the bottom and observe. What were your initial observations? Awe. We're all experienced scuba divers, but to go down without the limitations of scuba and relax was refreshing. Plus, I had a chance to see a new deep ledge. It was like an alien seascape.

A17b: Cathy/GRNMS pilot - Trish and Jenny, I relied mostly on observation taking notes of what I was seeing at what times. My dive began at 7:30 PM and ended at 11:30 PM. I was able to see the diurnal creatures still active and then the crepuscular activity - which was actually very little and then the change over to nocturnal. During the crepuscular and nocturnal periods I alternately kept the lights on and off. With the lights off I was able to see the most spectacular display of bioluminescence I have ever seen, and I have done a lot of night diving in the Caribbean and Keys. With the lights on the animals took advantage of it and interacted in front of me and the cameras. I taped some amazing footage of a medium sized octopus (~2' in diameter with arms outstretched) stalk and attack a black sea bass. The octopus was unsuccessful in its attempt, but it made great footage. Of course the hammerhead was outstanding as well as all the fry and smaller fish species that swarmed over my dome and lights like a cloud of mosquitoes on a hot humid night in a swamp. I did paint one of my light's lenses red with my toenail polish I happen to have with me (imagine that)but the light was too dim and eventually burned out to do any good. Next time I'll check that little important detail out before going down. The red light would have helped me see the crepuscular and nocturnal activity under more normal conditions.

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Q18: TrishJenny/NMEA Conf - Do you plan to revisit GRNMS in a different season to compare any seasonal differences?

A18: Ralph/GRNMS - We have a year round effort to visit Gray's Reef at various seasons to study the changes in fish and invertebrate populations. However, we only have the submersibles this one time this year and all other efforts will be by SCUBA.

Q19: TrishJenny/NMEA Conf - Do you plan to revisit GRNMS in a different season to compare any seasonal differences?

A19: Tom Pott/GRNMS Pilot - Absolutely. In this region of the South Atlantic Bight, we're privileged to see a complete transition from subtropical to temperate flora and fauna species. To get a handle on what's out there, when, and why, seasonal studies are not only essential, but critical.

Q20: Rachel/Philadelphia - Can you tell me more about Loggerhead Sea Turtles and the potential for recovery of the species?

A20: Alex and Bruce/GRNMS/pilot - Loggerhead sea turtle are on the threatened species list and do not appear to be in as much trouble as many other sea turtles, such as leatherbacks. There is data that suggests that maybe the Northern population of loggerheads, which include loggerheads North of Florida, are more endangered then the Southern population. With collaboration to coastal sea turtle research and offshore work we hopefully will be able to answer that question one day.

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Q21: Keith/Atlanta - Are reef fish protected within the boundaries of Gray's Reef?

A21: Reed Bohne/GRNMS - Keith, yes we do have specific protections in place for reef fish at the sanctuary. Our regulations prohibit the use of any types of trawls in the sanctuary, no powerheads for spear fishing, no wire fish traps and no collection of tropical species. The federal regulations regarding catch and size limits for the region also apply at the sanctuary so the sport fishers know well the limits there. We will be revising our management plan in the fall and the community will be assessing whether other measures are appropriate for reef fish conservation at the Sanctuary. We invite you to be part of that process and encourage you to contact our office and check out our webpage at **www.graysreef.nos.noaa.gov** for more info on our programs

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Q22: Tom/Nashville - Was it very hot inside the DeepWorker or do you have air conditioning?

A22a: Laura Francis/SSE education - It can be very hot. When I was in the pilot training in Key West, we made a makeshift air conditioner out of a frozen water bottle that we put in front of the scrubber fan. It kept the left quadrant of my left knee cool, but did not have much of an effect otherwise!

A22b: Tom Pott/GRNMS Pilot - Tom, DeepWorker was INCREDIBLY hot when diving within the Sanctuary. The air temperature during the two weeks was in the 90-100F range. Plus, the water temperature was around 84F so we didn't get any relief when submerged. Unfortunately, since the sub is so small and battery power is a precious commodity, having air conditioning or a fan is out of the question. Heat exhaustion was a real concern when diving and the technicians were consistently monitoring how the pilots fared on the bottom. At the deep reef area, though, water temperature was much more comfortable (in the 72-74F range). This sufficiently cooled the sub and made the hull chilly to the touch. This was a refreshing change that better allowed me to concentrate on conducting research.

Q23: Rachel/Philadelpha - What is the most common invertebrate at Gray's Reef and why is it important?

A23: Alex and Bruce/GRNMS/pilot - Sponges such as vase sponges and rope sponges are the most common invertebrate. Competition for space on hard bottom in the Georgia Bight is intense. Species of invertebrates are often seen growing above other species such as bryozoans above sponges, and tunicates above bryozoans. All the invertebrates play a vital role in the Live Bottom habitat. They provide food and shelter for other motile invertebrates and fish.

Q24: Ben - I'm curious, what type of temperatures did you encounter on the shelf and do they cause concern for precise navigation along the perimeters? Oh... this is directed to any of the pilots.

A24: Ralph/GRNMS - The water temperature on the reef site ranges from top at 91F to bottom around 85F. On the outer reef it was a bit cooler in the low 80's, but very warm this time of year. This had no effect on our navigation.

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Q25: Marilyn at Sustainable Seas In Washington - Hi! Trish and Jenny and the folks at NMEA. Was the area you are working dated with the newer Magnetic markers? What exactly are you looking at in marine paleo at the site. Is it geological paleo, or bio in nature?

A25: Alex and Bruce/GRNMS/pilot - No, send your contact information and we will have Dr. Ervan Garrison respond, the PI in this project, Bruce

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Q26: Keith/Atlanta - I've learned a little about the endangered right whale. Are there right whales at Gray's Reef?

A26: Ralph Rogers/GRNMS - The right whales are not in this area now. They spend the summer months much farther north feeding. We work with the right whales during the winter months during calving season. Last winter we worked with New England Aquarium and NMFS tracking a mother and calf pair to observe their behavior during this critical time.

Q27: Rachel/Philadelphia - Do you see leatherback sea turtles at Gray's Reef? If so, have you done any research specific to the species?

A27: Alex and Bruce/GRNMS/pilot - No usually at Gray's Reef but we have sighted them closer to the Continental Shelf. We found a whole school in early summer of about 10 leatherbacks about 50 miles offshore, Bruce and Alex

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Q28: Tom/Nashville - Is pollution a problem at Gray's Reef?

A28: Cathy/GRNMSpilot - Hi Tom in Nashville, I lived in Music City USA during junior high school! So far Gray's Reef is in great shape. We have not seen any indications that pollution is a problem. We have however noted in our observations a color change in some of the Oculina coral. In the past few months we have noticed that the normal brown color of some of the clusters of this coral have turned white. At this point we don't know if this is a natural phenomenon in their life cycle or if other influences have caused the change. Dr. Steve Giddings at NOAA Headquarters is currently drawing up a plan to systematically monitor the water quality at each of the existing 12 national marine sanctuaries.

Q29: Rachel/Philadelphia - 1) Did you see the same fish species at Gray's Reef

and the outer reef (Sapelo Scarp)? 2) Were their activities the same?

A29: Tom Pott/GRNMSPilot - 1) Some species were similar (such as a few of the grunts and damsel fish), but Sapelo Scarp supported more of a deep reef/tropical fish community. We observed quite a few tropical fish species that we've never documented at Gray's Reef, as well as a few groupers and trigger fish. 2) Primarily. Similar species will exhibit similar activities regardless of their environment.

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Q30: Keith/Atlanta - Will you be working with the New England Aquarium again this coming winter on the right whales?

A30: Ralph Rogers/GRNMS - Yes, we hope to be working with New England Aquarium again this winter to expand on our successful work.

Q31: TrishJenny/NMEA Conf - Cathy, Do you have any night vision goggles that could be used on later trips to avoid the artificial light problem? Will they even work underwater?? Can red lenses be placed over the Deep Workers lights?

A31: Cathy/GRNMSpilot - Trish and Jenny, Thanks for your terrific questions. Red lenses will work if the right brightness of the light is used. My light was way too dim for it to be effective. Night vision goggles I was told would not have worked well because of the amount of turbidity in water. The particulate matter would have looked like snow. I used the technology available to me which was the light switch. I turned the lights off and on and observed. Again though the most dramatic sighting for me was seeing the dinoflagellates and the tunicates and whatever else was out there light up like a tiny city coming to life after darkness sets in. I was thrilled to see what I saw and have an even bigger appetite now to see more.

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Q32: Tom/Nashville - What would happen if you caught someone stealing tropical fish from Gray's Reef?

A32: Reed Bohne/GRNMS - Tom - In the sanctuary program we make every effort to inform the public about the rules of the sanctuary and how all can contribute to conservation of the reef. This approach called 'Interpretive Enforcement" stresses education as an important element of enforcement. For a specific incident many factors would be considered. The procedures for a violation of sanctuary regulations pass through the enforcement and legal divisions of NOAA and may come before an Administrative Law judge for resolution. Our regulations provide for assessment of penalties of not more than $100,000. This limit can be assessed to the violation for

each day the violation continues. Of course this is the maximum dollar amount and lesser violation receive less severe assessments. In most cases we find that the public is very supportive of the protections in place for the sanctuary and we do not need to resort to civil penalty remedies.

Laura Francis/SSE education - It is close to 11am and we need to start wrapping up the chat. Thank you all for participating, especially the 7 member crew from Gray's Reef NMS. We sure needed all of you today. Thanks for the great question. Please remember to fill out an evaluation after the chat so we can get your feedback on how to make these events the best learning experience possible.

Q33: TrishJenny/NMEA Conf - WOW!! What a cool experience!! Are more studies planned?

A33: Ralph Rogers/GRNMS - We hope to have the subs back here in future years, but if not, we've got plenty of SCUBA work to keep us busy. Thanks for joining us in the web chat.

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Q34: Ben - Hey, you guys and gals are plenty bold to dive in a sub without A/C! And I am surprised the water was that warm. Will this effect future dive prospects based on unusually high surface temperatures?

A34a: Cathy/GRNMSpilot - Hi Ben, Actually the individual tolerance of the pilots for heat are an important factor in determining when a dive can be conducted. Sitting in the sub at the surface or on the deck of the boat with the hatch secured can be a most unpleasant circumstance. The greenhouse effect can be high. With a little prior planning however the deleterious effects of the heat can be minimized. I wore a bathing suit and had two frozen liter bottles of water inside the sub on the outside of my legs. I also had a towel and several bandanas to soak up the sweat and to rub the ice around my neck. I also drank the ice as it melted. Some battery operated fans would have been very good as well as a sun shield that could be employed inside the dome of the sub.

A34b: Alex and Bruce/GRNMS/pilot - It was really hot but bringing a couple of frozen bottles in the sub and placing them in front of the scrubber fan really helped. I don't think it will change our decisions on diving the sub. I hope that in the future we can be able to use the submersible throughout all four seasons.

A34c: Tom Pott/GRNMS Pilot - I don't think the warm temperatures will prohibit future sub work. Field scientists have been venturing into uncomfortable

environments for the sake of science for a very, very long time now. You just deal with the conditions and move on. For many of us, this is what makes our profession so exciting...if it was easy, then the challenge would be lost. However, pilots and technicians wouldn't permit a sub dive if conditions were exceedingly hazardous to anyone involved.

Laura Francis/SSE education - Please remember to log in to **http://sustainableseas.noaa.gov/aboutsse/liveevents/aug20video.html**

for the next live event that will take place from 10 am to 11 am pacific time on August 20. This will be a live video uplink from the Dry Tortugas in the Florida Keys National Marine Sanctuary. Look forward to seeing you all on line!

Ben: Most excellent interactive ! Thanks !

Reed Bohne/GRNMS - Dear Webchatters- Many thanks from all of us at Gray's Reef for taking time to join us online. We are all still on cloud 9 or fathom 50 at the conclusion of the SSE mission. We owe a tremendous debt of gratitude to Dr. Sylvia Earle for her vision and commitment to the Sanctuary program. Stay with the Expedition at the website **www.sustainableseas.noaa.gov** and track the exploits in the Florida Keys and Flower Garden Banks. We're be here at www.graysreef.nos.noaa.gov Feel free to contact us directly and join us in the revision of the GRNMS plan this fall.

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May 18, 1999
Video Broadcast Summary

10:00 am to 11:00 am Pacific time (1:00 pm to 2:00 pm eastern time)
Monterey Bay National Marine Sanctuary and Prickly Shark Ecology: The Process of Observation and Analysis

Introduction

Our Monterey Bay National Marine Sanctuary (MBNMS) host Andrew DeVogelaere , Assistant Manager of the MBNMS, Francesca Cava, SSE Project Manager, and Laura Francis, SSE Education Coordinator provide an overview of SSE and the MBNMS. During the event we were also joined by Rick Starr and Greg Cailliet from the Moss Landing Marine Lab. These two experts gave an overview of the "secret lives of the Prickly Shark." Our experts shared what they know about Prickly Shark ecology.

Monterey Canyon is the only place that Prickly Sharks have been observed and tagged in large numbers. In the MBNMS the DeepWorker will be used to conduct visual transects at the heads of several major canyons.

The waters of Monterey Bay and the adjacent Pacific Ocean off the central California coast were designated for protection in 1992 as the Monterey Bay National Marine Sanctuary. This vast area stretches 350 miles north to south, extends an average of 35 miles offshore, and covers over 5300 square statute miles. The Sanctuary is managed to balance recreational and commercial uses with protection of water quality, habitats, and its bountiful resident and migratory marine life.

Rick and Greg will tell you about the prickly shark ecology investigation underway during the Monterey expedition. Prickly sharks are found in tropical and temperate regions on the continental shelf or slope, generally from 70 to 400 meters. Monterey Canyon is the only place that prickly sharks have been observed and tagged in large numbers. It is not known whether prickly sharks reside in the canyon or stop there along a migratory route. Very little is known about the sharks' behavior and habitat preferences.

DeepWorker will be used to conduct visual transects at the heads of several major canyons to estimate the distribution and relative abundance of prickly sharks as well as other large sharks. Data obtained, combined with acoustic telemetry data from another study, will be used to determine habitat utilization, behavior, long- and short-term movements, and population dynamics of these sharks. In addition, the team will describe the role of observation in developing a scientific understanding of the marine habitats and species within the sanctuary. Other research topics that will be described briefly include the monitoring of fish populations at Big Creek Ecological Reserve (BCER) and assessing the distribution and abundance of mid water fish and invertebrates.

Come onboard and get to know the Monterey Bay National Marine Sanctuary and a little something about the elusive prickly shark!

To learn more about the Monterey Bay National Marine Sanctuary, visit these two NOAA Web sites:
www.sanctuaries.nos.noaa.gov/oms/omsmonterey/omsmonterey.html
and
http://bonita.mbnms.nos.noaa.gov/

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Highlights

Learn all that you ever wanted to know about the Monterey Bay National Marine Sanctuary (MBNMS) and the Prickley Shark! Our team of experts shared some great information from along the shore of the Monterey Bay at the Hopkins Marine Station managed by Stanford University.

During a brief introduction to the MBNMS by Sanctuary Research Coordinator, Andrew DeVogelaere, we were reminded of some of the many spectacular features of the Monterey Bay. He told us how the bay hosts the underwater Monterey Canyon. The Canyon is over 13,000 feet deep, and is as large as the Grand Canyon in Arizona.

Next, Francesca Cava and Sylvia Earle discussed the goal of SSE and the role that the DeepWorker plays in conducting research in the national marine sanctuaries. As Francesca shared some pre-recorded footage of the DeepWorker, she told us what it is like to be a pilot of this unique submersible. The most amazing thing she said was that she does research at such great depths, with such incredible visibility - all while staying warm and dry!

Our shark experts Rick Starr and Gregg Cailliet talked about 'the secret lives of the Prickley Shark'. The Prickley Shark has been spotted in the Monterey Bay Canyon at both 80 and 800 feet. They get their name from the scales that cover their bodies

that are like small volcanoes that are very rough or scratchy. In addition to the discussion of the physical features of the shark, its life and environment were also explored. Current research is focused on trying to use tagging techniques to learn more about their movements, such as why do they live in both the deep and shallow water and where they go when they leave the Monterey Canyon.

This one hour program shows again why Monterey Bay is such an amazing and unique marine environment!

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Video Link

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May 27, 1999
Video Broadcast Summary

11:00 am to 12:00 am Pacific time (2:00 pm to 3:00 pm eastern time)
Channel Islands National Marine Sanctuary and the Great American Fish Count

Introduction

We joined Ed Cassano, Manager at CINMS, Laura Francis, SSE Education Specialist and Julie Goodson, Education Outreach Coordinator from CINMS a as they conducted the Great American Fish Count. While the McARTHUR remained in the Bay supporting Ed in the DeepWorker, we will were stationed on Anacapa Island in the Channel Islands National Park. From Anacapa, Laura will take us underwater to demonstrate how the fish count is conducted and explain what is learned during this project. While underwater, Laura is also joined by Ed as he conducts his own fish count in the DeepWorker.

The waters that swirl around the five islands contained within NOAA's Channel Islands sanctuary combine warm and cool currents to create an exceptional breeding ground for many species of plants and animals. Nearby forests of giant kelp provide a nutrient-rich environment for teeming populations of fish and invertebrates. Every year over 27 species of whales and dolphins visit or inhabit the sanctuary including the rare blue, humpback and sea whales. On the islands seabird colonies and pinniped rookeries flourish while overhead brown pelicans and Western gulls search the water for food. The Channel Islands sanctuary is located 25 miles off the coast of Santa Barbara, California. Today, the sanctuary encompasses the waters that surround Anacapa, Santa Cruz, Santa Rosa, San Miguel and Santa Barbara Islands, extending from mean high tide to six nautical miles offshore.

We will join sanctuary staff and volunteers as they conduct the Great American Fish Count. This annual event mobilizes and trains volunteer divers and snorkelers in established methods to identify and document fish diversity and population trends in marine sanctuaries and coastal areas. The Fish Count inspires recreational divers and snorkelers to: participate in year-round volunteer monitoring programs; raise awareness in the diving community and public-at-large regarding marine habitats and

trends in fish populations; provide researchers, marine resource managers and policy makers with this useful information that otherwise would be unavailable.

During this event, the NOAA Ship McArthur will be stationed a few hundred yards off Landing Cove at Anacapa Island. Dr. Earle will conduct a deep fish count transect using the DeepWorker while volunteer divers are counting fish in shallower water using scuba. We will be able to gather fish population data along a shallow to deep transect in the sanctuary. During the event, Ed Cassano will take you on a virtual fish count dive in the kelp forest of Anacapa landing cove and will talk to you live from underwater using specially adapted diving equipment.

Join us as we explore, count fish with DeepWorker and Volunteer scuba divers at Anacapa Island in NOAA's Channel Islands National Marine Sanctuary!

To learn more about the Channel Islands National Marine Sanctuary, visit these two NOAA Web sites:
www.sanctuaries.nos.noaa.gov/oms/omschannel/omschannel.html
and
http://www.cinms.nos.noaa.gov/

To learn more about the Great American Fish Count visit this web site:
http://www.fishcount.org/

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Highlights

Wow, what an exciting time on Anacapa Island! With the generous support of the Channel Islands National Park's underwater video team, we were able to take you on an actual fish count with our diver host Laura Francis as she met up with the DeepWorker, also diving close to Anacapa Island.

The event begins with Julie Goodson and her student summit team on the Anacapa Island dive platform. Julie and the team provided a brief overview of the Channel Islands Marine Sanctuary and the Great American Fish Count (GAFC). The GAFC is a volunteer dive and underwater observation program that allows marine resource specialists to understand fish habitats as they are monitored in a non-obtrusive manner.

Next, with the help of Dave Stoltz, Park Service diver/camera person, we were able to watch Laura conduct her fish count, live, underwater. She identified and recorded 15 different species. Later in this dive, she swam up to the DeepWorker and greeted Ed, sitting in the cockpit, with a slow wave of her hand. Ed had launched the submersible from the NOAA ship McARTHUR earlier in the morning.

Ed had been conducting a fish count in waters deeper than those SCUBA will support. To his pleasant surprise during his count he observed a Black Sea Bass. This was good news as this species had been fished to near extinction in previous decades. Everyone involved in the mission were encouraged that their efforts to preserve the fish are clearly producing observable results!

Our program ends as Ed leaves the Anacapa cove to continue his fish count. Laura meets up with other volunteer fish count divers and makes her way back to the Anacapa dive platform... and as she goes, she shows us a Pink Abalone and encourages it to snack on some kelp from a local plant.

Our Channel Island experience was a great hour of discovery and exploration!

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Video Link

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July 28, 1999

1:00 pm - 2:00 pm eastern time (10:00 am - 11:00 am Pacific time)
Gray's Reef National Marine Sanctuary (GRNMS): Technologies Used by SSE and GRNMS

Introduction

During this hour-long live video event, we will take you live toGray's Reef National Marine Sancturary (GRNMS) located 17 miles off of the Georgia coast. Reed Bohne, Sanctuary Manager hosts a panel of invertebrate, fish and archeological experts. They discuss the activities are the reef and what makes this such a unique environment. Later Alex Score, Information Systems Coordinator, provides an indepth tour of the DeepWorker. Our program then takes you underwater while Cathy Sakas, sanctuary education coordinator, provides an interpretation of what our underwater camera is capturing at the reef. During our program we also meet up with the DeepWorker submersible. As a DeepWorker pilot, Cathy is able to give more background on the DeepWorker and how Alex is able to easily explore the reef using this exciting new technology.

As we take questions from Sally Yozell at the Coastal Zone '99 conference, from students participating via Georgia distance learning programs and chatters from around the world, Cathy and Laddie Akins from the REEF Foundation, serve as our experts and guides. We learned about the other exciting investigations that are occurring in this important marine environment, such as characterization of invertebrate and fish populations, surveys of archeological artifacts, and behavioral studies of loggerhead sea turtles. SSE exploration is focused on three areas: inside the boundaries of the Gray's Reef sanctuary, at the shelf break, and at a midway point between the two, each on live bottom areas. Abundance and distribution data for invertebrates, turtles, and fishes collected will be a part of ongoing and continuing seasonal and annual variation studies.

Gray's Reef is one of the largest nearshore live-bottom reefs of the southeastern United States. The sanctuary is located 32 kilometers (17.5 nautical miles) off Sapelo Island, Georgia and encompasses 58 square kilometers (17 sq. nautical miles) of live-bottom habitat.

Gray's Reef is a submerged hard bottom (limestone) area that, as compared to surrounding areas, contains extensive but discontinuous rock outcropping of moderate (6 to 10 feet) height with sandy, flat-bottomed troughs between. The series of rock ledges and sand expanses has produced a complex habitat of caves, burrows, troughs, and overhangs that provide a solid base for the abundant sessile (attached or non-moving) invertebrates to attach and grow. This rocky platform with its carpet of attached organisms is known locally as a "live bottom habitat". This topography supports an unusual assemblage of temperate and tropical marine flora and fauna. Algae and invertebrates grow on the exposed rock surfaces: dominant invertebrates include sponges, barnacles, sea fans, hard coral, sea stars, crabs, lobsters, snails, and shrimp. The reef attracts numerous species of benthic and pelagic fish, including black sea bass, snapper, grouper, and mackerel. Since Gray's Reef lies in a transition area between temperate and tropical waters, reef fish population composition changes seasonally. Loggerhead sea turtles, a threatened species, use Gray's Reef year-round for foraging and resting and the reef is part of the only known winter calving ground for the highly endangered northern right whale. Fossil bivalves and gastropods, and mastodon bones located in this area indicate that the reef was once a shallow coastal environment and an exposed landform as recently as 10,000 years ago.

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Highlights

During this hour of adventure we take an action-packed marine field trip to Gray's Reef National Marine Sanctuary (GRNMS.) Our location was from within the sanctuary waters 17 miles off of the Georgia coast. Sanctuary Manager Reed Bohne, hosted an hour full of activity.

We began with a conversation with three experts onboard the NOAA Recreational Vehicle, Jane Yarn. Laddie Akins, Executive Director of the Reef Environmental Education Foundation (REEF) discussed the diverse and unique fish population at Gray's Reef. He discussed the role of REEF to involve volunteers to observe and identify fish during their recreational dives. He commented on how valuable this information is to the research and scientific community in understanding our underwater environment.

Cathy Sakas, Marine Educator at GRNMS gave an overview of the fish and invertebrate population at the reef. She shared how the inhabitants use the reef and its ledges as protection and a food source. Cathy also provided an overview of the Loggerhead Turtle research the is conducted at the sanctuary. She discusses how currently researchers are tagging male turtles with transmitters in an effort to understand their habits.

Our third expert, Sherri Littman, leading the Geological and Archeological study at GRNMS, discussed this unique project underway at GRNMS. She explained that the

bones found in numbers appear to be from mammoth, mastedon and bison. They think that at one time the area of the reef was once like the Georgia coast today. They have dated some of the bones to be 6,000 years old, but they believe that some bones may be much older.

We then take some questions from our special guests at the Zoo Atlanda and the Aquarium at Skittiway Island in Georgia. We were also joined by the participants at the Coastal Zone '99 conference underway in San Diego, California.

After a pre-taped tour of the DeepWorker conducted by Alex Score, Information Specialist at GRNMS, we are then taken underwater by SSE videographer, Kip Evans. During Kip's tour of the reef we meet up with Alex as pilots the DeepWorker. We continue to take questions from our online audience, as Cathy and Laddie provide a topside interpretation of life along the reef.

So join us on our visit to this unique underwater world that is home to such exotic creatures as the Florida Sea Goddess and the curious Arrow Crab!

Video Link

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August 20, 1999

1:00 pm - 2:00 pm eastern time (10:00 am - 11:00 am Pacific time)
Florida Keys National Marine Sanctuary (FKNMS): Preserving the Beauty of the Keys

Introduction

During this program we will take you to Dry Tortugas located 70 miles from Key West, Florida. Our hosts Billy Causey, FKNMS sanctuary manager, and Mary Tagliareni, education coordinator, will take you on a great learning adventure. We will begin the program by reviewing national and regional perspectives on marine zoning. We will then explore the coordination being done in the Keys to establish Tortugas as a marine reserve. Later in the program, Bill Goodwin, resource manager, will give you a live underwater tour of the coral located in this spectacular environment.

You will see first-hand why few marine environments in the U.S. compare to the Florida Keys in terms of natural beauty and natural resources. The most extensive living coral reef in the United States is adjacent to the 126 mile island chain of the Florida Keys. The Keys are located on the southern tip of the Florida peninsula, beginning 60 miles south of Miami and ending just 90 miles north of Cuba. These coral reefs are intimately linked to a marine ecosystem that supports one of the most unique and diverse assemblages of plants and animals in North America. The 2,800 square nautical FKNMS surrounds the entire archipelago of the Florida Keys and includes the productive waters of Florida Bay, the Gulf of Mexico and the Atlantic Ocean. Cultural resources are also contained within the sanctuary. The proximity of coral reefs to centuries old shipping routes has resulted in a high concentration of shipwrecks and an abundance of artifacts.

At the tip of the Keys lies the Dry Tortugas region, a remote area some 70 miles west of Key West and over 140 miles from mainland Florida. Its coral reef, hardbottom, and seagrass communities are bathed by the clearest and cleanest waters in the Florida Keys archipelago, due in part to the strong influence of the Florida Current or Gulf Stream. At some point, the waters of the entire Caribbean Sea and Gulf of Mexico pass by the doorstep of the Tortugas, delivering a phenomenally rich array of organisms from a huge area of the Caribbean basin. As a result, the Tortugas is a

swirling vortex of marine biodiversity fueled by one of the world's strongest currents.

This region's characteristics are ecologically unique. It is North America's only breeding ground for sooty terns, brown noodies, masked boobies, and frigate birds all of which depend on healthy fish communities for their prey. The Tortugas are also home to America's largest brick structure and boasts a number of "firsts" including the location of the world's first underwater photograph, the world's first marine protected area (Fort Jefferson National Monument, est. 1935), and the first tropical marine laboratory in the Western Hemisphere.

In addition to its marine and historical features, this complex marine ecosystem also supports tourism and commercial fishing, the economic foundation of the Florida Keys. In the last 20 years the tourism industry has grown to over four million domestic and foreign visitors who drive, fly or cruise each year to the most accessible tropical paradise in the Caribbean Basin. The Keys support 82,000 full-time residents. Tourists and semi-permanent residents increase this population by 75% during "season" (November to April). This ecosystem's extensive nursery, feeding and breeding grounds also support a multi-million dollar commercial fishing industry that lands nearly 20 million pounds of seafood and marine products annually.

For well over a decade, Key Largo NMS (100 nm^2) and Looe Key NMS (5 nm^2) have provided protection to exemplary portions of Florida's Reef Tract. However, public concern about increasing threats to each of the habitats that comprise this sub-tropical ecosystem resulted in the establishment of the Florida Keys National Marine Sanctuary in 1990.

Come take a look at this world-class underwater world!

To learn more about what is special about the Tortugas region, how the ecological reserve will be established, and how you can get involved in the process if you so desire, see:
http://fpac.fsu.edu/tortugas/index.html

To learn more about the Florida Keys National Marine Sanctuary, see:
http://www.fknms.nos.noaa.gov/

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Highlights

Join us as we take an in depth look at the Florida Keys National Marine Sanctuary (FKNMS.) During this program we take you 70 miles out from Key West, Florida in the Dry Tortugas area. Our event takes place from the NOAA RV Dante Fascall.

Mary Tagliarni, Interim Education Coordinator at FKNMS hosts an all-star cast of

experts. Dr. Sylvia Earle, Explorer in Residence at the National Geographic Society and Head Scientist for SSE, Billy Causey, FKNMS Sanctuary Superintendent, and Walt Jaap from the Florida Marine Research Institute. This group of experts discussed the importance of marine reserves and the impact that this effort has on the preservation of the coral ecology at the Keys and around the world.

Mary hosts this panel as they share their significant knowledge about the Keys and the health of the coral environment there.

Sylvia discussed how we are just now learning the limits of what man's impact on the ocean may be. The role of the DeepWorker in extending our range of understanding of the sea as scientists personally explore the ocean as submersible pilots as well as observers. Dr. Earle shared some footage taken during one of her recent night dives and how the DeepWorker will also play a role in making these dives a richer learning experince. Finally, she discussed the unique challenges faced as we create marine reserves in our oceans. We learn how some of the work done during the SSE missions will contribute to this important conservation effort.

Billy Causey added that the Florida Keys marine zoning plan and its expansion are seeking to strike a balance between the use of underwater resources with protection of those resources. He explained that the effort at the Keys had resulted in five types of zones designed to accomplish varying goals in accordance with the unique needs of the area. Billy described how some of the zones are designed to preserve areas that have not yet experienced extensive damage and how other zones are designed to foster the re-growth of some coral and fish species. He explains how the preservation and conservation of selected areas results in the overall health and abundance of species in non-protected areas.

Walt Jaap has been studying coral in the Tortugas since 1975, Walt is also a DeepWorker Pilot. Walt described how the Tortugas was an extremely diverse environment that in addition to the coral there are also large fields of sea grass beds and sedimentary areas. These environment provide refuge, feeding and nursery habitat for many different fish species. Walt also shared what is happening to coral today. He stated that the study of the condition of the coral at Tortugas provides valuable insight into the impact that heavy use has on some of the less remote coral areas. He also shared how the DeepWorker observations were allowing an more in-depth study of the deeper reefs in Tortugas.

Later in the program our chat room host Laura Francis, Education Coordinator for SSE, shared questions from our audience, SSE videographer, Kip Evens, took us on an underwater tour guided by Bill Goodwin, Research Coordinator at FKNMS. As Bill guided us to some amazing underwater sites, our onboard experts answered questions and provided interpretation.

Prepare to get splashed as you take this up-close look at efforts to conserve our great coral colonies in the sea!

Video Link

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SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

VIDEO BROADCASTS

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September 7, 1999

3:00 pm - 4:00 pm eastern time (12:00 pm - 1:00 pm Pacific time)
Flower Gardens National Marine Sanctuary (FGNMS): Coral Spawning and Deep Water Habitats

Introduction

Join us from onboard the Ferrel as it docks in Galveston, Texas. During this last video event in the series we will explore the FGNMS and the SSE mission here. In addition, as SSE completes its first year in the sanctuaries we take an in depth look at how the NOAA Ship's McARTHUR and Ferrel have operated as launch and support platforms for the DeepWorker, the mission scientists and staff.

G.P. Schmahl, FGNMS Sanctuary Manager, will host this overview of Flower Gardens and its unique geographical features such as salt domes formed millions of years ago. We will then conduct an exploration of the SSE mission at FGNMS. We begin by providing an up close look at the operations that are conducted daily on the NOAA ship Ferrel. We will look at the video and tracking operations that are unique to SSE. We will also be given an overview of the daily operations necessary to keep the ship operating and able to accommodate its crew and the mission staff and scientists.

In addition, Emma Hickerson, research coordinator, will host an exploration of two major FGNMS projects being conducted during the SSE mission. First we will look at the amazing phenomenon of Coral Spawning. Since 1990, a substantial effort has been made to document the annual coral mass spawning at the Flower Garden Banks. In water, the emphasis has been to identify the organisms that participate, recording the timing of and behavior exhibited by each species, and the capture of genetic material for laboratory based observations. DeepWorker will provide the opportunity to conduct uninterrupted observations throughout the entire spawning period (>4 hrs). In addition, DeepWorker will allow researchers to document reproductive activities of corals well below safe scuba diving depths.

The next project will feature studies of the banks' deep habitats that are currently limited to work conducted in the 1970s. Areas of special interest include a graben and brine seeps. Surveys have been conducted around the perimeter of the East Bank to

determine the presence of brine seeps as well as document the biological assemblages below 30 meters. The U.S. Geological Survey has produced high resolution bathymetry of FGNMS. This USGS data will be used to predetermine locations of interest on which to deploy DeepWorker and a remotely operated vehicle.

Join us for this exploration of this garden in the sea!

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Highlights

This final web cast was a full hour with many guests. We covered a wide range of topics as we conducted the event from onboard the NOAA Ship Ferrel while at the Army Corp of Engineer dock in Galveston, Texas. Emma Hickerson, Science Coordinator at FGBNMS hosted this hour.

We began with a brief overview of the Flower Garden Banks by Sanctuay Manager GP Schmahl. GP discussed why the Flower Gardens are so unique. He told us about the salt dome formations and how this geological feature creates such a unique marine environment.

We then took a tour of the Ferrel narrated by Paul Moen, Ship Captain. Paul gave us a glimpse of what it is like to be onboard a ship as it supports an oceanographic science and research mission. He also introduced us to the NOAA Corp and why this group of people is so special to NOAA and the accomplishment of the administratgion's goals.

We were then joined by Stacy Muellen, Field Officer on the Ferrel, and also part of the NOAA Corp. Stacy discussed how she first heard of the Corp and why it held such special appeal to her as a scientist. She talked about what it was like to live onboard the ship and some of the research missions that she has been a part of all over the world.

We then talked with two people that conduct the onboard support of two very important functions for the SSE missions. We first met Kip Evens, SSE Videographer with the National Geographic Society. Kip gave us a quick tour of his editing studio onboard the Ferrel. He discussed the importance of capturing the dives on video and how the scientists use the footage to further their research goals. We then talked with Dave Lott, from NOAA's Special Projects Office. Dave works with the tracking software used during the DeepWorker dives. He told us how the data collected during the dives will be used to visualize the underwater environments and better understand the geography of the sanctuaries.

We then shifted focus and discussed some of the exploration conducted during the Flower Garden Banks National Marine Sanctuary mission. Emma hosted a conversation with Steve Gittings, SSE Science Coordinator and Peter Vize from the University of Texas. Peter and Steve discussed coral spawning. The gave an overview

of how the phenomenon was first observed and their theories about why it occurs at such a specific time of the year. They then reviewed what they were able to observe during past years and what they were able to observe this year.

Steve and Emma then went on to give an overview of the Brine Seep in the sanctuary waters. We learned what creates these underwater pools and their impact on the surrounding ecology. Steve explained how difficult it is to study these environments as they occur at such great depths.

We finished the program with a few words from Dr. Sylvia Earle. Dr. Earle gave an overview of what happened during the SSE missions this year and what we can expect next year as the expeditions continue!

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September 2, 1999

1:00 pm - 2:00 pm eastern time (10:00 am - 11:00 am Pacific time)
Florida Keys National Marine Sanctuary (FKNMS): 1999 SSE Mission Overview/Preserving the Keys

Introduction

Join us for this chat with Billy Causey, sanctuary manager, Mary Tageliareni, education coordinator, Bill Goodwin for a chat about what they learned during their first mission in the Keys.

Investigations in the first year of the Sustainable Seas Expeditions will focus on: exploration and site characterization of the proposed Tortugas no-take ecological reserve as part of the Tortugas 2000 initiative; scientific monitoring of deep coral reef health; and baseline monitoring of selected artificial reef sites. Deep water exploration of coral reefs will be conducted to expand present knowledge of sanctuary resources and provide information important to understanding ecosystem health. It will allow scientists to compare the health of deep reefs with shallow reefs, which appear to be undergoing increases in coral disease and bleaching. Observations recently made at Conch Reef suggest reef health is better at greater depths. Sustainable Seas Expeditions missions will: survey the vitality of deep water coral populations; create permanently marked deep reef sites for benthic cover and species composition monitoring; determine the limits of hermatypic coral growth; and assess diseases and bleaching along transects to limits of hermatypic coral growth. Data will serve as a baseline to monitor future changes.

Coral reef exploration and characterization missions will concentrate on Carysfort Reef, Elbow Reef, and the Tortugas Banks. A 1979 submersible survey described a reef system in 30-50 meters depth offshore of Carysfort and Elbow Reefs, but little is known about its present condition. The Tortugas Banks are a complex of deep reefs west and south of Loggerhead Key, Dry Tortugas. This area has important fisheries, unique coral communities, and is proposed as a portion of the country's largest Ecological Reserve/No-Take Zone (185 square nm). Because of its remote location, this area is poorly understood, yet it offers a unique setting in which effects associated with the Gulf of Mexico can be discerned from those associated with South

Florida.

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Highlights

This chat with the experts and staff at Florida Keys National Marine Sanctuary (FKNMS) proved to be a highly informative hour of online interactivity. We were joined by:

- Walt Jaap, Associate Research Scientist / Florida Marine Research Institute
- Dr. Erich Mueller, Director of Florida Keys Marine Research Center / Mote Marine Research Institute / at the Center for Tropical Research
- Bill Goodwin, Resource Manager / Florida Keys National Marine Sanctuary
- Ben Haskell, Science Coordinator / Florida Keys National Marine Sanctuary
- Mary Tagliareni, Interim Education Coordinator / Florida Keys National Marine Sanctuary

Each of our experts shared a great deal about their experiences in the Floriday Keys and other areas where they have conducted research. Walt Jaap shared his extensive understanding of the history of the coral in the Florida Keys. The time it takes to build a coral reef can be a few hundred to millions of years. In our area, the Florida Keys, the geological experts (See article by Shinn and others, 1977, Proceeding of the 3rd International Coral Reef Symposium) have found that the reefs off the Florida Keys came into existence following the Wisconsin Ice Age 4000 to 7000 years before present." He goes on to discuss how coral age is determined.

Erich Mueller also shared some of what he knows about the coral in his response to a question regarding coral disease in the Keys. "Along with colleagues, I have been looking at the incidence of coral diseases throughout the Keys and in the Bahamas. Last year we also began to include bleaching and do not have as good a quantitative handle on the variance in bleaching. Bleaching was particularly bad in 1997 and 1998 and the last El Niño is widely believed to have been responsible for elevated temperatures and calm weather that may be largely responsible for coral bleaching events." Erich goes on to discuss some of the other factors that are believed to play a role in coral bleaching and why it impacts certain coral environments.

Ben Haskell gave an overview on what he sees as the impact of no-take zones. "You asked whether the no-take zones are working and why we aren't seeing large fish in the deeper waters. The no-take zones, of which there are 23, have been in effect for two years. After only a year, the zones had a positive effect on fish abundance and lobster abundance and size. We determined this by counting and measuring fish and lobster inside and outside of the zones once or sometimes twice a year." He went on to explain how they will continue the same level of monitoring for the next three years at which time they will produce a 'Zone Performance Report' that will be used to evaluate the effectiveness of no-take zones as a management tool for marine conservation.

Our two sanctuary staff member in the chat encouraged chatters to pursue their interest in the oceans and to get involved in the sanctuaries as much as they can. Bill shared what inspired him to want to be involved with the sanctuary, " I knew that I wanted to work for the Sanctuary after I attended a presentation on Looe Key NMS by Billy Causey while I was a marine science instructor at Sea Camp (1987). Five years later I became the assistant manager of the Key Largo site. I would certainly encourage students to visit the sanctuary, particularly as a student participant in some of the excellent marine education programs..."

Mary encourages students to stretch themselves and their imaginations and they just may find themselves doing something similar to her. "I am not a marine biologist by formal training. I was a Recreation/Outdoor Education major... Taking chances is what makes life interesting and a challenge!!!"

So read on, you will be amazed at what you will learn from this stellar group of marine experts!

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Web Chat Transcript

Andrea/NASAChatHost - Welcome to the chat room for the chat with the Florida Keys National Marine Sanctuary staff and several of the scientists that participated in the SSE mission. We will provide you with a brief introduction to each of our experts. You are invited to ask your questions any time before the chat begins - however, you will not see your questions in the chat room until a moderator has had a chance to review it and add it to the chat room. Thanks for joining us!

Walt Jaap, Associate Research Scientist / Florida Marine Research Institute / Mr. Jaap has been with the Florida Marine Research Institute in St. Petersburg, Florida for 27 years. He has been conducting research on the coral reefs in the Tortugas since 1975. During the first week of the Sustainable Seas Mission, Mr. Jaap conducted three DeepWorker dives investigating the deep reefs in the Tortugas.

Dr. Erich Mueller, Director of Florida Keys Marine Research Center / Mote Marine Research Institute / at the Center for Tropical Research. His research is focused on scleractinian corals including mechanisms of calcification, environmental controls of growth, reef restoration and patterns of coral disease occurrence. He primarily works in the Florida Keys and Bahamas with experience in Jamaica and Australia. During SSE, Dr. Mueller focused on the effect of Gulf Waters on the benthic habitat in the Tortugas.

Bill Goodwin, Resource Manager / Florida Keys National Marine Sanctuary / Mr. Goodwin has been with the Florida Keys National Marine Sanctuary since 1991 when

he first served as the Assistant Manager in the Upper Region office. More recently, Mr. Goodwin has worked extensively in coral and seagrass damage assessment and restoration in the Florida Keys. In the Florida Keys, he has assisted with the restoration at the Maitland, Elpis, and Columbis Iselin sites.

Ben Haskell, Science Coordinator / Florida Keys National Marine Sanctuary / Mr. Haskell is responsible for administrating the no-take zone monitoring program. He is also the project coordinator for Tortugas 2000- a collaborative effort to establish an ecological reserve in the Tortugas.

Mary Tagliareni, Interim Education Coordinator / Florida Keys National Marine Sanctuary / Ms. Tagliareni has been with the Sanctuary since 1990. She has designed and implemented several education programs in the Florida Keys. She was also trained as a DeepWorker pilot and conducted two dives during the Florida Keys mission.

Laura Francis/SSE education - I'm glad Jenny and Trish are on board today. These two teachers participated in our SSE teacher workshop in the Gray's Reef National Marine Sanctuary in June and have been enthusiastic participants of several of our SSE chat sessions - Great to have you and your students here!

We have most of our experts on line, fingertips ready for typing , so go ahead and start with your questions.

Q1: Robert Ginsberg - Why does the major development of corals at Sherwood Forest occur on the north and west margins of Tortugas Bank?

A1a: Ben Haskell/FKNMS Robert- My guess is that corals are better developed on the NW margin of Tortugas Bank because this is where the food is abundant and optimal feeding occurs. In other words, as the Gulf of Mexico loop current hits Tortugas Bank it causes upwelling of nutrient-rich water which fuels the food chain part of which is zoo plankton which corals feed on.

A1b: Walt Jaap/pilot researcher - Bob: As usual, you ask the difficult questions. The Tortugas Bank System, including the Sherwood Forest, probably came into existence thousands of years ago when sea level was much shallower than it is today. The area may have had a slight elevation from a Pleistocene reef. The coral larvae settled and grew as shallow reef system until the depth of water was sufficient to reduce the light and coral growth rates such that today, we see a drown reef with corals forming plates and mushroom growth forms indicating that they are doing their best to gather the light. At the base of the reef at about 130 ft, I was impressed to see that even there the corals were striving to survive. The fact that through-water visibility is good is a sustaining factor that this deep reef system has survived. Other deep reefs around the Dry Tortugas seem to be controlled by the amount of light that penetrates to depth. For example, the Bird Key Reef, SE of Garden Key has a large growth of corals in depth of 30 to 60 ft, but beyond about 80 ft the reef changes into

a sand or sediment habitat.

Q2: Jenny/CCHS - I'm interested in the mushroom corals you described at Sherwood forest. Are they found elsewhere? Are they strangely formed because of environmental stresses (i.e. deeper than normal water)? Is the SSE/FKNMS studying these corals?

A2a: Ben Haskell/FKNMS Jenny- We're interested in the mushroom corals as well. Not much is known about this shape or morphology and what causes it. Dr. Robert Ginsburg, a coral reef biologist at Univ. of Miami, is studying these corals and trying to determine how and why they grow the way they do. I suspect it is an adaptation to the low light conditions in which these corals grow at 70 plus feet. I have heard of these formations in other parts of the Caribbean like Cayman Islands. They are definitely unique to the Florida Keys' reef tract.

A2b: Walt Jaap/pilot researcher - Jenny: The mushroom shape of the corals we found in Sherwood forest and Reiley's hump are the result of very low light at the 90 to 130 ft depths. When light (a precious resource for an organism that depends on photosynthesis for a large portion of its energy budget)is limited, corals maximize their surface area by forming the plates and cones that we saw in out submarine excursions. The undersides of the corals are are not protected by the coral polyps and they become a popular location for worms, shrimp, algae, and sponges to take up residence. These plants animals can bore into the coral skeleton and as time passes, the process we call bioerosion removes much of the coral skeleton. The end result is a small column (stem) supporting a cone- the mushroom look. In diving many areas of the world, I have seen corals of a similar shape. The area off of Freeport in the Bahamas has a similar look. I am told that corals in the Flower Garden Bank also have a mushroom shape. The FKNMS and a US EPA project have established monitoring stations in a nearby area we call Black Coral Rock. We will be studying the coral diversity (number of species), percent coral cover, and incidence of disease. This is the first year that we have sampled Black Coral rock. For details on the project see http://www.fmri.usf.edu/coral.htm.

Q3: Don - What effect will global warming have on the coral reefs as the ocean waters warm up?

A3: Walt Jaap/pilot researcher - Don: Your question has stimulated a good deal of discussion over the past decade. We know that corals, the principal builders of coral reefs can survive and do well in water temperatures that range from about 64 to 86 ° F. When temperatures rise above 88 ° F the corals are stressed and physiological processes start going haywire. As a result, the corals and other reef organisms with sysbiotic algae bleach or turn white. In severe cases there is massive die off. If global climate change brings increasing and chronic rises in seawater temperatures in areas where coral reefs thrive, the prediction is that the reefs will be at risk for several

reasons. The symbiotic algae are a principal provider of food to the corals and without this source of energy, the corals will cease to grow, will crease to reproduce, and possibly will die and be replaced by a different type of community. Besides the threat of seawater temperature increase, ozone depletion, facilitates greater ultra violet (UV) solar spectrum to pass through the atmosphere and subsequently through the shallow waters. UV can cause skin cancer in humans and is an agent that is documented to cause genetic mutations. Reef organisms that are attached (not mobile) in shallow depths are at risk from uv poisoning. The increase in carbon dioxide in the atmosphere is sometimes referred to as, "the greenhouse effect." It stimulates atmospheric heating (temperature rise). This decade is reported by climate experts to be the hottest on record. In addition to the temperature effects associated with carbon dioxide increases, the increase in CO2 may result in oceanic chemical changes in the CO2 cycle. Masses of CO2 are tied up in limestone and seawater; the chemistry is complex but in essence CO2 from the atmosphere is absorbed by seawater and then the corals and other organisms that use it in building their skeletons. Changes in atmospheric CO2 affect the ocean and reefs. Higher seawater temperature, more CO2, and UV will change the reefs in many ways. We are unable to predict with precision what will happen. Will reefs expand to more temperate regions? Will reefs move into deeper water? Will reefs become extinct in shallow tropical areas?, Will the evolutionary process modify the shallow-water reef organisms and provide stocks that are tolerant of the changing environment? Can humans modify their habits to reduce the impacts that are causing the global climate change?

Q4: Ben - How long does it take to make a coral reef?

A4: Walt Jaap/pilot researcher - Ben: The time to build a coral reef can be a few hundred to millions of years. In our area, the Florida Keys, the geological experts (See article by Shinn and others, 1977, Proceeding of the 3rd International Coral Reef Symposium)that the reefs off the Florida Keys came into existence following the Wisconsin Ice Age 4000 to 7000 years before present. They used a core drill, recovered the material, and carbon dated the base of the boring. If you use coral growth rates for the star corals, about one-half inch in a year, in 100 years that coral would grow to a bit over four feet (This assumes no loss from boring or problems with hurricanes). The branching corals (staghorn) grow at a rate of about 4 to 5 inches in a year. In 100 years a thicket 37 ft high could accumulate. This does not occur because the branhces are fragile and storms and disease will usually control the height to a few feet. Atoll reefs in the Pacific are millions of years old. The cores indicate long periods of sustained coral growth and interruptions from sea level changes.

Q5: Trish/CCHS - What are the major water quality differences between the Gulf of Mexico and the Atlantic Ocean? Is there a gradual merging between the two or is there a definite line?

A5a: Erich Mueller/Mote Marine Lab - Trish: The interaction of the Gulf of Mexico with those of the Atlantic Ocean is via the Florida Current (which becomes the Gulf Stream off the east coast of Florida). The Gulf itself is fed by Caribbean waters from the Yucatan Current and by large amounts of fresh water input from the Mississippi and other rivers emptying into the Gulf. So, the Gulf receives tropical waters which are then modified by their residence time in the Gulf and runoff from approximately 50% of the U.S. area. Thus, the Gulf becomes substantially influenced by land, including sediments, natural organic material and pollutants. All of that water exits the Gulf in basically two ways: 1) by evaporation or 2) via the Straits of Florida (between the Florida Keys and Cuba). The Gulf waters enter the Straits west of the Dry Tortugas and through the Keys themselves. While there is considerable mixing, the mixing area is fairly small on an oceanic basis (perhaps a few hundred square miles). The line of the Keys, including the extension beyond the Dry Tortugas could be considered the "mixing line".

A5b: Walt Jaap/Pilot researcher - Trish: The eastern Gulf of Mexico, Caribbean Sea, and the Atlantic Ocean converge around the Dry Tortugas. A major ocean current passes from the Caribbean Sea between Cuba and Mexico and at various times during the year spins off a shunt called the Loop Current. The Loop Current may penetrate far north into the Gulf and then reverse course and return to the Straits of Florida where it joins the Florida Current-Gulf Stream. One interesting facet of the Loop Current is that in the spring, it often captures the Mississippi runoff and carries it along. The Mississippi water is low in salinity and often filled with materials that make it look brown. The Mississippi Rive runoff is typically detected in August off the Keys and in Oct off North Carolina. In general, the water on the Atlantic side of the Florida Keys has a more constant and higher salinity, and is less turbid (better visibility through the water column). This is one of the reasons the reefs are far more abundant on the Atlantic side of the Keys.

Q6: Trish/CCHS - There is still a lot of bleaching on Looe Key. Why is there not as much in the Tortugas? Is bleaching related to environmental stress, disease or a combination of both?

A6: Erich Mueller/Mote Marine Lab - Trish: Along with colleagues, I have been looking at the incidence of coral diseases throughout the Keys and in the Bahamas. Last year we also began to include bleaching and do not have as good a quantitative handle on the variance in bleaching. Bleaching was particularly bad in 1997 and 1998 and the last El Niño is widely believed to have been responsible for elevated temperatures and calm weather that may be largely responsible for coral bleaching events. Bleaching caused by such physical parameters can be considered an "abiotic" disease (like asbestosis or heat stroke in humans). There is one example in a Mediterranean coral where bleaching is caused by a bacterial infection and more such linkages may be found in the future. Although I cannot comment on differential bleaching in the Tortugas relative to the other Keys, we have found that other coral diseases have a significantly lower incidence in the Dry Tortugas than in the Key West area. We are looking at the distribution of diseases in the Keys to see if there might be a "smoking gun" that relates water quality to the incidence of disease. With that

said, I should note an observation made in June at a remote site in the Exumas (Bahamas) where there was virtually no local human impact. I found a reef where almost every large coral head (of several species) was infected with disease, in some cases, multiple diseases on a single colony. I have never seen such a concentration of disease on any reef of the Keys. Thus, there may be regional or even global factors influencing the incidence of coral diseases.

Q7: Jenny/CCHS/GA - Hi! Our students have been reading about the SSE project in the Keys and have several questions. I will try to categorize them for you. We will be signing on with a class full of students later. Thanks! Jenny Brady and Trish DuBose. 1) CORAL STRESS --What is causing the stress on the coral? Why is there less disease in the deep water reefs? How is the habitat/conditions different? Is the coral "safer" in deep water? Can the coral be transplanted to another location? 2) EFFECTS OF DIVING -- What effects does diving the submarine have on your body? Do you feel the pressure changes on your ears, like swimming or scuba diving? What special precautions do you take to stay safe? Is it difficult to "hold the camera straight" while diving? 3) WAVES/STORMS -- Was the SSE Project effected by Hurricane Dennis? How big do the waves in the Keys? At what point do you have to stop diving the submersibles? Can you feel the waves/storms underwater while you are in DeepWorker? How does the currents effect navigating the submarine? 4) STUDENT SUMMIT -- What was the outcome of the Student Summit? What plans did the students come up with? How did they react to the summit? Were they enthused? Will you be involving students in other parts of the country? When is the next Summit? 5) CAREERS -- How did you get into diving and your current jobs with the SSE program and Marine Sanctuaries? What advise do you have for HS Students interested in Marine Related careers? 6) COLLECTION -- Do you collect organisms during your dive? Do you bring them back to your lab to study? Do you eat any of them? 7) NAVIGATION -- How do you navigate/drive the submersible (and know where you are going)? Do you ever get lost? You mentioned on the last day that poor visibility cut your dive short. Why was using the sonar harmful for the coral? 8) MANAGEMENT -- Are the no-take zones working? Why aren't you seeing the large fish you expect (especially in the deeper reefs)? 9)Are you pleased with the outcome of your mission? Thank you!

A7a: Mary Tagliareni/FKNMS - I am glad to see you have joined us for the chat. You asked very good questions during the uplink. I will address some of your questions- EFFECTS OF DIVING- There are no effects on the body when you are in the DeepWorker like there are when you SCUBA dive. It is a closed system and the atmosphere is maintained at 1. By maintaining 1 atmosphere, we do not need to be concerned about how deep we go, how long we stay, or how fast we come up. The DeepWorker is very safe with a redundancy of life support systems. There are two oxygen systems, two CO2 scrubbing systems, an emergency air supply, and an emergency power system. During the two week training, we learned what to do in different emergencies. Because of the camera system and the float buoys attached to the front of the DeepWorker it is a little difficult to drive a straight line- it tends to "wander". However, I think we all improved with every dive we did. The camera is mounted on the sub so we do not have to worry about holding it straight- we just

have to drive smooth and straight. WAVES/STORMS- We were very lucky and did not receive any bad weather from Hurricane Dennis- we certainly watched him very closely! The dive supervisor will decide if it is too rough too launch the DeepWorker. He is always real concerned about the safety of the pilot, the swimmer in the water, and the crew on the ship. If the waves are higher than 2-3 feet it would be too dangerous to launch the sub. The DeepWorker has a maximum speed of about 3-4 knots so a current will have an effect on the DeepWorker. In the Keys off of Carys fort there was about a one knot current that the pilots were able to maneuver in. STUDENT SUMMIT- We held a mini-summit on the 22nd during the open house in Key West. The students met with Dr. Earle, toured the NOAA ship Ferrel and DeepWorkers, and helped plan a Student Summit for October. During the second leg of the mission, some of the students were on board the Ferrel to observe submersible operations. It seemed like they really enjoyed being able to be on site during the mission. A tentative agenda has been set for the October summit with the activities that the students developed. The summit will begin with a panel discussion by SSE pilots and experts, a student directed debate on "hot topics" such as marine zoning, jet skis, and water quality; students will conclude the summit with a brainstorming session on goals and activities for SSE next year. We will summarize the summit on the web page. Contact ivy.kelley@noaa.gov for further details and outcomes. CAREERS - All of us have a different story- I went to school in Illinois, moved to the Keys to teach field classes of marine science for a non-profit org., worked as a Park Ranger and started with the FKNMS 10 years ago. I spent my first four years as a full-time law enforcement officer and then switched back to education/volunteer programs. My recommendation is to begin volunteering and getting involved early- there is stiff competition for jobs and the more experience you have the better. NAVIGATION- The DeepWorker is traced from the surface from a transponder attached to the sub. The surface helps with your direction and there is a compass on board that you can use to follow compass courses. The sonar was not harmful to the coral- the problem was that I could not see the coral and I did not want to hit it or injure it with the sub. The sonar only detected and let me know about objects that were in its range and that did not include low profile corals. COLLECTION- The DeepWorker did not have a arm that could be used for collecting this year. Instead of an arm it was equipped with cameras.

A7b: Walt Jaap/Pilot researcher - Jenny: I am responding to the questions about the submarine and diving. DeepWorker is a pressurized boat- we dive at surface pressure, so we are not affected by the pressures a diver would experience. Upon closing the hatch, a small vacuum pump is used to decrease the submarine internal pressure; this ensures a tight seal. We spent three hours at depth on the typical dive and went as deep as 180 ft. We did not feel the hydrostatic pressure in the sub. The only consideration for creature comfort would be a mini-ac. The internal cabin is warm and it gets moist from the pilot's exhaling. We used a vest filled with frozen gel packs to help us stay cool.

Jenny: This answer is related to sub navigation. There is a compass in DeepWorker and it works like a conventional marine compass. You try to maintain a straight course, but it was a bit challenging. The Ferrel has a navigating system that tracks the position of DeepWorker relative to the ship's position. If you are trying to navigate to a known location (for example a latitude - longitude position), the ship can tell you to steer a course to get there. I navigated from one spot to the next by

using the ship's information to guide me. As long as the through-water communication was good, the system was easy to use got me from a to b. You may have learned that DeepWorker uses foot pedals to steer and go up and down. This is a new sensation, to maintain a course you using the right foot to adjust left and right, and the left foot to go up and down.

A7c: Ben Haskell/FKNMS - Jenny et al.- You asked whether the no-take zones are working and why we aren't seeing large fish in the deeper waters. The no-take zones, of which there are 23, have been in effect for two years. After only a year, the zones had a positive effect on fish abundance and lobster abundance and size. We determined this by counting and measuring fish and lobster inside and outside of the zones once or sometimes twice a year. In addition to measuring changes in ecosystem structure (size and abundance) we are also measuring changes in ecosystem function or processes like coral recruitment, fish grazing and predation. We will continue this monitoring program for the next 3 years at which time we will generate a Zone Performance Report that state and federal resource managers will use to evaluate the effectiveness of the no-take zones as a management tool for protecting biodiversity. I suspect we are not seeing large fish in deeper waters because of overfishing. Large predators such as grouper are extremely vulnerable to overfishing because they are long-lived, tend to stay in one general area once they're adults, and are often curious. The Florida Keys experience intense recreational and commercial fishing pressure and it is on the rise as population increases.

A7d: Erich Mueller/Mote Marine Laboratory - Jenny: There are many debates about factors in the environment causing stress on corals and other organisms. Corals have some rather limited tolerances with respect to temperature, salinity, light availability, sedimentation and many other water quality factors that we are just beginning to understand. There are also natural changes on various time scales that may make corals in some areas less viable. Any given stressor may be within tolerance limits but the effects of multiple stresses may result in morbidity or mortality. Thus, just what factors are causing the loss of corals is often difficult to determine unless very obvious (vessel grounding or serious, acute pollution, for example). New approaches are being worked on to detect the effects of stress at the biochemical and molecular levels before there is visual evidence of distress. There are various proteins that are produced in response to stress such as heat, oxidative stress, etc. and detecting their enhanced production may allow a very sensitive measure of stress and identifying its cause. Dr. Jane Hawkridge will be joining me in January to work on the SSE project and it is this sort of approach that she will take to identify stressors on reef corals.

Q8: Marian - How did you feel being tangled up in ropes and stuck on the bottom? Also how long were you down there?

A8: Mary Tagliareni/FKNMS - Marian (Mom)- Good question! I was only in 45' of

water when I became entangled so I knew divers could come down and untangle me. The biggest problem was that it was really, really hot in the sub. I was tangled for about 40 minutes but my whole dive was 4 hours long at Conch Reef on the 26th.

Q9: Mellie - I have three questions. 1. Will there be a SSE Teacher Workshop next summer? If so, how may a teacher apply? 2. Are there any plans yet to involve certified divers in monitoring projects with the FKNMS such as with REEF? 3. Do any of you support the PADI Research Diver Program? In other words, could a certified diver work with any of you for six to eight weeks during the summer as a volunteer on a research assignment?

A9a: Ben Haskell/FKNMS - Mellie- I'll respond to question 2 and 3. #2- We have 3 volunteer monitoring programs related to the no-take zones that divers can participate in. First, there's the Reef Env. Education Foundation which involves roving about the reef counting fish. It's a superb program that generates very useful data. Contact: Laddie Akins 305-451-0312 Second, there's ReefKeeper International's ReefWatch program which conducts ReefCheck in the FKNMS every summer. Contact Alex Stone at 305-358-4600. Third, there's The Nature Conservancy's Sea Stewards program that uses volunteers to map out a reef area and track populations of grazing urchins, damsel fish territories, and count fish cleaning stations. Contact: Sherry Dawson at 289-9060. #3- A PADI research diver could volunteer with the Sanctuary or any one of the organizations above.

A9b: Laura Francis/SSE education - Mellie, I'll take a crack at the first question. We were very pleased with the outcome of our two teacher workshops this summer at Gray's Reef NMS and Olympic Coast NMS. We hope to offer several more teacher workshops next summer. Our challenge right now is to find funding to do this, but we are very interested in making it happen. Please send me your email information (laura.francis@noaa.gov) and I will keep you posted about status of the workshops and application procedure.

Q10: Carol National Coral Reef Inst - What lessons have been learned in this marine preserve that can be used in establishing other future marine protected areas (MPA)?

A10: Mary Tagliareni/FKNMS - We have had MPA in the Keys since 1976 with the Key Largo NMS and Looe Key NMS in 1981. I think in both cases we have been able to notice a difference in fish populations, less damage to the corals, and stewardship by the local community. Ex.: In Key Largo and Looe Key we were able to install mooring buoys and see a real difference in the amount of damage to the corals. In working with other countries as they think about establishing MPA- it is important to take action now because the effects of the action may be slow and take many years for results to be seen.

Q11: Mellie - Laura, Could you please tell me more about the Student Summit mentioned earlier. Thank you.

A11: Laura Francis/SSE education - Mellie, One of the national education initiatives that we have taken on this year is a series of sanctuary student summits at all of the marine sanctuary sites. Since this is a big pilot year for SSE, we have been experimenting at the different sites with what is the best way to do these. The general idea is that students and teachers come together with sanctuary staff and SSE scientists and learn about the exploration, research and monitoring that is going on at the site. Then the students begin to think of their own field investigations that might complement this work. In the Florida Keys, we had students come out to the ship for a first hand experience with the expedition and those students are planning what the larger summit will look like in October. These summits are very grass-roots efforts, and we want to engage students and teachers in their design. For the future, I see the possibility of regional and national summits as well as virtual summits over the web.

Q12: Trish/CCHS - Here are a few more of the questions from the students...they should arrive here in just a minute or two...What inspired you to work in the sanctuary program? Would you recommend a senior in high school to visit the FKNMS? How are the people to selected to work in the DeepWorker? Are you going to make a movie using this information? Have you ever had any near-death experiences with the weather or with animals? Where is your favorite place to dive?

A12a: Mary Tagliareni/FKNMS - In the FKNMS, most of the pilots were selected because they had responded to a RFP for scientific research. There were also education collaboration proposals submitted last year. For next year, there will be proposals accepted. We do have internship positions open that students can apply for to come and work at FKNMS. Most of the time these are filled by college students because they are looking for finishing a degree and sometimes getting credit. The biggest problem is that it is expensive living in the Keys and at this time we do not offer stipends or housing for interns. I have been spoiled and only SCUBA dive in warm water- the farthest north I have been diving is off of North Key Largo. I like to go to small, lesser known, unmarked reefs where I don't see as much human impact.

A12b: Walt Jaap/Pilot researcher - Trish: A group of researchers at my institutions (FMRI & USF Marine Science) were inspired to submit a proposal to use DeepWorker to study the Tortugas Banks. After review, the SSE and FKNMS people selected our proposal to do this project. I was interested in becoming a pilot, so I went to Monterey and Key West for training. The most exciting thing that has occurred in my life, related to close encounters is that I was at sea, off Key West and got smacked in the head with a hydraulic tool. It broke three teeth from my jaw and I had to be evacuated. I had an excellent group of people that took care of me on the boat. Because of their first aid skills and God and I can still smile.

A12c: Bill Goodwin/FKNMS - Trish: I knew that I wanted to work for the Sanctuary after I attended a presentation on Looe Key NMS by Billy Causey while I was a marine science instructor at Sea Camp (1987). Five years later I became the assistant manager of the Key Largo site. I would certainly encourage students to visit the sanctuary, particularly as a student participant in some of the excellent marine education programs conducted within the Keys, such as Newfound Harbor Marine Institute on Big Pine or Marine Resources Development Foundation in Key Largo, to name a couple. Oh, I've never had a near death experience as result of contact with marine life, although I did think I wasn't going to make it when a group of other divers and I were left behind (at sunset, sharks swimming around us) by a commercial dive operation off a remote Puerto Rican island. We had to swim about a half a mile back to shore, climb out of the water on a jagged rocky shoreline, and hike (in full Scuba gear) about 5 miles back to camp. True story.

Q13: Carol National Coral Reef Inst - How can marine scientists best contribute to the management and sustainability of marine sanctuaries? Specifically, as managers of the Florida Keys National Marine Sanctuary (FKNMS), what further involvement would you like to see from the scientific community?

A13a: Erich Mueller/Mote Marine Laboratory - Carol: I am going to address this question from the point of view of a scientist, not a manager. Science has traditionally attempted to understand the natural world and technology has used such knowledge to modify it. Natural resource management falls somewhere between - it is generally trying to maintain natural systems through proactive means. Most of these means are through modifying human behavior towards the natural world but other management strategies work directly on the resources, usually trying to return them to a pre-human influenced state. Because of the incredibly complex nature of even microscopic natural systems, this becomes a daunting task and there are many failures in the history of environmental management A classic example is the prevention of fires, ostensibly for environmental benefit, before the concept of fire-climax communities was understood. An understanding of natural systems (be it an organism or an ecosystem) is essential for successful management. Another example is fisheries management where understanding life histories is pointing the way to new, hopefully more effective, management strategies such as limiting the largest size of fish that can be taken because the largest fish in most species contribute disproportionately to the offspring production. Management is also realizing that what used to be considered "basic" studies (and not usually funded by management agencies) must be conducted to know whether there is a management issue or not. Take the case of coral diseases. If the apparent explosion of coral disease mortality in the Western Atlantic region is a natural cycle, then, in my opinion, it should not be managed; this may be nature's way of clearing reef space for new, better adapted corals to establish themselves. On the other hand, if stresses caused by humans are causing diseases, or making corals more prone to disease, then it is a management issue and steps should be taken to reduce and eliminate those stresses. While there are many opinions on this issue, there just isn't the data right now to make that call. Managers NEED that information to make decisions!

A13b: Ben Haskell/FKNMS - Carol- Marine scientists can best contribute to the management and sustainability of marine sanctuaries by 1) tweaking their research program so that it addresses key management issues, 2) getting aggressively involved in the sanctuaries' education and outreach efforts, i.e. by volunteering to be a speaker at schools, giving seminars, etc., 3) getting involved in sanctuaries' 5-year evaluations which is an excellent opportunity to fine tune sanctuary management so that they do what they're supposed to do which is protect bio diversity and submerged cultural resources (3 sanctuaries are up for reevaluation: Channel Islands, Stellwagen Bank, and Gray's Reef), and 4) letting Congress know that you care about ocean conservation and the Sanctuary Program. Here in the FKNMS, we have seen a shift in science from basic to applied as researchers become more aware of our needs and funding agencies require that there be a nexus with management. Basic science is very necessary but there are some urgent applied issues that need addressing. For example, how many divers and snorkelers can a discrete coral reef area, like Looe Key, accommodate over the course of a year without showing a decrease in coral abundance, diversity or other measures of health? What does a totally protected coral reef ecosystem look like and behave like? How are trophic linkages different from an unprotected and fished area? We know very little about what a natural reef is like and we now have the opportunity to find out with the sanctuary's no-take zones so I would like to see the marine science community take advantage of this opportunity.

Q14: Marian/cchs - How is it different diving during the day versus the night?

A14a: Mary Tagliareni/FKNMS - Since we usually have good visibility in the Florida Keys the difference between day and night diving is the distance that you can see. During the night, one tends to focus on items much closer simply because you can not see as far. The DeepWorker was equipped with two headlights and there were two more lights mounted for photography and videography. During the night dives n the Tortugas we could see the glow of the DeepWorker from the surface. My favorite time to dive is at night- it makes me concentrate on what I am doing and seeing. It is also a lot of fun!!

A14b: Walt Jaap/Pilot researcher - Mirian: The night dive I made at Reiley's Hump was interesting. I went down in the light and it slowly became dark. The lights on the sub provide for local illumination and attracted fish and plankton that swarmed around the lights. I found a nice reef outcrop at about 115 ft and set DeepWorker close by. I turned off the lights for about five minutes and then turned them back on. There was a bit of action as a few fish that had come close to inspect the sub darted away. A gray reef shark and a medium sized barracuda followed me around for a while. The was a feeling of quiet and peace as I sat looking into the blackness. The return to the surface was interesting. I had no perception of going up or down. The only way I could tell I was moving was to look at the depth gauge. When I surfaced, I saw stars and the Ferrel coming to get me.

A14c: Erich Mueller/Mote Marine Laboratory - Marian: Yes. At night there is s shift in the apparent reef community with some organisms coming out and others

"sleeping". Many corals feed at night and their polyps extend after being closed during the day. Also, corals spawn in the evening/night hours which will be investigated at the Flower Gardens over the next few days. From a research point of view, a night dive is justified when one wishes to study what happens at night. It is also difficult to do properly because lights carried by divers or on the DeepWorker attract some organisms and probably scare off others. Thus, proper night research should utilize very low light cameras or red lights which are not as disruptive to animal behavior. From an operational point of view, one has to be more careful operating the sub at night because one's field of vision is very limited. On my dive, I could see about 10-15 ft around the sub so I proceeded much more slowly.

Q15: Trish/CCHS - What type of qualifications do you need?

A15: Mary Tagliareni/FKNMS - Trish- The DeepWorker pilots had to be SCUBA certified and not too large or tall because of the small space. It was also helpful if you had boating or navigation experience. The first week of training was in Monterey CA last fall. The FKNMS pilots went through a week of advanced training in Key West the week prior to the mission.

Q16: Trish/CCHS - Is it fun?

A16: Walt Jaap/Pilot researcher - Trish: The question of fun. I would be growing a long nose if I said that the experience was just hard work. It was a great experience and I can say that I did enjoy and had fun doing the work. I think we had a great support crew on the Ferrel, FKNMS staff, and from Nuytco. I had fun working with the crew and felt honored to be blasted by Jeff Heaton and Steve Drover with their high tech water guns. I will get even.

Q17: Jake/CCHS - How much does one of those submarines cost?

A17a: Mary Tagliareni/FKNMS - Jake- The DeepWorkers cost about a half million dollars each. Remember- you should always have two on site. One that is diving and one that is available for rescue and backup.

A17b: Bill Goodwin/FKNMS - "If you have to ask, you can't afford it"

Q18: Johnny/CCHS - How much do you get paid for diving?

A18: Mary Tagliareni/FKNMS - Johnny- I do not get paid "extra" for SCUBA diving or DeepWorker diving. It is considered part of my duties at the Sanctuary. In fact- some people probably think I should pay them for allowing me to have such a great job and getting to do fun things like this.

Q19: Sarah - What is the green fungus or mold growing on the coral reefs off the coast of Florida called? and how can we prevent it from destroying our reefs?

A19a: Walt Jaap/Pilot researcher - Sarah: I am not sure what area on the east coast you are speaking of. In the past, a green algae genus Codium had great blooms that

A19b: Bill Goodwin/FKNMS - Sarah: There are numerous species of marine aquatic plants that inhabit Florida coastal waters. Most of these are some form of green algae. The ones that are large enough to see with the naked eye are called macroalgae, and if you need a microscope to see them they are called microalgae. They occur naturally as part of the ecosystem and usually pose no threat to coral reefs. However, if "fed" unnaturally high doses of nutrients, such as phosphates, these plants have population explosions which can reduce light levels (corals need relatively clear water) and overgrow small, weakened or injured corals. One of the best ways we can prevent this is through wise wastewater management practices which minimize the introduction of excessive nutrients.

A19c: Erich Mueller/Mote Marine Laboratory - Sarah: I do not know of a green fungus growing on the reefs. you may be thinking of algae that seem to be more prevalent, at times "smothering" reefs. There are two basic reason why this occurs: 1) increasing nutrients that allow algae to grow faster and 2) reduced grazing on the algae by fish or other organisms like sea urchins. Both factors have been identified on reefs in various combinations. This is a complicated issue and one that needs much more research. There is certainly no lack of scientific debate!

Q20: Johnny/CCHS - What happens when the data you collect isn't what you expected it to be?

A20a: Erich Mueller/Mote Marine Laboratory - Johnny: It is EXTREMELY important that scientists maintain an open mind to results. One should never want data to be one way or the other in answering a question. Being human, it is virtually impossible to not have some expectations and this is expressed as a hypothesis. When data are obtained, whether supportive or contrary to the hypothesis, one should make sure the observations are repeatable and conduct other experiments that address the question from other angles to confirm the observations. Scientists need to let the data guide their thinking and not the other way around.

A20b: Bill Goodwin/FKNMS - We go back to the computer and contort the data until it fits. You can say anything you want with statistics. Just kidding. Very often we as scientists are surprised by what the collected data tells us. It's our job to analyze and report on our findings as honestly and objectively as possible

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Q21: Trish/CCHS - In college, did you take some classes that made you think that you didn't want to become what you became?

A21: Mary Tagliareni/FKNMS - Trish- I am probably the wrong person to answer this. I am not a marine biologist by formal training. I was a Recreation/Outdoor Education major. Of course- one always has questions if what they are doing is right or if they will be happy doing it for a long time. Taking chances is what makes life interesting and a challenge!!!

Q22: Shaun - Do you think any thing will happen to our ecosystem in the year 2000?

A22: Ben Haskell/FKNMS - Shaun- The ocean ecosystem will never crash like a computer system might crash. However, if we don't manage ourselves better and eliminate or greatly minimize the impacts we are currently having on the ocean these impacts will force the ecosystem to shift from one state (or condition) to a different one that could be potentially much less desirable to us. For example, decades of over fishing have removed larger fish from the ecosystem leaving behind, in some areas, smaller fish of little to no economic or protein value. The constant runoff of millions of tons of Nitrogen into the ocean every year is one of the biggest threats and is fueling the development of a different, less desirable ecosystem. These impacts and many others have got to be either stopped or the level of the activity must be made sustainable such that the ability of future generations, such as yourself, to enjoy and use the ecosystem is not impaired. So I encourage you to get involved and make your voice heard. Thanks!!

Andrea/NASA Chat Host - Everyone - What a great chat today. Your questions were great! We will give our experts a few minutes to answer one last question and add any comments - you can imagine they are very busy folks!

Mary Tagliareni/FKNMS - Reminder: If you missed the FKNMS SSE uplink from the Tortugas on August 20, it will be archived soon. Go to:

http://sustainableseas.noaa.gov/aboutsse/liveevents/aug20video.html
sustainableseas.noaa.gov

to view it.

Jake/CCHS - Thanks for sharing with us, hope to see you at the next chat!

Trish/CCHS - Thank you for taking your time to help us out with some questions, see you next time! (hopefully)

Andrea/NASA Chat Host - We also hope you can join us from Flower Gardens Bank National Marine Sanctuary next Tuesday, Sept. 7 at 3:00 - 4:00 p.m. Eastern.

John - Hi, Gang! The Monitor NMS just wanted to say "Hi" and wish you well. Looks like the chat went well, and we're taking notes on how it works!

Laura Francis/SSE education - Please join us for a live video broadcast from the NOAA Ship Ferrel on September 7th. Go to sustainableseas.noaa.gov for more information about this uplink and the Flower Gardens NMS Mission. Please fill out your evaluation forms for the chat. We need this information to help us meet your needs and interests for upcoming chats...

Mellie - Thank you both for answering my questions. We've participated in the Great American Fish Count and Reef Watch Programs, but did not know about the Sea Stewards Program. I'll call Sherry Dawson and see if we can work something out for next summer. Laura, can't wait for the "virtual summits" to begin so that Maryland students can be involved in SSE. Thanks again.

Andrea/NASA Chat Host - I would like to thank Mary, Billy, Bill, Ben, Walt and Erich for their time - this was a great chat - I learned a lot!

Laura Francis/SSE education - Thanks everyone, particularly the experts for taking the time to chat about their experiences with SSE in Florida Keys NMS and thanks for the great questions.

Mary Tagliareni/FKNMS - Thanks Erich, Walt, Bill and Ben. Your answers were great and I really learned from them too!!!!

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SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

September 16, 1999

2:00 pm - 3:00 pm eastern time (11:00 am - 12:00 pm Pacific time)
Flower Gardens National Marine Sanctuary (FGNMS): 1999 SSE Mission Overview

Introduction

During this chat we will be joined by G.P. Schmahl, sanctuary manager, Emma Hickerson, sanctuary research coordinator, and Shelley Du Puy, sanctuaary education coordinator, will give an overview of what was seen during this mission.

Investigations in the first year of the Sustainable Seas Expeditions will focus on reproductive biology of mass spawning corals and characterization of deep habitats. Coral spawning in the Flower Garden Banks has been the subject of substantial research efforts since 1990. This research has focused on identifying participating organisms, recording their behavior, and capturing genetic material for fertilization and developmental studies. Researchers are now interested in determining gene flow among reef sites throughout the western Caribbean and Gulf of Mexico. Year-one missions will conduct uninterrupted observations throughout the coral spawning period, conduct observation of coral spawning in habitat deeper than previously observed, and collect gamete samples.

The Flower Garden Banks are surface expressions of underlying salt domes, pushed up as portions of 160 million year old salt layers rise through the seabed. Seawater percolating through the porous carbonate bank to the level of the salt dome produces brine seepage, most notably on the East Flower Garden Bank where water is seven times saltier than overlying seawater. The unusual chemistry of brine seeps gives rise to bizarre bacterial-based food chains. As salt layers dissolve, grabens, areas of collapsed substrate, form. The DeepWorker will be used in a comprehensive exploration of these unique habitats. Missions will likely significantly increase the species reported to date.

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Highlights

During this chat with we learned even more about coral and the exciting phenomenon of coral spawning. Our experts, GP Schmahl, Sanctuary Manager, Emma Hickerson, Science Coordinator, and Shelley Dupuy, Education Coordinator at Flower Garden Banks National Marine Sanctuary all shared fondly what they know about their sanctuary.

The Flower Garden Banks host a unique place in the Gulf of Mexico where coral grow at unusual depths. Shelley gave an overview of the coral found at the sanctuary, " The deepest depth at which corals can survive depend on several different variables. Some species can survive with less light than others. If the water is full of dirt or plankton, less light gets through so the corals need to shallower. In clear water, they can grow deeper. At the Flower Gardens, most of the species grow in 140 feet or less. A few species grow in depths up to 180 or 200 feet. She went on to estimate that there are approximately 23 species of coral at FGBNMS.

As this chat took place while Hurricane Floyd threatened and moved its way up the Atlantic coast, the chatters were very concerned with the impact that these storms have on coral. GP shared, "Hurricanes can have devastating impacts on shallow coral reefs where the physical damage to coral of the wind and waves can destroy coral colonies. However, coral reefs have developed over millions of years and in that time scale, hurricanes are frequent occurrences that reefs have learned to deal with. Many corals, such as the branching staghorn and elkhorn corals actually reproduce through breakage and reattachment. So there are good points and bad points related to hurricanes."

On the topic of coral spawning Emma talked about the uncooperative seas that they experienced the first week of the mission, and what having the wealth of SSE resources available meant to the team this year. "... Fortunately we had an ROV (remotely operated vehicle) provided by SSE on hand, and we were able to document the amazing sight of coral spawning. We are thankful for SSE and the Nuytco ROV operators, Ian, Phil, and Steve, to give us this opportunity to witness the event on this evening."

Emma continued by sharing a bit about the mission on the second week. "During the second week of SSE, the weather was much more forgiving, and we were able to conduct around 12 successful dives between 70 and 340 feet in depth. Some of the dives were over 3 and a half hours long! We encountered several different species of sharks, manta rays, and hundreds of reef and pelagic fish. We were able to document several interesting topographical features on the West Bank."

The team also describes partnerships and efforts to protect the sanctuary waters. They discuss the importance of bouys in preventing damage to the coral and how relationships with the oil industry are critical to the health of the waters. You will also learn a bit about some of the unique geological features at Flower Garden Banks National Marine Sanctuary. This area hosts salt domes an extremely rare underwater

environment formed over millions of years.

Get ready to use your imagination as our experts tell you about this remote and amazing sanctuary!

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Web Chat Transcript

Flower Garden Banks National Marine Sanctuary: 1999 SSE Mission Overview

Laura Francis- Good Day Everyone. We will get started with the chat in a couple of minutes. We will have Emma Hickerson, research coordinator, Shelley DuPuy, Education Coordinator and GP Schmahl joining us today to tell us about their recent expedition to the Flower Gardens Sanctuary. I was lucky enough to go scuba diving out there last week and it was unbelievably beautiful!

Laura Francis- I forgot to add that GP is the manager of the Flower Gardens (my head was swimming thinking about my dive with the loggerhead sea turtle - sorry GP!)

Q1: Laura Francis- Ok, We have our experts online - go ahead and start asking questions. Perhaps Emma could give us a quick summary of the cruise - How was it out there?

A1: Emma Hickerson- Here's a quick summary of what was accomplished during the SSE expedition at the Flower Gardens. The first week out proved quite challenging as we had less than flat seas! On the first night of the coral spawning, the seas were so rough that we were unable to put scuba divers in, let along submersibles! Fortunately we had an ROV (remotely operated vehicle) provided by SSE on hand, and we were able to document the amazing sight of coral spawning. We are thankful for SSE and the Nuytco ROV operators, Ian, Phil, and Steve, to give us this opportunity to witness the event on this evening. During the second week of SSE, the weather was much more forgiving, and we were able to conduct around 12 successful dives between 70 and 340 feet in depth. Some of the dives were over 3 and a half hours long! We encountered several different species of sharks, manta rays, and hundreds of reef and pelagic fish. We were able to document several interesting topographical features on the West Bank.

Q2: Chauntay - So was it really cool to swim with the turtles?

A2: Shelley DuPuy- Hi Chauntay - swimming with the turtles was VERY cool! We saw two turtles during one dive. One was swimming to the surface to get a breath of air. The other was snoozing under a ledge and allowed us to take quite a few photos before swimming off.

(top)

Q3: Chauntay - I got registered a little late... can you tell me a little about the flower gardens?

A3: Emma Hickerson- The Flower Gardens are located approximately 110 miles south of the Texas/Louisiana border. They consist of 2 coral reef systems and one sponge/fire coral habitat. You can look at some images and read up about the Sanctuary at: **www.flowergarden.nos.noaa.gov** or **www.sanctuaries.nos.noaa.gov**.

Q4: Tiffany - Laura this is Tiffany from Houston,Tx. How is the flower garden health compared to the other coral reefs?

A4: Emma Hickerson - The Flower Gardens is an extremely healthy coral reef system! We have little, if any disease, and are not effected by bleaching like the shallower reefs, and are not effected from runoff of pollution like reefs closer to the coast.

(top)

Q5: Chauntay - How big of an impact do things like hurricanes have on the reef systems?

A5: GP Schmahl- Hurricanes can have devastating impacts on shallow coral reefs where the physical damage to coral of the wind and waves can destroy coral colonies. However, coral reefs have developed over millions of years and in that time scale, hurricanes are frequent occurrences that reefs have learned to deal with. Many corals, such as the branching staghorn and elkhorn corals actually reproduce through breakage and reattachment. So there are good points and bad points related to hurricanes. The Flower Gardens are generally too deep (greater than 60 feet deep) to have much effect from hurricanes, although we have seen large coral heads which have been toppled from them.

Q6: Jason/ClarkMS - I was reading the question earlier - what is a Remora?

A6: GP Schmahl - A remora is a type of fish that has a suction-like structure on the top of his head. They use that to attach to other fish and "hitchhike" for a free ride. They usually attach to sharks or rays, but also associate with turtles and other big animals. Scientists think that they benefit by being able to feed on the scraps of food that sharks leave behind. Remoras may help by cleaning the bigger fish and preventing some types of parasites. They do not hurt the fish they hitchhike on.

(top)

Q7: Jason/ClarkMS - I was watching the event last week - did you see a whale shark this week?

A7: Shelley DuPuy- No one on the Sustainable Seas Expedition saw a whale shark, unfortunately! A group that went out on a two day recreational dive trip while the research vessel was in port to refuel saw one, though. It's just a luck of the draw!

Q8: Mr. Black - Are there many predator fish at Flower Gardens? Have you ever seen one when you were diving?

A8: Shelley DuPuy - There are many predator fish at the Flower Gardens. The one most commonly thought of are sharks. We have several different species of sharks, including silky, Caribbean reef, spinner, dusky, sandbar, nurse and the popular scalloped hammerheads that school by the hundreds around the Gardens from late December through early March. The only ones I have personally encountered at the Flower Gardens were nurse sharks. Contrary to popular belief, these animals are not normally aggressive towards humans.

(top)

Q9: Andrew - Another question is since the coral is so far out what would keep ships from running into the coral our putting an anchor on top of it?

A9: GP Schmahl- Andrew - Sanctuary regulations prohibit vessels larger than 100 feet in length from anchoring on the Flower Garden Banks. This is enforced by the Sanctuary and the US Coast Guard. Nautical charts show the boundary of the sanctuary with a note that says anchoring is prohibited. We are also putting out large marker buoys to warn vessels that this is a no-anchor zone.

Q10: Nicole - Hello, how do you protect the Flower Garden from commercial exploitation?

A10: Emma Hickerson - Nicole, This is a hard one to answer, because it depends on what species you are talking about. There are regulations prohibiting people from harvesting the mollusks for their shells, conch for their meat, lobster, etc., but certain kinds of fishing are legal at the Flower Gardens, including certain types of commercial fishing. This is an issue we are getting more and more concerned about, so in a couple of years, regulations may be put into place regulating the fishing practices currently in place.

(top)

Q11: Annette - What is the deepest water depths reefs can survive in?

A11: Shelley DuPuy- Annette, The deepest depth at which corals can survive depend on several different variables. Some species can survive with less light than others. If the water is full of dirt or plankton, less light gets through so the corals need to shallower. In clear water, they can grow deeper. At the Flower Gardens, most of the species grow in 140 feet or less. A few species grow in depths up to 180 or 200 feet.

Q12: Rashad - How many species of animals live there?

A12: Shelley DuPuy - Rashad, These numbers are approximate: there are 23 species of corals, 200+ species of other invertebrates, 175+ species of fish, one species of turtle (2 other species have been sighted occasionally, but are not residents). There are no resident marine mammals.

(top)

Q13: Carl - Why is the Flower Garden the farthest northen reef?

A13: Emma Hickerson- Carl, The only reason the Flower Gardens are located where they are is because they have formed on top of salt domes, which are formed from heavy silt and mud pressing down on salt deposits. In weak areas, the pressure has forced the salt up forming underwater mountains, and bring the ocean floor within the range of depths that coral can survive. If there were none of these mountains, the sea floor would be around 400 feet - not enough light ets to these levels for the algae

that lives within the corals tissue, to photosynthesize, and provide energy for the corals to survive.

Q14: Annette - What keeps the big ships from anchoring on the coral reefs?

A14: GP Schmahl - Annette - In addition to the regulations that prohibit anchoring, we work with the shipping, oil and gas industry and insurance industry to educate the captains of large ships about how sensitive the coral reefs are. Most of the captains don't know that coral reefs are living animals - they just think they are shallow spots in the ocean. Once they learn about the reef, they usually will not want to anchor there!

(top)

Q15: Mr. Black - We would like to know what it was like to dive in the DeepWorker?

A15: GP Schmahl - Diving in the DeepWorker is an incredible experience. There is just enough room for one person along with a whole bunch of scientific and life support gear. Once you are in there, it's kind of cramped, but you are so busy that you don't have time to think about that. You have a large plexi-glass dome over your head that allows you to look all the way around you. The controls of the sub are all done using your feet and it is very responsive. You can turn on a dime! Once you are down on the bottom, you have the opportunity to just sit and observe for long periods of time (hours, if you want) which you can never do on SCUBA. One interesting thing that happened to me is that a big school of Rainbow runners (a type of jack) totally encircled me and swam around and around for several minutes. It was like being in a fish tornado!

Q16: Aqua Man - Can you tell us about any of the significant finds that having a submarine on the reefs let you find, that you could not have observed via other research methods?

A16: Emma Hickerson - Aquaman (I'm digging your handle!!!) - The coral spawning is an event that occurs over several hours in an evening. Using traditional scuba, a diver can only observe a limited window of time. When using DeepWorker subs, you can sit for up to 8 hours at a time, and therefore witness the coral spawning event from start to finish. The areas around the coral cap of the Flower Gardens are below scuba diving depths, in most cases. Although we can reach the bottom of the coral ledge, we can only stay briefly on scuba. During one of my sub dives I was able to stay more than three hours at the interface between the coral reef and the sandy bottom - huge numbers of fish inhabit this area. We were also able to document the presence of a sunken area that probably has been caused by dissolving of the salt

dome underneath the coral cap.

(top)

Q17: Mr. Black's class - Why is it called Flower Garden?

A17: Shelley DuPuy - Snapper fishermen in the late 1800's could see the colorful corals from the surface. They would also pull up bits and pieces of the sponges and corals on their lines. They thought they looked like flowers, so they nicknamed the area Flower Gardens.

Q18: Carl - Emma do you love turtles?

A18: Emma Hickerson - Carl, I feel a deep fondness for the sea turtles that I have worked with at the Flower Gardens - they all have their personalities and it thrills me to be on a dive or on the deck of a boat and see a turtle that I have put a satellite transmitter on, and know some of the history of that turtle, and some of its habits.

(top)

Q19: Nikki - What is your favorite animal on the reef?

A19a: GP Schmahl - Nikki - my favorite animals on the reef are sponges! Even though they are a very primitive life form, they add much color to the reef and help filter the water around the reef to keep it clean.

A19b: Shelley DuPuy- NNikki, My personal favorite is the golden smooth trunkfish, because it is not found anywhere else!

A19c: Emma Hickerson - Nikki, Besides, of course, the sea turtles, I would have to say that the manta rays are my other favorite animal. Sometimes they will glide gracefully over my head and then stop in front of me with their wing tips up, waiting for me to gently scratch parasites like copepods off their shoulders. Then there are the cute little red lip blenny, and the porgy, and the spotted eagle rays, and the hammerhead sharks. I could go on and on!!!

Q20: Timothy - What do you do to keep the reef healthy?

A20: Shelley DuPuy - Timothy, we do a lot of different things to keep the reef

healthy. The most significant is probably the installation of mooring buoys so boats can tie up to them, instead of dropping an anchor on the reef. We also talk to recreational divers, teachers, students and industry to teach them how to act around the reef. We also monitor the reef to make sure it stays healthy.

(top)

Q21: Andrew - What is the tallest coral ever recorded?

A21: Emma Hickerson - Andrew, We recently measured corals at the Flower Gardens that were 2m (6feet) high, but they for sure are not the tallest ones known. Unfortunately we don't know what the tallest ones are. Sorry! Good question!

Q22: Tiffany - Emma,How big has the longest coral reef grown?

A22: Emma Hickerson - Tiffany, The Flower Gardens have been aged at around 15,000 years old. The Florida coral reef is around 7-8000 years old - it was exposed in the last ice age. I don't have information about other coral reefs around the world unfortunately.

Q23: Mr. David Baxter - Amber wants to know how we stop ships anchors from hurting the coral?

A23: Shelley DuPuy - Amber/Mr.Baxter, The only way to keep an anchor from hurting the coral is to NOT drop it! That's why we have mooring buoys, so boats can tie up instead of dropping anchor. We still have to deal with large vessels that can't use the buoys. All we can do is keep telling people about the corals and that they shouldn't drop their anchors. You can help us do that! Spread the word!

Q24: Roger/Clark MS - Are ships allowed to fish at the sanctuary?

A24: GP Schmahl - Ships may fish in the sanctuary as long as they are using only typical hook and line type fishing gear. Any kind of other fishing gear is prohibited, including spearfishing. Also, ships larger than 100 feet in length are not allowed to anchor in the sanctuary, and all vessels must use the mooring buoys out there, if one is available.

(top)

Q25: Marine Boy - I see that you say on the Mission log that you saw two Manta Rays spawning. Do they lay a lot of eggs, or give birth to live young?

A25: Emma Hickerson - We actually are not sure about manta rays "spawning" - it was interesting footage filmed by Kip Evans during a sub dive. The mantas we have documented at the Flower Gardens are more than likely juveniles or subadults, and therefore wouldn't be capable of spawning. After consultation with marine ecologist, Jeff Childs (TAMU - Corpus Christi), we think possibly this was territorial behavior. The manta rays swam directly into one another, and "bumped bellies". Mantas give birth to live young.

Q26: Roger/Clark MS - Will your area get a DeepWorker next year?

A26: Emma Hickerson - Roger, The plans are not firm yet, but we are hoping to get the subs back at the Flower Garden again next year for the coral spawning. We are also working with SSE to get the ROV back to document the schooling hammerheads in late February, early March.

(top)

Q27: Jason/Clark MS - I read that the Coral Spawn in August and September - Do the coral in Flower Garden only spawn in September?

A27: Shelley DuPuy - Corals at the Flower Gardens generally spawn about 8 to 10 days after the August full moon. If the full moon is late enough in August, that means they spawn in early Sept. If it is earlier in August, the spawn would occur in late August. Every few years, there will be two full moons in August. The last time that happened, some of the corals spawned after the first full moon, but more of them spawned after the 2nd one. Scientists think it might have been because the water was warmer after the 2nd full moon, making conditions more favorable for larval development.

Q28: Katie Coral - Do you know what triggers the coral spawning? How do they all know its time for their big night? Do any coral get it wrong, and spawn too early or late?

A28: GP Schmahl - Corals spawn around a week after the full moon in August. No one is exactly sure what triggers this event, but this time of year is that which is also the time of the warmest water temperatures. It is also usually calm at this time of

year (this year was an exception) - this helps because many of the eggs are fertilized at the water surface and calm water allows the eggs and sperm to collect together. Sometimes there are 2 full moons in August (known as a "blue moon"). If this happens, it appears that the 2nd full moon is the one that triggers most corals. However, some corals do spawn after the first full moon, and some corals also spawn on nights other than those predicted. At the Flower Gardens, it has been observed that the 8th night after the full moon is usually the big event. BUT this year, the corals spawned a day a two early! So maybe we don't know as much about it as we pretend we do!

(top)

Q29: Nathan - About how many divers do you get a year?

A29: Emma Hickerson - Nathan, We get around 3,000 divers visiting the Flower Gardens each year - A LOT fewer than the Florida Keys - another reason we have such a pristine reef system.

Q30: Ilse - Why does Stetson Bank not have coral?

A30: GP Schmahl - Stetson Bank is located closer to shore than the Flower Gardens. It is about 70 miles offshore, where the Flower Gardens are over 100 miles. Because Stetson is closer to shore it is more under the influence of the near shore waters of Texas and Louisiana. These near shore waters change temperature rapidly with the air temperature, so in the winter it gets pretty cold. This cold water moves offshore far enough to affect Stetson Bank. Corals need warm water to thrive, usually more than 72 degrees. Since the temperature gets lower than that at Stetson, there are very few corals there. However, there are lots and lots of sponges and other stuff.

(top)

Q31: Amanda - How far out can baby sea turtles go?

A31: Emma Hickerson - Amanda, We have seen baby sea turtles in sargassum floats at the Flower Gardens - 110 miles offshore. Very little is known about hatchlings once they leave the nesting beach - they float around in sargassum floats, which travel out a lot further than the Flower Gardens occurs.

Q32: Annette - What is the longest life spand that the coral reefs usually have?

A32: GP Schmahl - Annette - coral reefs have extremely long life spans - usually thousands of years. Coral reefs will continue to grow as long as the environment is favorable: warm, clear water, no pollution, etc. It is estimated that the coral reefs at the Flower Gardens began growing about 15,000 years ago.

(top)

Q33: Nicholas - What is the biggest coral reefe in the world?

A33: Emma Hickerson - Nicholas, The Great Barrier Reef off the East Coast of Australia is the largest coral reef. The second largest is the reef that runs down the east coast of Mexico, down past Belize, and further south through Central America.

Q34: Nicholas - What role does the Gulfstream play for the flower garden?

A34: Shelley DuPuy- Nicholas, The loop currents that come up around the Yucatan Peninsula cross over the Flower Gardens and bath them in warm water, making it suitable for corals. Scientists think they might also have carried baby corals (called planula) up from the Mexican reefs to start the Flower Gardens originally. Once the current swings around the Gulf and goes around the Florida Keys. That's when they start calling it the Gulf Stream on the oceanographic maps.

(top)

Q35: Tiffany - Emma, How long have you been an profession in your field or a scientist?

A35: Emma Hickerson - Tiffany, I started my undergraduate work with sea turtles in 1992 when I worked in Costa Rica on a Olive Ridley sea turtle nesting beach - so that makes around 7 years.

Q36: Mr. Black's class - Many of our students want to know what you like the most about your job - are you all scientists?

A36a: Shelley DuPuy- While I have a Bachelor of Science in Marine Science, I am not currently a esearcher. My title is Education Coordinator and I am responsible for coordinating all of the education, outreach and media activities for the Sanctuary. I really like my work because it gives me a chance to see the research that goes on and relay it to the public. I get to meet a wide variety of people, including recreational divers, oil and gas industry representatives, teachers, students, and concerned

citizens. There is a lot of variety, so I never get bored. Best of all, I get to dive the Flower Garden and Stetson Banks two or three times a year!

A36b: Emma Hickerson- Mr. Black's class, I love being out at the Flower Gardens, or on my way to the Flower Gardens. I got off of the NOAA ship Ferrel, after boarding it on August 28 in Key West, Florida! During the transit to the Flower Gardens we encountered a sperm whale, and were awed by beautiful bioluminescent animals lighting up on the bow of the ship. I love teaching people about the Flower Gardens - one of my favorite things to do is to dive with someone who has never been there before... Even though I'd been out for quite a while, I was not ready to get off of the boat. I'll be out there again soon I hope. Yes, I am a scientist - I studied Zoology in college, but focused by attention on Marine Biology.

(top)

Q37: Mr. David Baxter - Kendra wants to know , How big do sea turtles get?

A37: Emma Hickerson - Kendra, The largest sea turtle species is the leatherback sea turtle, which sometimes occurs at the Flower Gardens - it is not a resident, but follows lines of jellyfish that get moved along by the wind and currents - jellyfish are it's favorite food! These leatherbacks get to the size of a VW bug - around 6 feet long, and nearly 1500 lbs!

Q38: Rashad - Do you keep the Flower Garden a restricted area?

A38: GP Schmahl- The Flower Gardens are restricted to only certain activities. Anchoring is not allowed, and any kind of fishing, except for traditional hook and line fishing, is also prohibited. People are also restricted from taking or harming any coral or from collecting other marine animals, such as mollusks for their shells. However, people are not restricted from going to the Flower Gardens and SCUBA diving there to observe the beautiful reef. We only try to restrict those activities that we think may harm the coral reef.

(top)

Q39: Carl - Are the sea turtles endangered?

A39: Emma Hickerson - Carl, All but one of the 8 sea turtle species of the world are either endangered or threatened. The Australian Flatback turtle is the only species that is not.

Q40: Abby - Are there any seals or sea lions on the reef?

A40: Emma Hickerson- Abby, there are no seals or sea lions living at the Flower Gardens.

Q41: Jason/Clark MS - Do you have Brain Coral there?

A41: Emma Hickerson - Jason, yes, we have two species of brain coral - Diploria strigosa, and Colpophylia natans. It takes some practice to identify them underwater - the obvious difference is the grooves on top of the ridges, and the width between the ridges.

Q42: Mr. Black's class - What causes the coral to have color?

A42: Shelley DuPuy- Corals have a symbiotic algae that lives inside their tissue. The algae uses the sun to photosynthesize food and then shares it with the coral. In turn the algae lives in a protected area and receives the waste products of the coral, which it uses in the photosynthesis. The coral tissue is almost clear, so the pigment of the algae shows through, giving the coral its color.

(top)

Q43: Jason/Clark MS - What is your next project now that SSE is over?

A43: Emma Hickerson - Jason, time to think about SSE next year! We hope to have SSE's ROV at the Flower Gardens in February, March for the schooling hammerheads, and spotted eagle rays, and well as document the presence of other shark species, including tiger sharks. We have presentations to give, research to coordinate, administration duties to take care of, etc., before we can go play again at the Flower Gardens.

Q44: Timothy - Do you check on the reef every month ?

A44: GP Schmahl- Timothy - unfortunately we are not able to get out to the Flower Gardens every month. During the winter the weather is very rough and there are long periods where we may not be able to get out. During the summer and fall we are usually out there more than once a month doing research and observing the condition of the reef. We rely very much also on recreational divers who report back to us when

they see something unusual when we are not out there.

(top)

Q45: Nicole - Shelley, what kind of education are you in? Are you a teacher or principal?

A45: Shelley DuPuy - Nicole, I am neither a teacher or a principal. I have a Bachelors Degree in Marine Science from Texas A&M at Galveston. I got into education because I realized that most people know so little about our oceans and I believe strongly that we must use the oceans wisely if we want to continue having a high quality of life. After all, over 70% of our planet is covered in water and we all need it to survive!

Q46: Carl - Can you get one as a pet if it is Endangered?

A46: GP Schmahl- Carl, If an animal is endangered, you cannot keep it as a pet. In some instances, if an animal is injured and are qualified to care for it, or you are working in a zoo, you can have permits to keep the animals.

(top)

Q47: Andrew - Are there whales were the reef is? If there is, what would keep huge animals like that from destroying the reef and why are they there?

A47: GP Schmahl - There are not many whales seen in the vicinity of the Flower Gardens, although there have been reports of Sperm Whales and False Killer Whales there. Whales, like dolphins, have very good radar-like navigation abilities, so they would never run into a reef and cause damage.

Q48: Katie Coral - If there is a salt dome underneath the coral, is the reef an area of extra high salinity? Does the salinity affect species spread, like are there species adapted for high salinity that don't live elsewhere?

A48: GP Schmahl- Salt domes lie far underneath the seafloor (thousands of feet). As the salt expands, it pushes up the overlying rocks and sediments and these rise up from the surrounding bottom, sometimes hundreds of feet. At the East Flower Garden Bank, there is what is known as a "brine seep". This is where the underlying salt has found a direct outlet to the surrounding water. This forms a salt pool of water with over 200 parts per thousand of salt (normal seawater is 35 parts per thousand). Not

much can live directly in this salty water, however there are some types of bacteria that grow there. There does not appear to be any direct effect of the super salty water on the adjacent coral reef. One reason is that the brine is much heavier than regular seawater and sinks to deeper water rather than rise to the depths where the coral is. Also the brine gets diluted very quickly (dilution is the solution!) and the impacts are not measured very far from the seep.

(top)

Q49: Chauntay - How many colors of coral are there? Do different reefs have different colors associated with their region?

A49: GP Schmahl - Most corals are various shades of green, brown, orange or yellow. This reflects the symbiotic algae that live within their tissues. But I have seen other corals that are pink, red, blue and purple! So corals come in pretty much every color of the rainbow. Certain color types of coral do seem to be associated with certain regions. For example, in Florida at the Dry Tortugas, there is a common color morph of the large star coral which is very pink. But this pink morph is not very common at the Flower Gardens.

Q50: Tiffany - Emma, the reason for coral reef not growing further up north by Canada is because of the temperature. Is that correct?

A50: Emma Hickerson- Tiffany, you are correct! Temperature plays a big role in where coral can survive and the Flower Gardens is a good example for this - the East and West Flower Gardens are healthy coral reef systems as you know, but 40 miles NW of the West Bank is Stetson Bank, which is around the same depths, but further north. The water gets a few degrees cooler in the winter than the other two banks - and corals don't grow there! The East and West Banks are on the very limit of temperature range for corals.

Q51: Rashad - Why do coral reefs turn colors?

A51: GP Schmahl - Rashad - the different colors of the coral reef are caused by two things. One is that all corals have types of microscopic algae that live within its tissue, called zooxanthellae. These one-celled plants have pigment that help give the corals their color. Also some corals also make their own color pigments in their tissues. Some scientists think that this is caused by the coral taking up things from the water because corals can be different colors under different conditions.

Q52: Rashad - What is main thing GP that you study?

A52: GP Schmahl- As manager of the sanctuary, the main thing I am interested in is the health and condition of the reef. So we have a long term monitoring program set up to detect changes. Then, if we see changes that show the corals are suffering, we can try to do things to protect it, through regulations, education or by doing things like putting out mooring buoys so people do not have to anchor.

(top)

Laura Francis - Thanks everyone for joining us today on the final chat for SSE 1999! There were some great questions. We hope to continue our chats in 2000. Please check in with the SSE web site to find out about upcoming events.

Mr. Black's class - We have to go - thank you for answering our questions!

Katie Coral - Just wanted to say thanks: fascinating stuff, and you guys sound like you are enjoying every minute of it.

Jason/Clark MS - Thanks.

Nicole - Thank you Shelley for answering my question, that's a really neat job!

Ilse - Thank you for answering my questions.

Alan - Thank you a lot for answering our questions, Alan

Andrew - Thank you very much for answering all my questions.

Daniel - Thank you for helping us.

Timothy - Thank you for answering my questions.

Nicole - Thank you, GP, Shelley, Emma, Andrea, and Laura for your help . From Nicole. Bye!

Elizabethl - Thank You !!!!! For helpin' us!!!!!!!!!!!!!!!

Emma Hickerson - See you next year!

(top) RETURN

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May 19, 1999

Michael Guardino, Teacher-in-the-Sea
Carmel High School

Steven Webster, Senior Marine Biologist
Monterey Bay Aquarium

Michael Guardino writes:

Time: 8:21 pm
Weather: Overcast sky, calm seas, cold but clear water
All in a Day's Work

Michael Guardino, Teacher-in-the-Sea, from Carmel High School.

Even though I have only been on the NOAA Ship McARTHUR for three days now, it seems like so much longer! When there is work to be done aboard a research vessel everyone works hard to make their contribution until the mission is accomplished. Such was the case today when the POD (plan of the day) called for a meeting on the bridge at 4:00 am to survey possible dive sites around Carmel Bay for Dr. Steven Webster (senior biologist at the Monterey Bay Aquarium) and I to complete our education missions in the DeepWorker submersible. Captain Bill Sites wanted to get an early start by dropping anchor just outside of Stillwater Cove before sunrise but we had to change our plans when we came upon over a dozen fishing boats that had retreated into this calm refuge to spend the night on this southern end of the Monterey peninsula. Fishers know that the lee side of Pescadero Point affords ample protection from the northwest swell that has prevailed lately. By the time we came back to the Cove to drop our hook an hour later all of the boats had sailed off in pursuit of this season's, as yet, elusive salmon.

Dr. Webster and I wasted no time completing pre-dive preparations for the DeepWorker by 6:00 am in order to take full advantage of our "window of opportunity." We have both been preparing for this day for a long time and our early start seemed a small price to pay to ensure the success of our missions. We each completed our final training dives on the northern end of Monterey Bay near Soquel yesterday where we acclimated ourselves to some of the new features in the DeepWorker such as the tracking devices, SONAR computer, and high tech imaging equipment supplied by the National Geographic Society.

On this opening day of The Phantom Menace I couldn't help but feel like I was flying a Star Wars fighter as I sat in the DeepWorker and was being hoisted off the fantail of the McARTHUR into the cold, clear waters of Carmel Bay. Rather than wielding a light saber like a Jedi knight I was positioning parallel laser beams in the center of my video image in order to accurately measure strip transects. I motored out from the McARTHUR on the surface toward a granite pinnacle that rises out of 90 feet of water near Pescadero Point before receiving permission from dive supervisor Larry Shumaker to begin my descent. I knew right away that all of the training, waiting and preparation was worth it when I looked through the acrylic dome port at a reef covered by a palette of colorful invertebrate life that featured a large cluster of Metridium gigantium anemones that look like so many like huge cauliflower. My biggest thrill came when I encountered a 3 meter siphonophore (Praya sp.?) that coiled up like a barber pole in front of the sub. This deep water animal could have been carried into (relatively) shallow water by the upwelling of cold, nutrient rich water from Carmel submarine Canyon.

I am fortunate to live only a few miles from Carmel Bay and have logged over 1,600 SCUBA dives here in the last ten years. I got a new appreciation for ocean exploration while piloting the DeepWorker without the ever present concern about depth and dive time that must be more closely monitored on SCUBA. It was nice to dive this familiar reef in such a high tech fashion and I will never forget it. My two hour dive seemed like it was over in no time and it left me anxious to climb back in the pilot's seat soon. I only wish that I could share the thrill of piloting DeepWorker more directly with my high school students. After certifying many of them in SCUBA and watching as they mature into research divers it is obvious that they too would make excellent submarine pilots! Who knows, maybe we will soon have "Students-in-the-Sea" as well.

(top)

I had the good fortune to be selected America's first Teacher-in-the-Sea and the experience has been very enriching. Perhaps one of the most intriguing events that I witnessed happened over dinner yesterday in the galley of the McARTHUR. I listened as two of the world's most eminent deep ocean scientists: Dr. Sylvia Earle (National Geographic Society's Explorer-in-Residence) and Dr. Bruce Robison (midwater biologist at the Monterey Bay Aquarium Research Institute) discussed their work and lives spent at sea. It was a unique treat to hear two people get so excited as they discussed their work and the love that they share for the ocean. It is comforting to know that the leadership to sustain our seas is in the hands of people with a passion for the research they pursue. They set a fine example for all of us!

Steven Webster writes:

Steven Webster in DeepWorker.

0400 and my visions of giant squids riding motorcycles are rudely interrupted when Mike Guardino opens the door and gently informs me it's 0400 and the day's half over. He's been up on the bridge since 0330 checking conditions and looking over the situation at the dive site. Mike's so jazzed about diving in Carmel Bay he's practically moving between decks of the McARTHUR without using the stairs.

The captain has selected the Pescadero Point - Stillwater Cove area for our dives, but we're temporarily hampered by about twenty fishing boats that have been anchored there for the night. Just about dawn they move seaward to fish, and the McARTHUR is clear to anchor in about 100 feet of water about 1000 yards from our intended dive site (the wash rock just west of Stillwater Cove). Mike knows a reef there he's investigated on SCUBA, and our plan is to survey that area below SCUBA depth.

Mike's dive goes really well, and now we've prepped the sub and I'm ready to go. We go on hold for a few minutes while Kip Evans is shuttled out from shore to get in his drysuit to do some video and stills of the sub toward the end of my dive. This gives me time to run (walk with a high degree of motivation) to the galley to sample the brownies I've heard about. The food on the McARTHUR is terrific, and the brownies are superb!

OK, into the sub and away we go. Scott has the video monitor working and all sub systems are up and running. Larry's my dive supervisor. Larry and Ian are great confidence-builders in us neophytes. Larry's been around subs for decades, and knowing this means the "remember to worry a lot" part of my brain can be secured and I'll just activate the "remember to remember that you're in a submarine, dummy" part of the brain. This is activated, we do life support checks (I wake up doing these in the middle of the night, these days - I may just put a rack of gauges by my pillow so I won't have to do contortions to see them) and I'm swung off the stern. I can see the ship's props -- we have visibility!!

Dana unhooks the lines and hooks up the towline. I try to capture him on the hand-held digital video I have in pocket number 7b (now where is that thing?). Getting towed by the RHIB (rigid hull inflatable boat) about 1000 yards to the dive site I focus on the tow line float. Something stable in an otherwise mixmaster sort of world. No mal de mer wells up, so all's well in subville. The alternative is not pretty.

On site, unhooked, life support checks are completed and I have permission to dive. Sonar turned on and down we go. Very dilute pea soup -- about 15-foot visibility. Still

Siphonophore

gets pretty dark as I reach the bottom at 78 feet. I can see, but it's like twilight time. Sand bottom with current ripples, some small pieces of drift algae. Sonar tells me where the reef is, so I take a compass heading and fly slowly to the reef. First rock is about Buick size (topside asks me to repeat that one so I use Oldsmobile, instead) rock with a toupe of Metridium (white plume anemones) covering the top. Gorgeous. I try the pan and tilt on the video camera (not using the hand-held on this dive) and find flying the sub is the easier way to compose the shot. A little current's running, so I gently (?) nudge a rock beside me I hadn't seen. "Remember, dummy, you're in a submarine, not a Jeep!"

Pick a heading along the base of the reef and move deeper to about 90 feet. Stop along the way to get video of some nice invertebrate turfs on vertical rocks walls (not much light on the vertical walls, so these communities are dominated by invertebrates -- not algae). Lots of anemones, solitary corals, sponges and tunicates. A lot of filter-feeders trying to screen the pea particles from the soup. Currents here likely keep these critters well fed -- they are doing very well. No bare rock here -- just a 100% turf of invertebrates and a very few leafy and coralline red algae that do well in low light.

(top)

A few rockfishes hovering just above the rock. Sebastes serranoides, I think. Will have to check the video. Lots of sea stars. Predators of the sessile (stuck to the rock) inverts.

Oops, current is taking me west (as in toward Japan). Strike out on compass course back to whence I've come. Try to hold sub steady while doing video of more rock faces and big sunflower stars. Tricky. Being neutrally buoyant, it's a battle to hold steady, take pictures, do life support checks, check sonar, check video tape in the recorder, adjust oxygen flow, etc. Good practice. I remember my dad's reference to a "one-armed paper hanger with the hives." That's me!

Larry, in a pained and apologetic voice, gently informs me he'd really like to have me on the surface before I (and the sub) run out of electrical power needed for a second dive with Kip, so I say, "Well, since you insist," (one does not question one's sole connection to the rest of the world) I say and up we go. On the surface we switch to VHF radio, Dana hooks up the towline and the RHIB and crew tow me back toward Stillwater Cove. I'm heavier now (having added hard ballast to get neutral) and they are able to tow me just under the surface with just the VHF antenna sticking up. Comms (that's subese for communications) are good and the ride's much steadier at this speed. Just-visible plankton are zipping by (Big dinoflagellates? Crustacean larvae? The size of big pinheads.)

We're at Stillwater in a jiffy and I'm asked to descend to the bottom (about 66 feet) and stay put until I'm joined by Kip and Wayne. Oh boy, a second dive in one day! This is too good to be true. More peas in the soup, now, so visibility has dropped to about twelve feet. I get planted on the bottom in sand among rocks (the sonar looks like a half-pumpkin with chicken pox - red poxes are rocks).

Out of the green gloom (that's the water - I'm in full anti-gloom) come Kip and Wayne looking comfy in their drysuits (but not nearly as comfy as I am, the water's about 49.5 degrees F) with cameras in hand. Kip says "look like you're doing something scientific" using SSE underwater sign language which he's just invented. OK, so I point the handheld video camera at the rock face I'm illuminating with the sub's video lights. Trying to look my scientific best. More life support checks. Press button on headset while taking video with other hand while contorting to see gauges while staying off foot peddles so we don't do wheelies while looking profoundly scientific.

DeepWorker

A bead of sweat drips into my right eye (the only good one I have left from a dumb accident at Stanford 43 years ago - don't play with sticks, people!) so now I've gone mostly blind. OK, put down the camera, keep talking to Larry (don't tell him I can't see), smile at Kip (do scientists smile? Sure we do - lots - we love what we're doing even with sweat in the eyes). Ah, back to relative normality, Kip motions me to follow him. Give the sub some "up" to fly over the low rocks and we fly to Kip as he swims upside down and backwards taking video back toward me. Some people are 2/3 fish - Kip and Wayne and Dana are excellent cases in point.

After about 40 minutes of this modeling session Kip and Wayne wave goodbye and start off toward the surface. Soon Larry apologizes again and suggests I might want to ascend before running entirely out of electricity (me and the sub).

Up we go (DeepWorker and I) looking up so we don't come up under the RHIB. No decompression stops here - just ascend straight to the surface. And my fingers are still warm. And I could munch a carrot (if I'd remembered to bring one). What a great machine!! Larry asks me to motor over to the McARTHUR without running over Dana. Seems fair enough. Lighten up with that bubble of soft ballast air, and we're off to the stern where Dana hooks up all the lines and in no time it's the Z ride back to the deck of the McARTHUR. Seems like I've been in the sub about 45 minutes. It's been over three hours!

Hey, Sylvia, where do I get one of these things?! DeepWorker has to be the best

thing since SCUBA. On second thought, it wouldn't work very well without the terrific Nuytco crew, the great McARTHUR crew (especially the chefs), Kip and the National Geographic folks and all the other SSE pilots and support folks from whom I've learned heaps. And the support of Bill Douros and the sanctuary staff who have been so helpful in planning and implementing these two weeks of SSE activities. I couldn't afford even to feed these people, so I guess I'll just have to wait for next year.

Thanks to you all - this was the best three hours I've ever spent in the ocean. Next year the winds will be calm and we'll go for a lot more science in the sanctuary. Can't wait!

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EXPEDITION UPDATE

May 9 - 22, 1999

In Cordell Bank and Gulf of the Farallones, we had a chance to get our feet wet. We deliberately kept our dives shallower, well within the DeepWorkers' capacity, because most of our pilots are new at this, and we're all learning quite a lot as we go. The subs we're using for this part of the expedition are the first generation of DeepWorker, which is rated to 350 feet. The first 2000 foot capable DeepWorkers ever built are almost ready to go, and will replace these when we get to the Olympic Coast. Even so, these shallower subs will enable us to go further than people normally can manage with SCUBA alone.

On May 9, Sunday, we anchored in Soquel Cove off the Santa Cruz Boardwalk, and brought on some personnel from shore using RHIB boat AR-3. Bruce Robison and Kim Reisenbichler, both from the Monterey Bay Aquarium Research Institute (MBARI), completed their checkout dives. Weather conditions were nice and sunny with very little wind. We completed another three checkout dives on the 10th: Rick Starr, Mary Yoklavich, and Chris Harrold. Winds picked up a little Monday evening, and a swell started rolling in the late afternoon. We pulled anchor late Monday night and headed to Soquel Cove in Santa Cruz to anchor for the night. On the 11th, we headed out for Point Pinos for more checkout dives, but got socked in by very thick fog.

Since then, we've gotten quite a few more dives completed, but weather has continued to be a frequent barrier to operations. Bruce Robison dove the sub off the McARTHUR and met up with the Remotely Operated Vehicle (ROV) Ventana which was launched off the MBARI ship Point

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Lobos. Phil Otalora took the sub to 285 feet and saw some fantastic bioluminescent syphonophores. And our Teacher in the Sea Mike Guardino was able to fold his 6'4" frame into the sub's tiny cockpit for his long-awaited dives.

Until recently, all our dives had been while the Mac was at anchor. Now, we've gotten some practice safely launching and recovering the sub from a moving ship, which increases our flexibility with regard to where we can dive the sub. When we start diving deeper water, anchoring will not be an option, so it's important to get the hang of this!

Towards the end of the mission, the Mac moved down to Big Creek to try to complete some research dives. Once again, the high winds and rough seas proved a barrier to completing as many dives as we wanted to, but Bill Douros was able to use the sub to complete some survey work near a proposed dumping site. Next year, we'll be more experienced, and better prepared to make the most of our time in Monterey Bay. But for now, it's time to continue our southward journey and check out the Channel Islands sanctuary. Join us there starting May 25.

Gale Mead, Expedition Log Editor

VIRTUAL TOUR

Interview

Interview with William J. Douros, Manager
Monterey Bay National Marine Sanctuary
March 9, 1999

Why does the Monterey Bay National Marine Sanctuary exist?

Click here for audio response. (RealAudio), for help see About this Site

Bill Douros

The answer to that question falls into two parts, the *legal/legislative* part and the *natural* part.

Legally, the United States Congress created the U.S. National Marine Sanctuary program in 1972 as part of a wave of new environmental legislation. The program can be likened to an oceanic equivalent of the National Forest Service--protect the resources while promoting public and private uses of them, to the extent that those uses are compatible with the main mandate to protect the resources. In the sanctuary program, we also have a mandate to conduct and coordinate research to help understand the natural functions of the ecosystem and how human use can influence those natural processes. We also have a mandate to conduct public outreach and education to improve public awareness of protecting sanctuary resources. On September 18, 1992, Congress established the Monterey Bay National Marine Sanctuary, the country's largest.

Now, the *natural reasons* for the Sanctuary are much more complicated and represent the special value that the Central California ecosystem holds for Americans. Due to certain oceanographic and geologic conditions, such as upwelling and the Monterey Submarine Canyon, the near-shore waters and diverse marine habitats are highly productive and support exceptionally rich

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and abundant marine floral and faunal communities. The variety of habitats--rocky shore, deep ocean, sandy intertidal, and kelp forests, to name a few--is one of the major determinants of the rich intertidal and subtidal communities.

Because of the incredible productivity and biodiversity of the ecosystem, the area supports a great diversity of marine mammals, including several endangered and threatened species, such as the California sea otter. Areas such as Ano Nuevo Island have been cited as one of the most important pinniped rookeries in California. Offshore canyon breaks, like those around the Carmel Canyon, can provide some of the best blue whale and fin whale watching anywhere in the world, with these large cetaceans coming within five miles of shore, a half-hour boat ride from the Monterey Harbor. Monterey Bay also plays a major role for migratory birds, as a staging habitat during migrations, as a feeding ground, and as winter and summer habitat.

The high density of habitat types and community assemblages provides an excellent environment for a wide variety of research projects, including deep-sea studies and educational opportunities.

(top)

What are some of the Monterey Bay Sanctuary's objectives for the Sustainable Seas Expeditions?

Click here for audio response.

Since this is a five-year project, we're still working on lining up projects that we can develop for many years. In this first year, we have the opportunity to place some of the area's outstanding researchers and educators on board the one-person submarine, the DeepWorker, that is being made available to us. Five scientific research projects will be launched this year:

- monitoring fish populations in the "no-take" zone of Big Creek Ecological Reserve
- studying the distribution and movement of prickly sharks
- day-night patterns in the activities of deepwater rockfish in natural harvest refugia [isolated areas]
- diurnal [daily] migrations of mesopelagic organisms [those that inhabit the middle depths far offshore] associated with the edge of submarine canyons
- a brief survey of sediment flow at the dredge site near Moss

VIRTUAL TOUR

Landing.

We'll also conduct a two-day education project we are calling Teacher-in-the-Sea. A local high school teacher has proposed to evaluate the effects of another "no-take reserve" to compare deep water habitats with shallow water depths. The teacher and his students will explore the area on scuba.

And our site, of course, like all the other sanctuaries, will be explored for two days by the National Geographic Society's explorer-in-residence, Dr. Sylvia Earle.

In this first year of the Sustainable Seas Expeditions the Monterey Bay National Marine Sanctuary has chosen to build upon the resources that are available in the local community. Each project has its own specific objective; however, all of the projects provide important information for marine resources management.

(top)

What benefits does sanctuary status bring to the Central California marine environment?

The purpose of the Monterey Bay National Marine Sanctuary is to provide a comprehensive ecosystem approach to natural and cultural resource management. Sanctuary status to this area permits the federal implementation of a coordinated and comprehensive management scheme. The sanctuary program enables us to bolster the existing regulatory regime for resource protection; establish a coordinated research program to expand knowledge of the Monterey Bay area environment and resources; implement a broad-based education and interpretive program to improve the public's understanding; and provide a comprehensive management framework with other federal and state resource management agencies to protect this habitat.

(top)

How do people use the resources of the Monterey Bay sanctuary?

The quality and abundance of natural resources have attracted people from the earliest prehistoric times. Native American cultures probably lived in the area more than 10,000 years before the present day.

The area supports several marine-related economic activities. The

most obvious activity, directly dependent on the resources, is fishing. Commercial fishing has played an important role in the recent economic and cultural history of the area, and continues to be a very important activity to the region's economy.

The area's biological and physical characteristics provide outstanding opportunities for scientific research on many aspects of marine ecosystems. Some 20 research/education facilities are found in the sanctuary boundary area. These institutions have a long history of research on the sanctuary's environment and its resources.

Tourism and recreational activities, business, commercial, and industrial uses of the area are also important. Major agricultural areas depend on the near-shore ocean climate for their productivity, including the Salinas and Pajaro Valleys. Large commercial vessels regularly traverse the sanctuary en route to and from the harbors in San Francisco and Oakland.

Of course, the sanctuary program is not about creating a "hands-off" attitude toward the sanctuary environment. In fact, one of our mandates is to encourage multiple uses of the sanctuary while protecting the environment and its resources. This, then, is the challenge we face.

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Natural Setting

The Monterey Bay National Marine Sanctuary: huge, beautiful, complex, and wild.
by Andrew De Vogelaere, Research Coordinator
Monterey Bay National Marine Sanctuary

Audubon magazine identified the Monterey Bay National Marine Sanctuary as one of the top ten paradises preserved in the United States this century. So, where do you get tickets? What time does it open? This may be one of the best deals on the planet. There are no gates or closing times, and access is free!

Andrew De Vogelaere

But, what makes this such a special place? And why visit and care for it?

Because it's huge, beautiful, complex, and wild.

Stretching from San Francisco to Cambria, covering 5,300 square miles of coast and ocean, the Monterey Bay sanctuary has roughly the same surface area as Connecticut. It's the largest sanctuary in the nation and, by volume, we think it's the largest in the world. In the center, down the middle of the Monterey Bay, is the Grand Canyon of the Ocean, where water just a few miles offshore is over 10,000 feet deep. To the north, surfers barrel down 40 feet waves at the famed "Mavericks" surf spot.

In the south, the cliffs are so tall and steep that only very small towns could develop, and streams of cars cling to Highway One and experience spectacular views from "the edge of the Earth." Add all this up, and we're talking "huge."

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There are many rocky shores along the 400+ miles of sanctuary coastline.

The sanctuary region has the highest concentration of marine research institutions in the world, partly because of the access to such a wide variety of beautiful habitats. Around just the Monterey Bay area, there are over 20 different marine research labs, agencies and institutions. Within the distance of a half-hour by car or boat you can reach marshes, mudflats, sandy beaches, rocky shores, kelp beds, subtidal sandy areas, open ocean, deep sea, marine canyons, and recently discovered "cold seeps." Here, cold water full of sulfide or methane bubbles through the deep seafloor to feed unique communities of clams and worms that never see light from the surface. The sea otter, a favorite among the general public, glides through all of the shallower habitats, eating a quarter of its weight in food daily.

The sanctuary water conditions and seasons are largely influenced by the California Current, bringing cold water down from Alaska, but it's a complex story. The surface water heads south, the deep water heads north, there are water jets and eddies depending on the location of coastal points and bays, and these water movements change seasonally. You know it's fall on the central California coast when the pickleweed marsh plants turn from green to deep red.

However, the sanctuary has three distinct seasons of its own: (1) The oceanic season, in September and October, when clear blue, less nutrient rich, offshore waters come close to the shore and bring sea turtles and ocean sunfish, (2) the Davidson Current season, November through February, when warmer water from the south is joined by the rains, and (3) the upwelling season, March through July, when winds drive surface water offshore and deep, cool water rises from the depths, laden with nutrients that mix with sunlight to make a hearty phytoplankton soup. The Monterey Bay sanctuary has some of the highest seabird densities in the world, as they travel from as far away as New Zealand to fatten-up on shrimp-like

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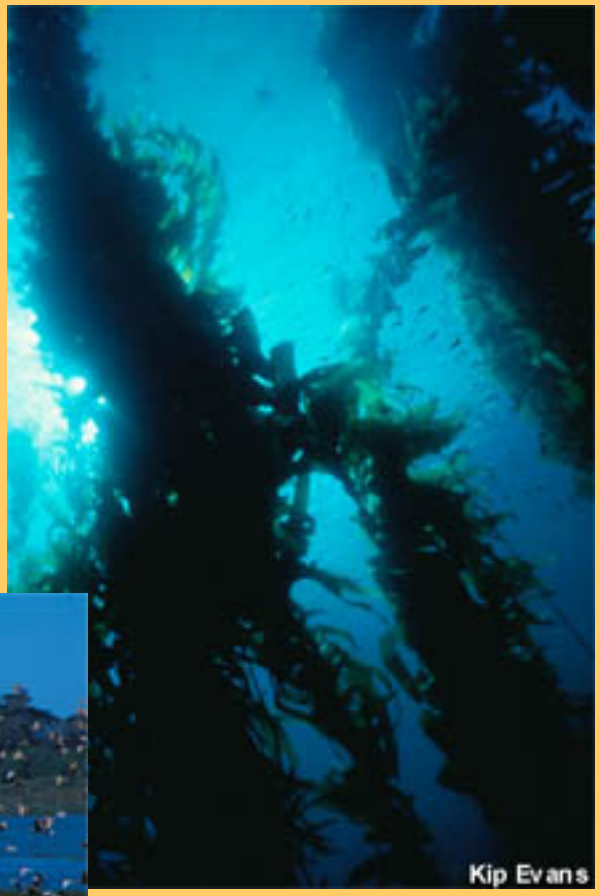
creatures and fish. The largest animal to ever grace the Earth also comes to participate in this feast; the blue whale can grow to 100 feet in length and weigh over 300,000 pounds. The upwelling season also brings consistent fog. This allows for the most diverse tide pool creatures you could dream of, because they are protected from harsh sun during low tides in the summer months.



is the fastest growing marine algae in the world. It grows an incredible 24 inches a day.

Thousands of birds visit or lie in the wetland areas along the boundary of the Monterey Bay National Marine Sanctuary. They come here for the abundance of food and refuge that these areas provide.

Heroic migrations of birds and fishes run through the sanctuary, but perhaps the most wild stories come from the mammals. The gray whale has the longest regular migration of any marine mammal. They are easy to spot as they hug the shores, migrating back and forth from the Bering Sea to Baja, California. As they reach Monterey Bay, the whales often forsake the relative safety of the shallow waters and save time by cutting across the bay. Pods of killer whales lie in wait and make an easy meal of the slower grays.

The elephant seal populations are increasing by the thousands near Año Nuevo and Pt. Piedras Blancas. These 4,000 pound wonders will migrate to the Aleutian Islands, diving up to 5,000 feet deep and sleeping underwater, but they return to the sanctuary to give birth and molt.

At Año Nuevo Island, great white sharks patrol the coast in front of the rookery picking off the less wary seals. These stories beg the

obvious question that my four year old son asked me the other day, "Dad, who's tougher, the killer whale or the great white shark?" They probably don't meet very often, but there is video footage taken in the Gulf of the Farallones Sanctuary showing an orca getting the best of that battle. Wild enough?

Transient Killer whales (Orcas) wait near the edge of the Monterey Bay canyon for gray whales to pass by. Gray whales, sea lions, dolphins, and other marine mammals are prey for transient Killer whales.

There is no way to do justice to the natural setting of the Monterey Bay National Marine Sanctuary in a few pages, and the above is simply a fun way to give a feel for this national treasure. Fortunately, numerous scientific experts have written a comprehensive review of the geology, oceanography, and biological communities in the Monterey Bay National Marine Sanctuary Site Characterization. I encourage you to look there for excellent overviews with an additional 10,000 references in the bibliography that you can search on-line.

It's been said that we will love only what we understand, and we will understand only what we have been taught. We still need to complete basic information such as a map of what the sanctuary seafloor looks like and describe what invertebrate species live there.

Now that we have underwater cameras and submersibles, new species of jellyfish-like creatures are being discovered and described. Jellies make up as much as 30 percent of the living material in the open water, and we've been ignoring them as "the crud" smashed in the bottom of sampling nets until just recently.

Future generations may wonder why we did not love and care for the sanctuary more; they may not realize

This purple striped jelly fish is just one example of the many types of jellies that mysteriously appear and vanish throughout the year in the Sanctuary.

what a primitive stage of understanding we are at in the 1990's. We need many projects like the Sustainable Seas Expeditions to bring our nation to that next level of understanding. Lets hope this is just one baby step for a new generation of expeditions to come.

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The Sanctuary

The waters of Monterey Bay and the adjacent Pacific Ocean off the central California coast were designated and protected in 1992 as the Monterey Bay National Marine Sanctuary. This vast area stretches 400 miles (348 nautical miles) north to south, extends an average of 35 miles (30 nautical miles) offshore, and covers over

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5300 square miles (4,024 square nautical miles). The sanctuary is managed to balance recreational and commercial uses with protection of natural resources, water quality, habitats, and its bountiful resident and migratory marine life. Major resource management issues in the sanctuary are vessel traffic and its potential impact on living resources and water quality; assessing the design and effectiveness of marine management zones; assessing impacts of increasing human populations; causes of change in threatened species populations, such as the sea otter; coastal erosion; non-point source pollution; and impacts of non-native, invasive species. Visitors will find a mostly undeveloped coast of spectacular steep cliffs in the southern half of the sanctuary. The Monterey Bay region includes the moderately sized cities of Monterey and Santa Cruz separated by vast sandy beaches. This area is home to over 20 marine research institutes, making it a world renowned center for marine research. To the north, the shoreline is rocky with intersperse pocket beaches and cliffs. Up until the city of San Francisco, this coast is dotted with small towns and moderately-sized cities.

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The Mission

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The mission will have four research thrusts:

1) a study of prickly shark ecology at the head of Monterey Canyon,
2) a study of day-night activity patterns on the shelf of the Monterey Canyon,
3) an examination of marine protected areas at the Point Lobos Ecological Reserve, and
4) a study of "no-take" areas as a resource management tool in the Big Creek Marine Ecological Reserve.

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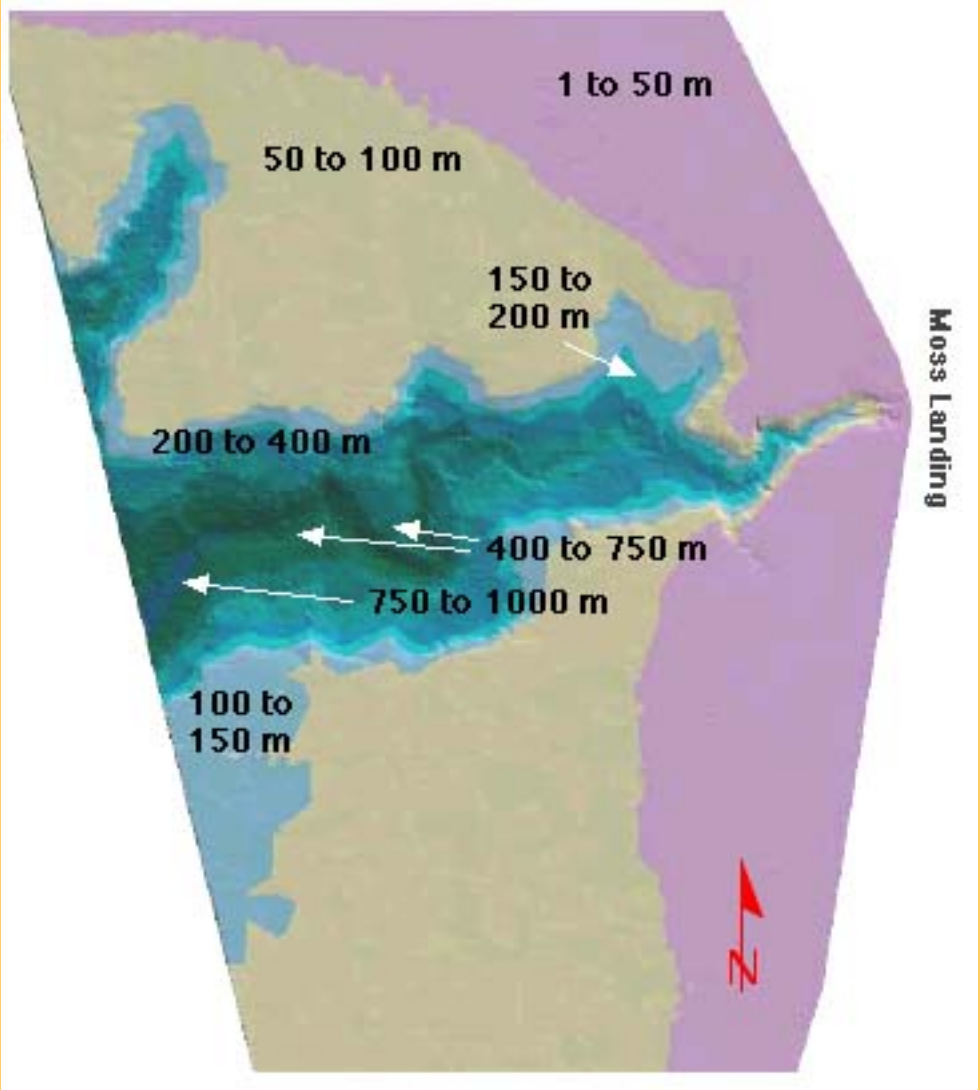
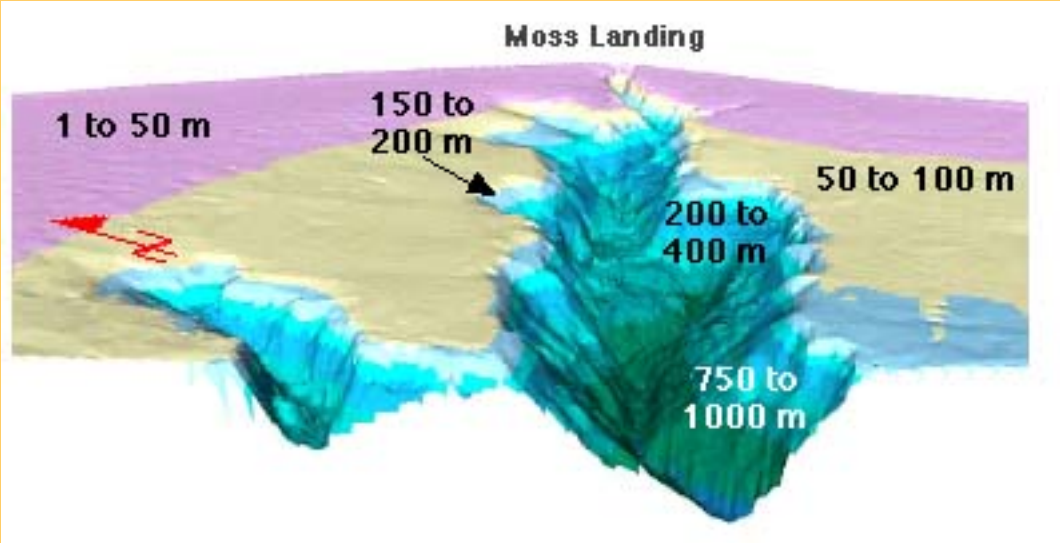
The Sea Floor



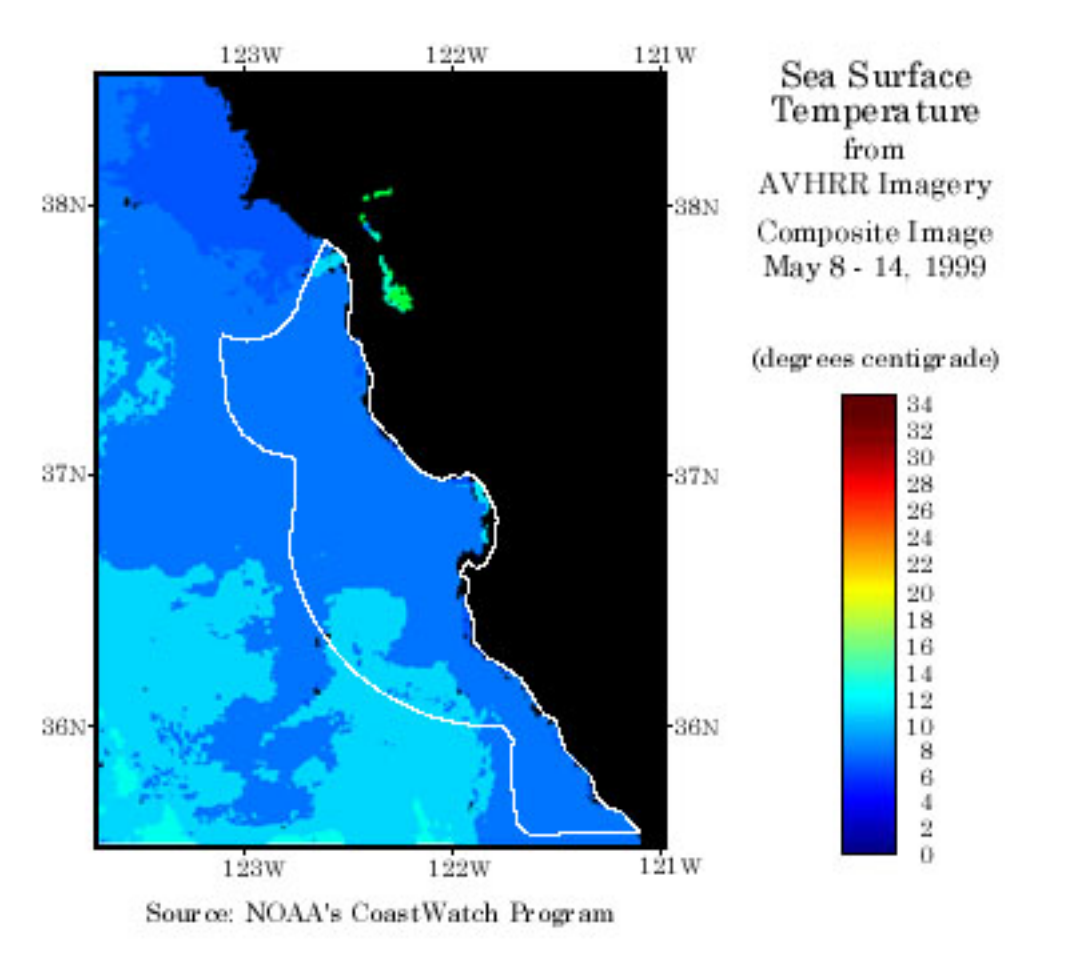


Two dimensional (top) and three dimensional maps of sea floor (bottom) in eastern portion of Monterey Canyon. Monterey Canyon is the dominant distinguishing feature of the sea floor in the

Monterey Bay National Marine Sanctuary, and serves to drain inner Monterey Bay. (Source: based on NOAA's hydrographic survey data collections)

top)

Sea Surface Temperature



Cool temperatures (8-12 degrees centigrade) characterize the springtime ocean surface waters of central California. Produced from the Advanced Very High Resolution Radiometer (AVHRR) on NOAA's polar orbiting spacecraft, the scene shows coolest waters just north of San Francisco Bay with slightly warmer waters southwest of the sanctuary boundary. Clouds and land are shown in black.

The AVHRR sensor measures radiation reflected from the earth's surface. Data are transmitted from the sensor to ground receiving stations and processed using multi-channel atmospherically corrected algorithms. This particular scene is a seven-day composite image of data collected from May 8-14, 1999.

Compositing helps remove clouds that keep radiation from reaching the sensor.

Resolution of AVHRR data is approximately one kilometer. This image represents a series of products being provided by NOAA's CoastWatch Program exclusively for the National Marine Sanctuaries and the Sustainable Seas Expeditions.

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Whales

by Morton Marcus

Click here to hear Morton Marcus read part of his poem (RealAudio), for help see About this Site.

Our future plunges with the whale:
chilled water weighs against our skulls,
flat forehead forces a passage
to that slow darkness miles below
where it swaggers into whale-shape --
that round unrolling from the end of darkness
to the beginning of light.

We slide up through fathoms of his shadow,
butting the underside of water
until we break the surface
and bask in the sun.

And when we roll in the swells
and release an easy breath,
his spout is a halo above our heads.

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Research

Monterey Bay National Marine Sanctuary Research and the Sustainable Seas Expeditions

Dr. Greg Cailliet
Monterey Bay National Marine Sanctuary Advisory Council Research Representative
Chair, Monterey Bay National Marine Sanctuary Research Activity Panel
Ichthyology Professor, Moss Landing Marine Laboratories

Dr. Andrew De Vogelaere
Monterey Bay National Marine Sanctuary Research Coordinator and Senior Scientist

Greg Cailliet

Coordinating the research program for a marine area encompassing over 5,300 square miles is a challenging task. The Monterey Bay National Marine Sanctuary encompasses diverse, sensitive ecosystems and the sanctuary office's staff, time, and budget are limited. So, our strategy has been to make the most of partnerships and pursue any quality research opportunity that presents itself. That is why we were thrilled to learn about the Sustainable Seas Expeditions (SSE) and we've eagerly anticipated the chance to use the one-person submersible DeepWorker as a research tool to further our knowledge of the sanctuary and its resources.

This sanctuary is a unique place - not only because of its spectacular, pristine marine environment but because this is a world-class center for marine research, with more than twenty marine science facilities around the greater Monterey Bay region.

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What better place to bring a collaborative research and education program?

Beaches are not only beautiful coastal areas, but they are also important biological habitats.

We feel very fortunate indeed to work in a region where scientists and institutions have a long history of successful partnerships. This collaboration has been facilitated by the sanctuary's research program. For example, the monthly meetings of the Research Activity Panel (RAP) - an advisory group to sanctuary management consisting of local scientists - ensure better communication and more interdisciplinary research among members. Further, the sanctuary has helped fund and/or organize numerous research projects, including an intertidal monitoring program, critical marine mammal habitat studies, an assessment of coastal erosion, and the highly successful Beachcombers volunteer program, which monitors deposition rates of marine birds and mammals along sanctuary beaches.

Research in the sanctuary is guided by the sanctuary's Scientific Research Plan and the RAP meetings. There are four components to the sanctuary's research program: facilitating research and collaboration among regional research institutions; providing technical information to and interpreting research information for decision makers; developing monitoring programs to determine the sanctuary's health; and encouraging research on resource management issues.

Our approach to SSE has been to complement and build upon existing research, and to work in partnership with scientists who have expertise in the deep sea and with remotely operated vehicles (ROVs) and submersibles. The projects we will carry out this month continue our collaborative efforts in ways that make

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the best use of the DeepWorker's capabilities.

This strategy makes the most sense for several reasons. Consider the size of the Monterey Bay National Marine Sanctuary and the finite resources we struggle to use efficiently. Given these limitations, two weeks is very little time to make significant steps toward the many research needs we have and the myriad resource management issues we'd like to address. Focusing on ongoing research projects has been a way to get the most "bang for our buck" out of the opportunities afforded by SSE. As a result, all dive time in the DeepWorker, with the exception of one staff person, has been assigned to expert, regional scientists from various institutions who are carrying out SSE research.

The Monterey Bay Region boasts one of the largest concentrations of marine science institutions in the world. Presently there are over 25 different organizations dedicated to marine research.

Greenspotted rockfish in typical habitat of mixed rock, boulders and soft sediment. This picture was taken at 100 m water depth off the Big Sur coast of California, near the Big Creek Ecological Reserve.

The DeepWorker is an excellent resource for characterizing habitats and developing monitoring programs, and we've selected research projects to take advantage of those strengths. For example, we are building on an existing prickly shark monitoring program by using the DeepWorker to conduct visual transects at the head of several of the major canyons in the sanctuary to estimate the distribution and relative abundance of this and other species of large deep-water sharks. The DeepWorker is also helping local efforts to make seasonal comparisons of deep water habitats and fishes in the Big Creek Marine Ecological Reserve along the Big Sur Coast.

A third study observes day-night migrations of fishes and small invertebrates, with a focus on gelatinous zooplankton. This is a particularly exciting use of the DeepWorker. Traditional sampling methods, such as nets, destroy these zooplankton during capture, but with sampling and observation techniques like DeepWorker and other submersibles, we're learning a lot more about these gelatinous and delicate organisms that constitute roughly one-third of the life in the water column.

Bob Lea, Greg Cailliet, and Mary Yoklavich carefully mapping habitat observations while in the wheel house of a research vessel off Big Creek Ecological Reserve.

The Sustainable Seas Expeditions mesh well with the mission of our research program by allowing us to move forward in exciting new ways with our ongoing efforts to characterize and monitor the sanctuary. Particularly intriguing is the ability we have, with the DeepWorker, to explore the deeper waters (down to about 2,000 feet, we hope) of the sanctuary, regions previously unreachable by conventional scuba diving. We look forward to the knowledge gained by these expeditions and a better picture of sanctuary resources that will result.

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Monterey Bay National Marine Sanctuary Education and the Sustainable Seas Expeditions

Pat Clark Gray
Sanctuary Advisory Council Education Representative
Chair, Sanctuary Education Panel
Interpretive Specialist, California State Parks, Monterey District

Liz Love, Education Coordinator
Monterey Bay National Marine Sanctuary

While scientists carry out their Sustainable Seas Expeditions (SSE) projects in the Monterey Bay area this month, the educational aspects of their research will not be far from their minds. The SSE program has made a point of including a strong educational component to the deep-water explorations taking place throughout the nation's marine sanctuaries, using the myriad projects as a source of both scientific learning and public education. The regional education community encompassed by the Monterey Bay National Marine Sanctuary is proud to have our special marine environment be the stage for a part of this important work.

The wonderful thing about these expeditions is that they give everyone the chance to be an ocean explorer. You'll be amazed at what you can learn just by investigating the many parts of this web site. For example, you can follow the day-to-day activities of researchers as they explore the sanctuary's depths, learn about the DeepWorker submersible and other underwater exploration technology, and investigate a sanctuary's natural resources. In addition to what you'll find here, photography and underwater videos from the dives and a special collection of SSE-related curriculum will allow the learning process to continue far beyond the specific time frame and geographic boundaries of these expeditions.

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Here in Monterey, the SSE educational program has taken on a life of its own thanks to the enthusiastic ideas and support of our Sanctuary Education Panel (SEP), an advisory group to sanctuary management consisting of local marine educators from more than 20 regional organizations and schools. To involve teachers and students more directly in the SSE expeditions, the SEP proposed the idea of training a teacher to pilot the DeepWorker submersible and carry out student driven research projects. This resulted in the selection of our "Teacher in the Sea," Carmel High School teacher Mike Guardino who is the only teacher in the nation trained to pilot the DeepWorker as part of this year's SSE. Mike has gone above and beyond what we could have hoped from his participation: in addition to training for his dives and working with students to prepare a DeepWorker research project, Mike has made over 50 public presentations about the SSE, and has created many of the activities which appear in the national SSE curriculum. His most important role has been to involve students directly in SSE by teaching a research SCUBA diving course to (and certifying) more than fifteen students from regional high schools.

(top)

The student research project that Mike is coordinating involves using the DeepWorker and SCUBA gear to survey bottom topography and compare organisms within and outside of an existing no-take zone at Point Lobos State Reserve. So far the students have completed a total of 21 dive days and 190 research dives on SCUBA collecting data inside and adjacent to Point Lobos Reserve. This project ties in with one of the sanctuary's DeepWorker research projects, in which Mary Yoklavich of the National Marine Fisheries Service will continue her study of the deep water habitats and fishes in the Big Creek Ecological Reserve, further south along the Big Sur Coast.

To build upon the work conducted by Mary Yoklavich and Mike Guardino and his students, other area high schools students were encouraged to conduct their own projects focusing on no-take reserves. Almost fifty students from eight schools have undertaken projects including a community survey on marine reserves, a project on exploited fish populations, a study of New Zealand marine reserves, and a survey of a proposed underwater park in the Monterey area. These students, their teachers, regional scientists, and Dr. Sylvia Earle, the National Geographic Society's Explorer-in-Residence, will gather together this month in Monterey at a student summit to discuss ocean conservation issues and to present their projects to one another.

Just as the SSE recognizes the importance of teaching people about

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the marine environment, here at the Monterey Bay National Marine Sanctuary we've always made education one of the pillars of our program. Our educational mission is to promote understanding and stewardship of the sanctuary, which we accomplish by getting the public, particularly children, as actively involved with our ocean and watersheds as possible. Rather than duplicate efforts, we coordinate with other organizations through the Sanctuary Education Panel to enhance existing programs or implement new ones where there is a need.

Every year we host or co-sponsor a number of events, such as the Great American Fish Count, in which volunteer divers help census sanctuary fish populations; the Sanctuary Currents Symposium, a gathering of researchers, educators, conservationists, and the general public to study and discuss a specific marine theme; and our annual sanctuary birthday celebrations, which showcase the strong educational component of our communities. We have produced a wide range of educational materials, including our Watersheds to Sea Shores video, informational brochures, newsletters and posters, and for the first time this year an annual report, our Ecosystem Observations, which highlights what we learned about the sanctuary in 1998.

Here in the Monterey Bay region we are very pleased to be a part of a national ocean event again. We hosted President Clinton and many government leaders at the National Ocean Conference in June 1998, and it is an honor to continue that trend by welcoming the Sustainable Seas Expeditions. We gladly take any opportunity to highlight the importance of this special region and the oceans in general; with the SSE in particular, it is exciting to participate in a program that is educating and encouraging the ocean explorers of today and tomorrow.

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Monterey Bay National Marine Sanctuary and the Public
by Dr. Steven Webster
Senior Marine Biologist, Monterey Bay Aquarium
Chairman, Monterey Bay National Marine Sanctuary Advisory Council

The Monterey Bay National Marine Sanctuary has a unique relationship with our community. Regional citizens literally created the Sanctuary, and this relationship has shaped the character and development of the sanctuary over the past seven years. We benefit greatly from the energy and commitment of our surrounding communities and organizations and in return, the sanctuary adds to the richness, diversity, and quality of life along California's Central Coast.

Steven Webster

The Sustainable Seas Expeditions (SSE) offer another opportunity for the sanctuary and its stakeholders to work together. Sanctuary staff are collaborating with regional scientists and educators to improve our knowledge of the sanctuary and to educate the community about what we learn using the unique tools and opportunities SSE makes available to us. The one-man DeepWorker submersible allows local researchers to study, photograph, and record the sanctuary's deep water environment in ways never done before. Related sanctuary education programs allow us to share the excitement of these

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expeditions and the knowledge gained from them with the general public and schoolchildren both locally and nationwide.

It is no understatement to say that the sanctuary wouldn't be what it is today - in fact might not even BE here today - without the hard work and dedication of the community: grassroots public support is what launched the idea of a marine sanctuary in and around Monterey Bay. In the late 1960s, the Sierra Club (Ventana Chapter) began lobbying for priority status for the Monterey Bay/Big Sur areas under a proposed Marine Sanctuaries Study Bill. The following decades saw the untiring support of former Congressman Leon Panetta and Congressman Sam Farr; nominations by the California Coastal Commission for the Monterey Bay area to be a sanctuary candidate; the rallying of citizen support by conservation groups; and public hearings in which the citizenry fought for the largest possible boundary. Finally, in 1992 our dream was realized. Part of that continuing dream happens when we are able to host world-class scientific discovery and educational projects like the SSE.

When the sanctuary was designated, community-based conservation, education, and scientific groups were already in place to offer support and advice to sanctuary staff. Today, these groups and their members still play an active role. For example, the Sanctuary Advisory Council (SAC) is the embodiment of sanctuary/community interaction. The volunteer council members are the public's connection to sanctuary management. They represent a variety of local user groups (such as fishing, agriculture, science, tourism and recreation) as well as the general public, and state and federal government agencies. Just some of the issues which have come before the SAC in the past several years include the live fish fishery, diver education and outreach, the Coast Highway 1 Management Plan, invasive species, and desalination plants in the sanctuary.

(top)

The SAC and its working groups provide a public forum for local constituents, enhancing communications and providing a conduit for bringing the concerns of user groups and stakeholders to the attention of the sanctuary. As an example, at a recent meeting many members of the fishing community addressed the Council on topics of concern to them; the exchange of ideas which resulted benefited everyone. The SAC has also been successful in encouraging kelp harvesters in the sanctuary region to work together to develop a single agreement which clearly outlines harvesting practices. A Kelp Harvesters Cooperative agreement was signed in late 1998 by the regional harvesters.

Active volunteer organizations complement and extend the

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sanctuary staff's work educating and inspiring many more people than we could hope to reach alone. BAYNET docents don their bright blue jackets and act as shorefront docent educators; Save Our Shores' Sanctuary Stewards give slide presentations and staff displays at community events; and BeachCOMBERS volunteers gather data to determine deposition rates of organisms along sanctuary beaches. In the Cambria region, Friends of the Elephant Seal docents work at the site of a growing population of elephant seals to educate the public about these fascinating marine mammals.

There are many volunteer organizations and events along the shores of the sanctuary. The Great American Fish Count which takes place during the first two weeks of July, allows recreational divers to help collect research data on near-shore fish species.

The sanctuary collaborates with a wide range of partners to carry out its mandate. For example, the sanctuary's Water Quality Protection Program (WQPP) brings together twenty-seven federal, state, and local agencies; public groups; and private organizations to develop and carry out a comprehensive water quality management plan for the Sanctuary and its surrounding watersheds.

The Vessel Traffic Management Work Group represents another collaborative success. That group consists of representatives from the shipping and petroleum industries, local, state, and federal government, conservation organizations, and the public who have been evaluating ways of reducing the risk of groundings and collisions while sustaining the economic vitality of the shipping industry. This group has had tremendous success in the past two years in developing a proposed set of strategies for a vessel traffic management system for the sanctuary.

The importance of our local community to the sanctuary is reflected in several prestigious awards given by NOAA in the last two years. In 1998 Moss Landing Marine Laboratories was the recipient of NOAA's National Marine Sanctuaries Stars of the Sea Award and NOAA's Environmental Hero Award. Just last month Brian Baird, with the California Resources Agency, and Rachel Saunders, with SEA Camp Monterey Bay, were also awarded NOAA's 1999 Environmental Heroes Awards.

This sanctuary can truly be called a community sanctuary. For everyone in Central California, from the people who fought so hard to create a sanctuary to the staff and volunteers who continue the work to preserve and protect the cultural and natural resources and to spread the word about marine conservation, the Sustainable Seas Expeditions can serve to remind us all why we do what we do. It is a treat to welcome this exciting program and the new scientific and educational tools it will give us to do our jobs that much better.

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The Monterey Bay Aquarium and the Sustainable Seas Expeditions

by Julie Packard, President
Monterey Bay Aquarium

Julie Packard

The Monterey Bay Aquarium enthusiastically welcomes the Sustainable Seas Expeditions (SSE) to the Monterey Bay National Marine Sanctuary. SSE represents an exciting approach to research and education. As an institution whose mission is to inspire conservation of the oceans, we're delighted to be a part of this effort.

Over the next five years, SSE aims to improve our understanding of the natural and cultural resources and ecosystems found in the nation's 12 national marine sanctuaries. Using the DeepWorker submersible, marine scientists will explore and document our sanctuaries to depths as great as 2,000 feet below the surface. Related education and outreach projects will ensure that the knowledge and excitement generated from these expeditions is shared with children around the world.

The Monterey Bay National Marine Sanctuary is the perfect place for one of these expeditions. The Monterey Bay region is one of the richest marine environments on Earth. And it is already home to a mosaic of research, education, and marine technology centers that regularly collaborate on a variety of projects. From sanctuary advisory groups for research, education, and conservation to the more recently created Monterey Bay Crescent Ocean Research

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Consortium, the Monterey Bay region has a history of innovation and discovery built on successful teamwork.

The Monterey sanctuary itself is truly a special place. It boasts a healthy marine environment, unique natural features and a diversity of habitats, from a mile-deep submarine canyon to rich coastal wetlands, tide pools and kelp forests. Marine life is equally diverse and abundant, from tiny plankton to blue whales. Indeed, it was this remarkable environment that inspired creation of the Monterey Bay Aquarium, the nation's largest aquarium dedicated to interpreting a single region -- the Monterey Bay National Marine Sanctuary.

(top)

The Monterey Bay Aquarium offers visitors an insider's look at the wonders of Monterey Bay.

Research and education are priorities for the aquarium, the Monterey Bay National Marine Sanctuary, and for many of our colleagues around the bay. We see these as pillars on which conservation efforts can be built. SSE will complement existing research and will raise the public profile of marine research in general. Its "Teacher in the Sea" project brings together research and education in a special way. Mike Guardino, a Carmel High School teacher, has trained to pilot the DeepWorker submersible. He will make several dives in the Carmel canyon where, assisted by the aquarium's senior marine biologist Dr. Steve Webster, he will conduct student research projects related to no-take marine reserves.

The Monterey Bay Aquarium is pleased that our staff is working with the National Geographic Society, SSE team, and the Monterey sanctuary to help conduct some of the SSE's research projects. In addition to Steve Webster, Dr. Chris Harrold, our director of conservation research, will be among the DeepWorker pilots.

Another aspect of SSE that is vitally important is the use of technology in support of marine conservation. When my father, David Packard, established the Monterey Bay Aquarium Research Institute (MBARI) in 1987, he sought to nurture collaborations between engineers and scientists to advance deep ocean research.

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He believed a much greater investment in ocean exploration was needed, and would have welcomed the DeepWorker project here in Monterey Bay.

The Monterey Bay Aquarium, MBARI, the sanctuary program and SSE share many values. All embrace research and education in the pursuit of conservation and the use of innovative technology, and encourage stewardship of the nation's marine resources.. The aquarium is committed to preserving healthy oceans and ocean wildlife for future generations. We applaud the Sustainable Seas Expeditions, its sponsors (the National Geographic Society and the Richard and Rhoda Goldman Fund) and the National Marine Sanctuary program for their vision in creating and implementing this ambitious nationwide effort to improve our understanding of the marine environment.

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The Bounty of Life

by Vicki Nichols
Executive Director, Save Our Shores
Conservation Representative, Sanctuary Advisory Council
Chair, Sanctuary Conservation Working Group

Vicki Nichols

Long lines of soaring pelicans skim the surf, almost dipping a wing into the waves. Sea lions bark from an offshore rock. Further out to sea, a whale blows and dives. You might glimpse these residents of the Monterey Bay National Marine Sanctuary by following Highway 1 along the coast. From just north of San Francisco, south along the entire Big Sur coast, 5,300 square miles of ocean are protected as a sanctuary. Ocean currents and undersea terrain make the Sanctuary waters a rich environment that supports a diversity of marine habitats and species.

From sandy beaches and rugged rocky shores, the sanctuary stretches out to sea an average of 30 miles, as far as 53 miles in some places. Close to shore, forests of

giant kelp nurture and shelter a riot of life, from abalone to sea otters, rockfish to sea urchins. The open waters teem with life: flocks of sea birds feed at the surface, schools of sardines and squid glide silently below. Although we cannot see what lies below the surface, a deep water canyon cuts through Monterey Bay, one of the largest and deepest underwater canyons on the west coast. The canyon is home to an array of deep water animals, living in the waters of the canyon and on its walls and seafloor.

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The sanctuary is home to many endangered and threatened species. Some live in these waters year round, others come here to feed or breed. Here they have a sanctuary, officially designated now. Perhaps the most celebrated endangered resident is the southern sea otter which frolics and feeds in the kelp forests.

Black oyster catchers feeding on mussels attached to the reef.

Hunted to near extinction for their warm fur, the sea otter population has grown with protection under the Endangered Species Act. Eight other marine mammal species severely depleted by commercial hunting swim the sanctuary's waters, including sperm, humpback and blue whales. Blue whales, the largest animal ever to live, larger even than dinosaurs, come to feed generally from August through October. This time of year currents carry in warm, plankton-rich waters. Krill is the blue whale's favorite food - and this is the time of year for krill. These leviathans gulp tons of water, straining it through baleen to catch their krill meal. Lucky whale-watchers may hear the loud blow and see the blues feeding. And on the same trip they may see humpback whales dive or even breach.

Black rockfish, like other rockfish, hide in kelp waiting for prey.

(top)

Endangered sea birds and fish frequent the sanctuary waters. California brown pelicans feed here but breed in the south from March to June. Once severely depleted because DDT weakened their eggs' shells, the pelicans are making a comeback and delight all in plunge diving and flying in formation along the coast. There are endangered fish here as well. Salmon populations are in trouble up and down the west coast. Several species swim

The Hermisseda nudibranch is one of many species of nudibranches which live in the intertidal zone, most of which are less than an inch in length.

the waters of the sanctuary including chinook and coho salmon, and steelhead trout.

Throughout the year, a parade of diverse species come here -- one of the reasons these waters are a sanctuary. In the winter months, northern elephant seals haul-out on shore to mate and give birth. Elephant seals are impressive in size, in the long distances they travel, and in their diving ability. They can dive as deep as sperm whales -- the record dive recorded was close to 1600 meters. Hunted to near extinction for their oil in the 1800's, the population of northern elephant seals is now recovered. Protection of coastal and open ocean habitats are vital to the future of the elephant seals.

The annual gray whale southward migration from Alaska passes through the sanctuary, peaking in mid-January when as many as 200 whales a day pass within a mile of shore in some places. They make their return

journey from Baja in the spring. Whalers hunted gray whales nearly to extinction by the middle of the nineteenth century. But the gray whale is a success story of protection: the population is now estimated at 21,000, about what it was before commercial whaling.

Seabirds abound in the rich waters: common murres, cormorants, guillemots, elegant terns and western gulls, to name only a few. In the summer, sooty shearwaters appear around the Monterey Bay in flocks of ten to hundreds of thousands. At their peak, there are about one million shearwaters around the bay. These birds have

come a long distance on their migrations: they breed in the southern hemisphere off New Zealand and the tip of South America.

Hundreds of invertebrate species are found on the sea bed.

The birds and sea otters, seals and sea lions are the most visible clues to the bounty of life in the Monterey Bay National Marine Sanctuary. Unlike a National Park on land, the diversity and richness of the sanctuary lie under the sea, mostly unseen. This haven is protected for all life: for the plants, the animals, and for us.

(top) **RETURN**

Expeditions and History of the Central California Coast

by Basil S. Douros

Much like the Sustainable Seas Expeditions today, other expeditions intent on discovery and exploration sought out the Central California coast, much of which is now encompassed by the Monterey Bay National Marine Sanctuary. Native Americans had lived in the area for over 10,000 years but the recorded history of the region began with the European explorers

Juan Rodriguez Cabrillo was the first of the European explorers to discover Central California. He explored northward from Jalisco, the present location of Guadalajara, Mexico, with two ships in search of the legendary Strait of Anian in 1542. The fabled strait had been thought to exist linking the Pacific Ocean with the Atlantic. He stopped in present day San Diego Bay on September 28. Continuing northward, he arrived at Point Concepcion on October 17, discovering San Pedro, Santa Monica, San Buenaventura and Santa Barbara on the way. Fierce winds and a storm forced them to turn back when they reached the northern coast of what is now Santa Barbara County. They found refuge in a harbor at San Miguel Island until November 11 when they resumed their northward explorations.

Cabrillo and his two ships reached the "Sierra de San Martin" in Southern Monterey county when another storm blew them back out to sea separating the two ships. Cabrillo decided to press on, and ultimately reached Point Ano Nuevo. Soon thereafter, he found his other ship near present-day Santa Cruz. The crew on that ship was nearly frozen, covered with ice, as the climate in Central California was considerably cooler 450 years ago. Resting, the two ships drifted southward discovering a harbor they called "Bahia de los Pinos," in all likelihood Monterey and its nearby Point Pinos. The explorers made their way back to the safety of the harbor at San Miguel Island once again, where they stayed for several months.

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Cabrillo died in January of 1543 from complications caused by a broken limb (historical records are contradictory as to whether he had a broken leg or arm) reportedly injured in a skirmish with Native Americans. Most historians believe he was buried on San Miguel Island where a grave marker can still be found.

(top)

Captain Bartolome Ferrelo took command of Cabrillo's expedition and sailed north on February 18, reaching a point around Cape Mendocino two weeks later. Another storm blew the ships all the way back to San Miguel Island in just four days, where they recouped and sailed south, arriving in Navidad (Acapulco, Mexico) in mid-April. Disappointed that the expedition did not discover the Strait of Anian, the kings of Spain neglected the area until Sir Francis Drake, also searching for the elusive Strait, reached the Pacific coasts after navigating around Cape Horn in 1578.

Sir Francis Drake, English explorer and privateer raided the Spanish treasure ships and threatened the safety of the fleet. Drake is believed to have sailed his ship, the Golden Hind, northward along the coast past Monterey Bay, landing in either Drake's Bay or Bodega Bay. Drake sailed further north and became the first European to land on the Northern California coast, ultimately reaching a point close to what is now known as the Umpqua River in Oregon.

The captains of Spanish ships that were returning to Baja California from the Phillipines were instructed to sail north to Latitude 30 degrees where they would find favorable winds, then steer south when they ran into large beds of seaweed, indicating they were close to land. Drake capitalized on this sailing route and successfully pirated numerous Spanish ships returning from the Phillipines with trade goods, including gold.

Another harbor in Central California, Morro Bay, was discovered and explored by Captain Pedro de Unamuno following that return route from the Phillipines. He stopped in Morro Bay on October 18, 1587 re-filled his water casks and explored the area around San Luis Obispo.

Sebastian Vizcaino sailed from Navidad (Acapulco) in 1602 with two ships, the San Diego and Santo Tomas, a frigate the Tres Reyes, and a long boat. Their mission was to further explore the coast and find at least two good ports that the Spanish fleets could use for sanctuary and to reaffirm Spanish dominance. The English pirates and privateers following Drakes' route around the Cape attacked Spanish galleons at will, emphasizing the need for Spanish ports

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and the need to strengthen her western coast.

Vizcaino abandoned the long ship before they reached San Diego after six months at sea. They arrived in the harbor on November 10, and two days later named the harbor San Diego in honor of the feast of San Diego de Alcala. They left the new harbor of San Diego on November 20, landed on Santa Catalina Island, passed through the Santa Barbara channel, and continued until they reached a prominent point which they named Point Concepcion, for the Feast of the Immaculate Conception on December 7. Leaving there, Vizcaino's expedition passed Carmel Bay and after negotiating around Point Pinos on December 16, named the harbor that they entered in honor of the sponsor of the expedition, the viceroy of Mexico, the Count of Monte Rey.

(top)

The trip had been a long and arduous journey, with 16 men dying of scurvy and many others sick. After landing and celebrating the first Catholic mass north of San Diego in the new world, one of the ships, the Santo Tomas, was sent back to Navidad, carrying the sick and reports of the expedition's progress.

Of the 34 men on board only nine survived the return journey. After a very cold Christmas with the mountains covered with snow, and ice forming in the ponds onshore, an exploration group of 12 men including Vizcaino and a priest, Father Andres, left the encampment at Monterey heading southeast where they found Carmel Bay and the Carmel river. They recorded that they saw signs of Indian activity and found one deserted village. The onshore expedition returned to camp without having seen a single Native American.

The remaining two ships left Monterey on January 7, 1603 sailing northward until they reached Drake's Bay where a storm separated them. The San Diego, captained by Vizcaino reached Cape Mendocino, but with only six men able to work because of scurvy, the ship returned to Mexico. The frigate, Tres Reyes, found safe anchorage behind Cape Mendocino during a storm, and may have subsequently sailed as far as the Oregon border. On January 19, with most of the crew dead or dying of scurvy, the explorers onboard the Tres Reyes turned around and headed south. The ship reached Acapulco on February 23, 1604 but only five men were left alive.

Vizcaino's expedition resulted in some detailed maps of the coast, and he identified potential ports for Spain to develop. Despite strict orders to the contrary, Vizcaino also re-named many of the locations that Cabrillo had discovered. Many of these names are the

ones used today. His enthusiasm and desire to attract attention to his expedition's accomplishments, to promote settlements and convert, to Christianity, the Native Americans he did encounter, caused Vizcaino to give glowing reports. He described a healthy population of well fed and friendly Indians, gentle and docile. To entice colonists he described fertile land, a gentle, sunny harbor in Monterey, and, in spite of the cold weather they had endured, described a climate much like Spain's.

Once again however, Spain was distracted and ignored the central California coast. The newly discovered harbors lay hidden in the fog until the expeditions of Gaspar De Portola over a hundred and fifty years later

Gaspar De Portola left San Diego in mid-July 1769 with a mixed complement of people including soldiers, Native Americans, and two Franciscan missionary priests, Fathers Crespi and Gomez. They were to travel overland, create maps and explore the land between San Diego and the harbor that Vizcaino had found and named Monterey. Traveling overland with pack mules, they planned to rendezvous with supply ships along the way. The expedition reached what is now called Los Angeles two weeks later, and Santa Barbara on August 19, 1769. Traveling over the rolling coastal plains was not difficult until they reached San Simeon about mid-September. The terrain forced them inland until they reached the Salinas Valley, near present day King City and the Salinas River. They followed the river downstream, encountering a few Native Americans along the way, eventually reaching the ocean somewhere around the present-day town of Marina.

(top)

The expedition expected to find Monterey harbor easily, but the fog was dense and they could not find anything that looked like what Vizcaino had so glowingly described. They continued northward still looking for Monterey, as well as their supply ship San Jose. By the time they reached the Pajaro river almost a dozen men were so weak from scurvy that they had to be carried. In a deserted village they found a straw bird with wings at least six feet long. They named the river and the area after it -- Pajaro.

The expedition struggled on and reached Santa Cruz on October 18, and the San Francisco Bay area by November 1. Realizing that they must have missed Monterey, they retraced their steps, low on supplies and by now reduced to eating their mules. On November 28 they reached Point Pinos and camped on a beach still without having found Monterey Harbor. Tired, sick and disillusioned, the expedition returned to San Diego without ever having found either Monterey or the supply ship San Jose.

After recuperating, Portola and Father Junipero Serra agreed to mount a land/sea expedition to find Monterey. Father Junipero Serra went with the ship carrying the supplies while Captain Portola led his men overland. Re-tracing their steps they eventually reached Monterey in 36 days on May 24, 1770. The ship, San Antonio with Junipero Serra aboard, reached Monterey on May 31, 1770. The ship made its way into the now visibly magnificent harbor with whales and sea lions all around them.

The mission of Monterey and the Presidio, or fort, were established. On July 9, Portola returned to Mexico with a letter from Father Junipero Serra to the viceroy, requesting permission to move the mission to Carmel so that the converted Indians would not be contaminated by the rowdy sailors and soldiers at the Presidio. That mission in Carmel still stands, and is the resting site of Father Junipero Serra's remains, the man who created the California mission system.

In 1791 a mission was built in Santa Cruz across the river from a pueblo settlement called Branciforte, established by the government to encourage settlements in the area. Men convicted of minor crimes were offered a musket, an adobe house, land, a plow and some farm utensils and animals to entice them to colonize the area. Soon, the missionaries were complaining that the converted Indians were being harassed and they too wanted to move the mission. The mission was abandoned after the pueblo and mission were attacked and sacked by the pirate Hyppolite Bouchard. Bouchard also sacked the Monterey Presidio in October, 1818.

These early expeditions led to the ultimate colonization of the Central California region, onshore of the present day Monterey Bay National Marine Sanctuary. Mexico expanded the European settlements in the area and Monterey was the capital of Alta (Upper) California. Ultimately, when the settlers in the region sought and gained freedom from Mexico, Monterey was considered California's capital, and most important city. The constitutional convention for California, where the state's constitution was debated and ultimately signed, was held in Monterey in adobe buildings that still stand today.

So many explorers have ventured up the California coast, and yet 450 years after that first expediton, few have been able to explore under the surface of the waters those travelers crossed. With the DeepWorker submersibles, and a team of dedicated explorers and scientists, Sustainable Seas will enable us to explore and discover the California that's just a little bit further west, in the waters of the Monterey Bay National Marine Sanctuary.

(top) RETURN

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MONTEREY BAY

POEM

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The Submerged Cultural Resources of the Monterey Bay National Marine Sanctuary

by Bruce G. Terrell, Marine Archaeologist
NOAA, National Marine Sanctuary Program

Monterey was Central California's governmental and economic center during the Spanish and Mexican periods.

Early humans lived as far as one to six miles out onto the Monterey Bay region's continental shelf during the last ice age. Until 10,000 years ago, much of the earth's water was frozen into the polar ice caps, which lowered sea levels more than 100 meters below modern day levels. As the ice melted and the sea levels gradually rose, the coastal peoples were forced to migrate eastward towards higher ground, leaving submerged remains of their culture.

The first Spanish visitors to central California's Monterey Bay encountered local people that they called Coastanoans (coastal dwellers). These Indian people were, in actuality, groups from several different cultural and language groups. Known today as Ohlone (from Miwok meaning "people of the west"), these people subsisted for over 4000 years by harvesting and processing resources from the sea and the estero environments. They hunted birds, small mammals, seals and sea lions and fished the waters as well. The Ohlone made disk-bead currency from clam shells and built their homes and raft-like boats from tule reed bundles.

The Ohlone people's rhythm of life was shattered by the arrival of the Spanish in the eighteenth century. The Spanish attempted to

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convert the Indians to Christianity at their missions at Santa Cruz, Monterey and Carmel. The church fathers' attempts to turn the native hunter-gatherers into farmers and laborers eventually met with failure.

The Spanish first came to Monterey Bay in the sixteenth century in sporadic episodes of exploration. The Bay was named in honor of explorer Sebastian Viscaino's sponsor and viceroy, the Conde de Monterey in 1603. However, it was not until 1770 that a religious and civil settlement was established there in response to the crown's fear of Russian and English incursions along the northern California coast.

Father Junipero Serra helped to establish the Monterey mission while a military presidio was established there in 1777 when Monterey became California's capital. Soon thereafter, missions began sprouting all along the coast and to the inland regions.

(top)

Small-scale local economies formed to support the needs of the missions. The Spanish used Indian labor in such industries as soap making, leather-working, weaving, milling and blacksmithing. Maritime trade consisted of Spanish supply ships traveling from Mexico and foreign fur trading ships that occasionally put in to Monterey for fresh water and supplies.

Monterey became a fur trading stop as mission residents obtained otter pelts from the Indians and traded them to ships from the East Coast. Native hunters killed otters at rookeries at Pillar Point, Point Ano Nuevo and Santa Cruz Point. They also used their tule rush canoes to hunt otters and seals among the kelp beds at such places as Point Sur and Cooper's Point. Their predominance in the hunt ended when the Russian Fur Trading Company imported Aleut Indian hunters from Alaska who used their native "Bidarka" kayaks made of skin on frame.

Monterey Bay continued as a port of destination following Mexican independence from Spain in 1821. Trade grew as California land owners amassed wealth from newly acquired ranchos carved from secularized church lands. They utilized Indian labor in the hide and tallow trade that followed as the fur-bearing otter and seal populations were depleted. Cattle were the source of leather products, as well as candles and soap. New England's Yankee traders, as well as ships from other nation's, collected the hides to sell and trade in New England and in Europe. Many of these hides were made into shoes that shod the rapidly growing American immigrant population in the east.

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Monterey also became a minor whaling port. While most whalers preferred San Francisco's superior harbor, some put in at Monterey. The town was the center of a local shore-based whaling practice along the Bay's shores. Nearshore kills were towed to trying-out or processing stations at places like Elkorn Slough. Products were then transported to Monterey for export.

Monterey and Santa Cruz flourished during the Mexican era between 1821 and 1846. However, the balance of power shifted as more and more American merchants settled. Their agitation for American control was in large part responsible for California's break with Mexico and incorporation into the United States in 1846.

Occurring on the heels of American acquisition, the 1850s Gold Rush had dire portents for Monterey. Overnight, the town was depopulated as most of its inhabitants headed for the gold fields.

(top)

Monterey Bay later became a regional economic center that supported San Francisco's gold rush-bloated population. The town of Santa Cruz also grew during this period due, in part, to its association with New England's Yankee traders. The main regional exports were grain and, briefly, lumber. Grain was transported down esteros and transferred to San Francisco-bound schooners at places such as Moss Landing at Elkhorn Slough.

The fisheries industry began in Monterey Bay during the Gold Rush to help feed the city's burgeoning population. The need for a fisheries coincided with political unrest in China's Kwangtun Province. Many Chinese exile Tanka boat people came to Monterey and carried out their traditional fishing practices in their distinctive junks and sampans. Chinese communities grew all around the Monterey Bay region.

The introduction of steam driven ships and trains revolutionized the shipment of freshly caught fish to San Francisco. San Francisco's Italian fishermen were quick to take advantage of the possibilities offered by rail transport and rapidly came to dominate the Bay's fisheries. They introduced their distinctive fishing boat, the felucca to the region. In the early 1900s,

Nineteenth-century Chinese fishermen brought their indigenous watercraft styles to California. Flat-bottomed junks were maneuverable and required few crew.

the sardine fisheries made famous by John Steinbeck, rose to prominence until that fish population collapsed in the 1940s.

Over one hundred historic shipwrecks have been recorded as lost in the Monterey Bay sanctuary region between 1831 and 1919. There were likely many other watercraft lost that were not documented. These shipwrecks represent significant periods of Monterey Bay's history and culture. They reflect a range of watercraft types and purposes.

A potentially significant shipwreck from the Mexican Period is the Star of the West, wrecked at Point Lobos in 1845. This vessel wrecked, in cargo, inbound for the port at Monterey. The Star's remains could tell researchers much about commerce in California during the Mexican period.

Another significant cultural resource in the sanctuary is the remains of the U.S. Navy dirigible USS Macon which crashed off Point Sur in 1935. The Macon was part of a Naval aviation experiment in the 1930s that used helium dirigibles as "flying aircraft carriers." The airship's remains have been located in 258 fathoms of water about 2-1/2 miles offshore. It is now a mass of twisted girders with the remains of its Maybach engines and several of its biplane Sparrowhawk fighters still intact. It is hoped that the sanctuary may study these remains in the future.

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Virtual Tour

Panorama of the Monterey Bay Canyon

To view a QuickTime Virtual Reality Panorama of the Monterey Bay Canyon, follow the directions below. This movie requires QuickTime 3.0 and the QuickTime Browser Plug-ins. To download QuickTime 3.0, click here.

Virtual Reality Panorama of the Monterey Bay Canyon

- To Zoom In, hold the SHIFT KEY down.
- To Zoom Out, hold the CONTROL KEY down.
- To Pan around the image, hold the mouse button down while dragging the mouse in the direction you would like to pan.

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About the image:

This image was generated from a uniform 3"x3" latitude/longitude grid of elevation and bathymetry data . The data for land areas came from the United States Geological Survey; ocean data are primarily from NOAA multibeam sonar surveys. Arbitrary vertical exaggeration was applied to make the geomorphic features stand out strongly. The land coloration was chosen to suggest the lush vegetation and reddish soils of the region. The view is from the South at about 75 ° elevation angle.

Credits:

3D plot by Peter W. Sloss, NOAA-NESDIS National Geophysical Data Center

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http://www.ngdc.noaa.gov/mgg/image/images.html

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May 10, 1999

Chris Harrold, Director of Research
Monterey Bay Aquarium

William J. Douros, Manager
Monterey Bay National Marine Sanctuary

Mary Yoklavich, Biologist
Southwest Fisheries Science Center, National Marine Fisheries Service

Rick Starr, Marine Scientist
Moss Landing Marine Laboratories

Chris Harrold writes:

Time: 0830 hrs
Weather: Clear, wind 5-10 mph, swell 1-2 ft, seas 1-2 ft
Location: Monterey Bay Aquarium/Hopkins Marine Station
DeepWorker Training and Check-Out

Chris Harrold prepares for a dive in DeepWorker.

The purpose of today's dive was check-out and training with the full suite of systems on DeepWorker: video cameras, still camera, HID lights, quartz lights, sonar, acoustic navigation as well as the regular submersible life support and operational systems.

Pre-dive check started at 0630 in order to launch at 0800. Clear skies, gentle breeze, rolling seas from the past week of extremely high northwesterly winds. The McARTHUR was holding position in 100 ft of water off of Cannery Row. This was to be the first "live boat" launch of DeepWorker, meaning that the ship would be under way (not at anchor) during launch. This will be necessary in the deep water dives later in the Monterey expeditions.

All pre-dive checks went smoothly, and I was lifted off the deck, over the stern and into the water by 0830. We soon discovered a steady westward moving surface current that pushed the submersible into the stern of the McARTHUR. On orders from the dive supervisor, I quickly enabled the thrusters and backed away from the ship. The swimmer had not had time to clear from the area so he grabbed onto the dome of the submersible and rode with me away from the ship, like a cowboy on a bucking bronco. Once I was 20 meters or so away from the ship, I disabled the thrusters, Matt disengaged and removed all lines from the sub and I was free.

This was a little more excitement that I had planned the first 3 minutes into the dive.

Chris Harrold is interviewed by KSBW.

On the surface I headed due east, away from the stern of the ship, until I was approximately 50 meters astern. This took a while due to the westward current. Once I was a safe distance away, the dive supervisor requested full life support readings. After some minor adjustments (oxygen was a bit low so I adjusted starboard bellows), I was cleared to dive.

Using full down thrusters I began my descent. Visibility was less than 5 ft due to high phytoplankton concentrations (the past week's winds created intense upwelling which brought nutrients to the surface). I touched bottom at 85 ft, where the visibility was slightly better. I checked all systems and underwater communications. I discovered that there was insufficient fluid in the hard ballast to add ballast to the sub. As a result I was slightly positively buoyant, which made sitting on the bottom quite difficult. We should change the pre- and post-dive procedures and checks to ensure the proper amount of fluid is in the sub for all dives.

(top)

I checked sonar, which was giving beautiful acoustic images of the bottom. No "hard targets" (e.g., rocks outcrops or other hard structures) were within the 90 ft range of the sonar. I started the video recorder and checked the image. The image was clear except during underwater communication transmission, which created temporary static on the screen. My hands and feet were too busy operating the sub to operate the pan/tilt/focus/zoom of the video camera, so I trained the camera on various marine life by positioning the sub. Large anemones, sea stars and sea whips were abundant so I filmed them all.

Having stabilized all systems, I spent the remainder of the dive following compass bearings given to me from the dive supervisor. During these transits I stayed within a few inches of the bottom and survey the benthic marine life. Drift kelp from the nearby kelp forests was abundant and the density of invertebrates was impressive. Fish were rare and the most common species were sand dabs. I was desperately

seeking rocky outcrops to practice my sonar skills and to photograph marine life but could find none. At one point I encountered 4 tall sea anemones, Metridium senile, but they were anchored to an abandoned tire rather than a rock outcrop. I also encountered an abandoned crab pot. Fortunately the door was missing so nothing was trapped inside.

The Monterey Bay Sustainable Seas Expeditions team.

My dive took me to 120 ft maximum depth. At this depth it was dark enough that I had to use a flashlight to check systems. My surface crewed vectored me around the area, trying to get me toward rocky reefs. During one of my transits I crossed the ship's anchor chain. This is not a good place to be so the surface crew vectored me away from the ship and chain. Once clear, I began to pick up hard targets on sonar, which were almost certainly rocky reefs. Unfortunately my dive time was up and I was asked to prepare for ascent. After reporting life support system readings, I slowly thrusted toward the surface. I surfaced approximately 50 astern of the ship, right on target. I was asked to maneuver to the stern of the ship, where Matt attached the rigging to the sub and I was quickly plucked from the sea and gently lowered to the deck. My total dive time was 2.5 hours. It felt like 15 minutes and I wasn't ready to quit.

(top)

Bill Douros writes:

Time: 9:00 pm
Weather: Gentle (12 knot) north wind, 4 - 8 ft seas

It's a little quiet right now, the ship, NOAA's McARTHUR is heading from Monterey's fabled Cannery Row to the coast off Santa Cruz. We are attempting to find a shelter from the wind and the swell, without which we'll be in for a long night of rocking and shaking for even a ship the size of the McARTHUR.

One of the reasons it is quiet right now is that most of the Monterey Bay National Marine Sanctuary SSE pilots have left the ship after completing checkout dives.

We have a large contingent of pilots, eight in all, and we spent the last two days completing dives to train us what a launch and recovery from the deck of a rolling ship is actually like. All in all, things have gone well. We got a very late start on the

first day, Mother's Day yesterday, and only completed two checkout dives, those of Bruce Robison and Kim Reisenbichler of MBARI. We did those dives off Santa Cruz, Capitola pier in fact, because there was too much wind blowing towards our original checkout site, off Hopkins Marine Life Refuge near Monterey.

DeepWorker is lowered over the side of the NOAA ship McARTHUR.

Today, with fairly good weather, we completed checkout dives by Chris Harrold of the Monterey Bay Aquarium, Mary Yoklavich of the National Marine Fisheries Service, and Rick Starr of UC Sea Grant program. Today's dives, conducted in 100 feet off Hopkins and the Monterey Bay Aquarium, allowed our pilots to see a bit more marine life than seen yesterday -- pea green soup today with some invertebrates and juvenile rockfish, compared to pea green soup and lots of sand yesterday.

(top)

Mary Yoklavich writes:

Mary Yoklavich

"After DeepWorker was pre-dived by some of the most experienced deepwater research divers on the Bay (Robie, Kim, Rick and myself), I was ready to begin my first open ocean dive to check out my skills at handling the submersible. Whatever small amount of anxiety I had about being launched and recovered from a ship as big as the McARTHUR was quickly dispelled by the competent teamwork of the deck crew. With complex hand-signals from the chief botswain, the sub and I were lifted 8-10 feet above the deck and carefully lowered over the backend of the ship. The McARTHUR's Executive Officer, Wade Blake, serving as the swimmer, released the sub from the ship's hook and I slowly made my way through a choppy sea surface and away from the ship. Dive-supervisor Ian gave me a 'good-to-go', I flooded soft-ballast and started my descent.

"'DeepWorker to Topside, I am on the bottom, depth is 89 feet, visibility is 8-10 feet, seafloor is soft sediment with acres of brittle stars, the occasional sea pen, bat star, and cottid, standing by...'

"Thus began a series of system checks during my 2-hour dive. DeepWorker in

outfitted with an array of equipment that includes sector-scanning sonar, a 35-mm and two video cameras with pan-and-tilt capabilities and high- and low-intensity lights. All performed very well, and I was becoming much more comfortable with each as the dive progressed. One task was to use the sonar system to search for rocky outcrops on the seafloor; finding rocks could mean finding rockfishes ...the subjects of my research project.

"Although I found no rocks today, I ended my dive knowing that DeepWorker and I are both 'good-to-go' down the coast to the Big Creek Ecological Reserve, where a diverse group of fishes and habitats are standing by.

"It appears that the fierce winds of the past two weeks off central California have done their job, if you are an oceanographer, or a whale. Those winds have produced a huge area of upwelled, cold, nutrient-rich water that has fostered a gigantic bloom of phytoplankton along the entire Central California coast. Within a month, that bloom of photosynthesizing algae will lead to small animals that graze on the algae, and they in turn to larger, shrimp-like animals called krill, who in turn become a meal for whales. It is a vast, fast moving cycle that is, at present, impeding our ability to see much out the dome of our submersible.

Yesterday, two other pilots who endured the brutal, gut retching, transit to Monterey Bay from the San Francisco Bay, Steve Webster and Mike Guardino, spent the day with us then left the ship at night. This afternoon, Chris had to leave to conduct a television interview in my place, and this evening, Mary and Rick left. That leaves only Bruce, Kim and me to kick off the first science dives for the project tomorrow. We intend to conduct some deeper water (app. 300 ft) transects off Point Pinos, to examine how mid-water invertebrates fare when they have drifted at night from deep water onto the upward sloping shelf of the Monterey Canyon. This is work the Bruce and a colleague, George Matsumoto, at MBARI have been evaluating with an ROV. Tomorrow we can test how well a one-person submersible detects those same creatures.

How fitting that our mission of exploration begins at a point of land where Spanish explorers first found the Monterey Bay over 400 years ago. A point that still bears the name those explorers chose -- Point Pinos.

(top)

Rick Starr describes his dive experience:

"I closed the hatch to the sub just before 4 pm, and waited for the deck crew to pick the sub up and lower it, with me, to the smooth ocean surface in the lee of the ship's stern. As I awaited my short journey to the sea, I looked out the sub's dome, and was amused by the distorted view of people caused by the refraction of light through the curved surface of the dome. It made me think of a fishbowl, only I was on the inside, looking out!

"Soon I was bobbing freely, ready to start my adventure. I looked around the sub as I

drove away from the ship; oxygen levels: normal; cabin pressure: the expected negative 1 atmosphere; carbon dioxide level: normal; carbon dioxide scrubber: working; ballast air: full; power systems: functioning properly, no water alarms, no ground faults. All systems were go. I reported the positive signs to the dive supervisor, and I was cleared to dive.

Rick Starr

"What can I say about the dive? It was intended to be a test of the sub systems and underwater navigation. It was that, but it turned out to be more. In between periods of testing the sonar, lights, cameras, buoyancy, thrusters, and the com systems, I had time to look for animals! The sub worked smoothly and efficiently. I was pleased with how easy it was to drive. It only took a few minutes for me to switch from sub pilot to scientific observer. In no time at all, I was thinking about the patterns of animals I saw on the bottom. As I headed towards deep water, the bottom was covered with brittle stars; then patches of anemones appeared. I saw small octopus in a depression in the sand, and a few small schools of young-of-the-year half-banded rockfish. Sea stars were common.

"Every 10 minutes, topside gave me a call to ask for my life support readings. I realized after a while that I shifted easily from observer back to pilot mode, and was doing so constantly during the dive. That solved some of the concerns I had early in this project when I thought it would be difficult to be both a pilot and a scientific observer.

"So, bring on the depths of the Monterey Bay National Marine Sanctuary. I am ready to explore and collect scientific observations!"

(top) **RETURN**

SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

MONTEREY BAY

SITE INDEX

May 11, 1999

William J. Douros, Manager
Monterey Bay National Marine Sanctuary

Bruce Robison, Chief Scientist
Monterey Bay Aquarium Research Institute

Bill Douros writes:

Weather: Foggy, no breeze, glassy seas; 1 ft swell

Today, we had the goal of getting underway very early offshore of Santa Cruz and steaming to Point Pinos, where Bruce Robison of MBARI would explore the creatures that drift at night from above the Monterey Canyon onto the upward slopes of the Canyon shelf. Unfortunately, when we got to Point Pinos we learned about a new weather constraint on submersible operations--fog. To conduct submersible operations in or near the Monterey Bay is to conduct them in or near fog.

The concern about fog is threefold: first, the ship is concerned about other vessels not seeing it and striking it while in fog; second, the submersible crew fears a vessel could run over the submersible while on the surface; finally, should the electronic tracking system on the sub fail, it would be exceedingly difficult for the sub and ship to find one another in such poor visibility, for recovery of the sub. In night diving, the sub's strobe light makes it easy to spot in the dark, but in fog, it's of no use.

Bruce Robison describes how we spent our time while waiting for the fog to clear:


Courtesy of Kip Evans

"Today we are exploring the intricacies of the DeepWorker' plumbing, wiring, and mechanics. Not quite what we had planned for, but a day of discovery nonetheless. This morning we woke to one of Monterey Bay's seasonal fogs, which often arise when upwelling brings deep water to the surface. At the air/sea interface the cold water meets humid air, the water in the air condenses, and we work on the submarine instead of in it because visibility is too poor for

safe operations.

Bruce Robison assists Chris Harrold, Director of Research with the Monterey Bay Aquarium, in preparation for a dive.

"When you pop open DeepWorker's dome and look inside, the intertwined maze of wires, tubes, pipes, and gizmos seems at first to be completely undecipherable. But if you can mentally isolate each of the systems (it helps to have a savvy technician around to point things out), it all becomes much clearer. All of the wires and pipes are really just conduits, something goes in one end (electricity, hydraulic fluid, air, water), and comes out somewhere else to do a job for you (power the VHF radio, move the manipulator, increase or decrease your buoyancy).

"With the fog wrapped around the McARTHUR and all aboard her, we focused on fixing some of the smaller glitches that always show up when you put technology into the ocean. We repaired the port and starboard oxygen hull-stop valves, which had become difficult to turn finger-tight. These valves control the flow of oxygen from the tanks in our backpack to the bellows-controlled system that precisely replaces the oxygen we remove from the sub's internal atmosphere by breathing.

(top)

"We did this work over deep water at the site we hoped to dive in as soon as the weather cleared. Below us the water column was filled with animals busily returning to their deep daytime habitats after a night spent feeding near the surface. The movements of animals from the food-rich upper layers to deep dark waters during the day, and their reciprocal movements back up again each evening, are the largest mass migrations of animals on Earth. Yet because they take place below the surface of the deep ocean, very few of us are even aware of this massive daily translocation of biomass.

The Kelp rockfish spends most of its time on or near the bottom of the ocean floor.

"We know that these animals (fishes, crustaceans, jellies, squids, and many others) come to the surface at night to feed. We also know that they move back down into deep water during the day in order to avoid the visually-cued predators who abound near the surface. What we don't know is how these migrations look: do the animals proceed upward and downward in the same stratified sequence that they occupy in the water column during the day, or do they all mix together while they relocate? Are the rules of predator and prey suspended during the migrations or is it still eat or be eaten? Do the migrators hurry purposefully toward their goals or do they just mosey along?

"No one has ever gotten a good look at these migrations, even though they happen throughout the world ocean, every day. The

migrations are responsible for transferring ocean productivity from the surface to the deep sea, and in the beautifully complex food web of Monterey Bay, the deep sea also re-supplies the shallower waters on the return trip. The goals of our mid-water research team (Kim Reisenbichler, George Matsumoto, and me) are to study this global phenomenon first-hand, using DeepWorker to make direct observations for the first time.

"After about an hour, we decided we needed to get to a safer spot where the fog might burn off and allow Dr. Robison to make his observations. Within an hour we were at a relatively open slope east of Soquel Canyon, offshore of Aptos, in the Bay. Once the fog cleared, we prepped the submersible and got a Nuytco pilot ready to dive it (they had to confirm it was safe at 350 ft rated depth). By now the fog had lifted, and as it does once fog lifts throughout coastal California, the wind began to blow. That delayed our submersible launch for another hour or two while we decided if the wind and slight, but growing, swell was too much. We ultimately concluded it would not allow a submersible launch, and headed for the Santa Cruz coast to conduct one final checkout dive, my checkout dive. That's when the next frustrating component of the day came to light.

"Ground faults" on a submersible literally come to light. They light up a warning on the submersible's control panel telling the pilot that somewhere within the sub's electrical circuitry there is a spot where the current may flow to ground, in our case, the Pacific Ocean. It can lead to the sub's batteries losing their charge or damage to an electrical system.

(top)

I was first dunked at around 6:30 pm, after the submersible's technician sleuthed out and remedied two separate ground faults. I had an excellent launch, since the seas had calmed to almost no swell and the wind was just light enough to keep the McARTHUR pointed into the swell. I was hoisted up off the stern, carried high in the A-frame over the water, and dropped into the ocean. A swimmer unhooked me from the hoist lines, and I motored to the dive site off the ship's port stern. I began my dive. At about 43 ft water depth, the ground fault alarm sounded. I radioed the ship, and their sigh of frustration was as apparent via the underwater communications as was my own sigh.

My handlers on the McARTHUR asked me to try turning on and off several systems. Some worked for a while, some did not. Ultimately, I was directed to complete the ultimate on/off test--I was asked to turn off all power in a particular sequence, wait 5 to 10 seconds, then turn it all back on, which would mean momentary loss of communications with the surface. Whoa, no power, no comms. Once all the power was off, I was stunned about how quiet that submersible can be. Without much more thought, all power systems were back on, as was the ground fault alarm.

I came back to the ship, got hoisted back onto the deck and the techs sleuthed some more. Within an hour, I was back in the water for an evening dive. Nice sunset vista from the top of the McARTHUR's A-frame. Before I was even off the tether however, I

had another ground fault alarm. That was it for the night. Two launches and recoveries, one dive to about 55 feet, and lots of ground fault alarms.

The DeepWorker is launched from the McARTHUR.

It is no small thing to end such a day on a positive note. But I can. When we arrived off Capitola in the afternoon, the McARTHUR's commanding officer, Lieutenant Commander Bill Sites, and I were talking on the bridge. I saw a large brown area on the water, about two miles offshore, about two miles long and 150 yards wide. We sailed over it but could only tell what it was not -- it wasn't kelp laying down in a big current, it wasn't an oil slick, and it wasn't a ball of krill.

When the ship was finally anchored, the brown patch of water drifted under us. Seeing that the ship is full of frustrated marine scientists, I rounded one of them up, Kim Reisenbichler of MBARI, and we rigged our scientific sampling tool -- a white, plastic bucket tied to a rope . By tossing it overboard, we had a secchi disk to tell the clarity of the water (about 6 feet of visibility) and a plankton net. Our first haul off the stern brought on board 5 gallons of seawater full of tiny reddish-brown plankton. They were so thick in the water that they had turned it brown. In fact, my submersible dive into this water had the singular highlight that I was able to gaze at a vast array of tiny invertebrates below the brown layer dancing along the sub's acrylic dome. We had parked the ship in a growing soup of primary productivity, blown to life by the winds of the last month and further fed by the springtime sun.

Finally, we got some science done on the Monterey Bay National Marine Sanctuary's leg of SSE!

(top) **RETURN**

May 13, 1999

Gale Mead, Expedition Log Editor

Time: 11:00 am
Weather: Sunny, light breeze

Bruce Robison summed it up in one word: "RATS!" Last night, scientists from the Monterey Bay Aquarium Research Institute (MBARI), SSE leaders, and ship's officers gathered at the sanctuary office to plan today's joint operations between SSE and the MBARI research vessel Point Lobos. We decided we would launch the subs, and Point Lobos their ROV, in a reputedly calm cove in Carmel Bay. Once everyone was back on board last night, we headed out, over rough seas with swells up to 14 feet, in search of calmer waters.

Sylvia Earle and Kim Reisenbichler prediving the sub.

Back when I was in DeepWorker pilot training, Ed Ueber of the Farallones and Cordell sanctuaries warned me: Do whatever you can to avoid being assigned to an athwartships bunk. That's a bunk that is oriented perpendicular to the ship, instead of bow to stern. In rough seas, you get tossed about something fierce either way, but in an athwartships bunk, you're forever getting your head bashed into the bulkhead with every roll of the ship.

My bunk was, in fact, oriented port-and-starboard, so I decided to sleep on the sofa in the O-4 lounge instead, and I wasn't a bit sorry I did! During the night, I heard horrendous crashes as pots, pans, and dishes went flying in the galley, even though they had been secured, and at least one dismayed scream (Leroy Jordan, one of the deck crew, later explained that his stereo had fallen on him during one particularly bad roll). No one got a good night's sleep.

This morning, we determined that the quiet, calm cove we hoped to find was anything but. We steamed back down to Monterey Bay, where, within sight of the Monterey Bay Aquarium, Sylvia and Bruce planned to do a two-sub dive, meeting up with the ROV Ventana, which was launched from the Point Lobos.

Shortly after Bruce's sub got in the water, however, winds started picking up, and the decision was made not to launch Sylvia's sub. Bruce's sub also showed a ground fault, a problem which has repeatedly plagued this mission. We decided to allow him to complete his dive anyway. The RHIB (rigid hull inflatable boat) towed him over to the Point Lobos, and he and the ROV took pictures of one another. Wind and waves continued to worsen, and it was a little dicey getting him back on board, although we eventually managed it.

The rest of the afternoon was spent working on the subs, and eventually heading back to the calmer waters near Santa Cruz, where we spent the night peacefully at anchor.

(top) **RETURN**

May 14, 1999

Gale Mead, Expedition Log Editor

Weather: Clear and sunny, light winds AM, increasing to 18 knots by 1400

This morning started on an encouraging note, as pre-dive ops went smoothly, and we got Bill Douros in the water for another checkout dive off the coast of Santa Cruz. Winds were down, and the sea state within this cove was nice and flat. Bill's dive went well, other than the total lack of visibility underwater, and an inexplicable failure of the tracking system. Our new dive supervisor, Larry Shumaker, reminds us that in sub ops, you can consider it a minor miracle if you have a dive where nothing goes wrong or malfunctions. It's simply the way things go when you're working in the ocean with this type of equipment.

Francesca Cava and Andrea McCurdy host a Web chat.

While Bill dove the sub, Francesca participated in a live online chat with students, a transcript of which is available on the Sustainable Seas Expeditions site.

As soon as Bill was back on deck, we went straight into pre-dive checks for Francesca Cava's dive, taking turns slipping to the wardroom for a quick bite of lunch. We had the sub back in the water by 13:30, and Francesca proceeded through an uneventful hour-long dive. Again, poor visibility made the dive a bit of a disappointment. We're all eager to see more of what these subs can allow us to observe under more favorable conditions.

We'd hoped to get three more dives in today. Scientist Steve Webster was due for his checkout dive, and Kip Evans and I were both scheduled to log some additional sub experience this afternoon.

Unfortunately, what seems to have become the most common enemy of successful sub ops reared its ugly head again. We watched the computer display with dismay as wind speeds increased from 8 knots to 15, 18, and higher. Larry decided to bring

On many days the team was unable to dive because of the sea state.

Francesca in before the winds got any worse, and determined that hers would be the last dive of the day.

We've lashed down the subs so they'll be secure when we get underway, and the sub team is now working on fixing the problem with the tracking computer's new software. The launch has departed, taking with it Ian, who's long overdue for a short break and a chance to spend some time with his newborn son. Also departing, Francesca Cava, Kip Evans, Bill Douros, and Steve Webster. More scientists will be rejoining us in the morning, but for the moment, it's a quiet evening, with just the ship's crew, me, and the two remaining sub techs.

When the launch returns from dropping off its passengers, we'll be heading back out to open water so the ship can make more potable water. Sadly, the water this close to shore is too likely to be contaminated, and therefore unsafe to convert to drinking water. Once we get offshore, we'll be back into the 12-14 foot swells again, so we're bracing ourselves for another rough night. It's all a part of doing research at sea.

(top) **RETURN**

May 17, 1999

Gale Mead, Expedition Log Editor

Steven Webster
Senior Marine Biologist, Monterey Bay Aquarium
Chairman, Monterey Bay National Marine Sanctuary Advisory Council

Gale writes:

Weather: Sunny, warm, calm

Over the weekend, SSE leaders, Monterey-based scientists, dive supervisors, and the CO of the ship met to discuss ways to refine our dive procedures. One thing we've needed more practice on is diving the sub when the ship is not anchored. This can be tricky, and is much riskier for the swimmer. The group decided to spend the next couple days practicing live launch and recovery of the sub.

Kaye Kenoshita and Steve Pierce on the RHIB during dive operations.

We motored back up to Soquel Cove, where the water was amazingly calm, and the wind was, for once, virtually nonexistent. Our usual swimmer, Matt, has been on the midnight to 4:00 am watch, so Lt. Dana Wilkes, and the ship's Executive Officer, Wade Blake, have been taking turns as the swimmer. First to pilot the sub was Phil Otalora, followed by yours truly, and then Kim Reisenbichler. No diving today, though. We just launched the sub, puttered about on the surface, then recovered it and launched again as quickly as possible. The objective was not to get dives in, but to familiarize everyone with the new procedures and fine tune the process so that when we do get into more challenging conditions we'll be prepared to deal with them.

The first two launches and recoveries went fairly smoothly, with good communication

and no mishaps. As the pilot, I didn't have a whole lot to do except sit tight and enjoy the ride. It gets hot in the sub when you spend much time on the surface with the sun bearing down on you, and the motion of the ocean can be a bit much if you're prone to seasickness. But I value any chance I can get, to become more familiar with operation of the sub. Except when I was instructed to motor back to the stern of the Mac for retrieval, I didn't even have my thrusters enabled, and my wildlife observation consisted of a single jellyfish who came zooming straight at the dome (actually, I was the one doing the zooming) while the sub was being towed back to the ship.

The third exercise was a little trickier. The team needed to practice how to recover the sub in the event that the sub was disabled, and unable to position itself for retrieval. The RHIB (rigid hull inflatable boat) hooked the sub up to a tow line, and the Mac came up alongside the RHIB. As the Mac passed the RHIB, the small boat maneuvered in behind the ship and Wade hooked the sub up to the ship's tow line. The recovery went as smoothly as we could have hoped, and we decided that with just a few minor adjustments, the procedures we have in place will work fine.

Meanwhile, back on shore, Steve Webster was orchestrating another Student Summit event in Monterey. He writes:

"The student summit was a gathering of about forty regional high school students who have been doing SSE projects ranging from public perceptions of marine reserves, to the politics of a new underwater park off Monterey, to SCUBA diving kelp forest research in and out of Pt. Lobos State Reserve to compare game fish and invertebrate populations. A panel of scientists (Sylvia Earle, Greg Cailliet, Andrew DeVogelaere, Mike Guardino) each gave a ten-minute talk on an aspect of marine protected areas and the SSE project. This was followed by student presentations--many groups of students--from several high schools in the region. Students presented the results of their SSE projects and used a great variety of presentation methods (slides, overheads, computer graphics, etc.). All did a very professional job of presenting their results and conclusions.

"The presentations were followed by a question and answer period in which the students were put on the hotseat--much like a graduate student giving a research seminar. This is a "character-building experience" and the teams of students did a good job fielding questions from their peers, as well as the curmudgeon biologists on the panel.

"The students were then randomly spread through four breakout groups to evaluate this year's projects (with the marine protected areas theme) and plan for next year's round of projects. Some exciting ideas came from these sessions, and next year's research topics will be a unique combination of projects relating to the future of the sanctuaries and effective ways of inspiring public awareness of and participation in the national marine sanctuary (and other protected area) programs."

Tomorrow, the scientists from Monterey will be back on board for more launch and recovery practice. Then it's back to the serious business of trying to get some science

dives completed, maybe at Big Creek, maybe at Point Lobos... It all depends on what the weather has in store for us next.

(top) **RETURN**

May 18, 1999

Laura Francis, Education Coordinator
National Marine Sanctuary Program

Steve Webster, Senior Marine Biologist
Monterey Bay Aquarium

Dive operations from the NOAA ship McARTHUR in the Monterey Bay National Marine Sanctuary (MBNMS) resumed today under clear skies, calm seas, good visibility and all around excellent weather. "It is like a lake out here" said MBNMS Mission Coordinator and Sanctuary Manager, Bill Douros. Let's hope the good weather holds, as we are certainly due for some.

Bill Douros in the sub, about to dive, with Ian Griffith and Steve Webster standing by.

Teacher-in-the-Sea Mike Guardino, and Steve Webster from the Monterey Bay Aquarium were able to complete their checkout dives today in Soquel Cove. Here's what Steve Webster had to say about his checkout dive experience:

"The weather is cooperating for a change -- calm winds and seas off Capitola at the north end of Monterey Bay. We were up bright and early on the McARTHUR with the ship's and Nuytco crews to prep the subs for Mike Guardino and me (we went separately). All went smoothly and we were in the water with amazing grace! Only to find we were diving in what looked like a mixture of Gatorade and split pea soup!

"We're getting a good deal of upwelling (of nutrients and cold water) from all this wind, and so the phytoplankton, large and small, are loving it and are engaged in a frenzy of productivity. Visibility is not quite to the bow of the DeepWorker sub -- maybe 50cm! OK, so we're flying on instruments again -- great practice. And this is a checkout dive, after all, so practice is the "mission" of the day. Since I'm new at this a line with a bright orange buoy attached is hooked to the sub so the ship and dive crews will know where I am. Can't get below 45 feet deep here without a shovel, and none was requested for this mission.

Lacey O'Neil helps launch DeepWorker.

"I'm in the sub; the hatch is closed. I'm trying to perform sub functions while taking video from the sub with a small hand-held digital video camera. In the course of doing 37 things at once I forget to listen carefully to the oxygen bellows and the O2 percent in the sub climbs to 26% before I get a handle on it. OK -- time to put down the camera and pay attention to piloting. Camera put back in my fishing vest (has more pockets than I can count -- great for keeping everything handy -- but I practically need an index to keep it all straight). Adjust cabin pressure to zero, open hatch, get the cabin air equalized with Earth's atmosphere once again and determine, this time, to keep it that way (within about one percent either side of 20.8%). Close hatch, pull the vacuum to seal the hatch closed, and away we go again. This time checking O2 level every minute, or so.

"I'm unhooked from the lifting cable and the tag lines by one of our terrific swimmers and am instructed to motor back away from the stern of the ship. The first set of life support readings are requested by Robie (Bruce Robison -- experienced sub pilot and biologists/oceanographer at MBARI who is my topside communicator for this mission). We're still on the VHF radio while I'm on the surface. I perform the contortions necessary for reading all the gauges, remove the headset from my right ear to make sure the oxygen bellows sounds right, and then get the message that I'm cleared to dive.

(top)

"The sandy bottom looms up about the time I settle gently onto it. ("Topside, the DeepWorker has landed. A sort of green glurp for mankind.") Robie acknowledges with dry wit and asks for life support readings, the first of what will be a gentle reminder every fifteen minutes from now on. We get to know each other well on these dives.

"I'm now free to follow a couple of compass headings and spend time getting comfortable with all the systems, controls, sonar, video, sub handling, etc. This goes on for an hour and in what seems like 10 minutes I'm informed that it is time to ascend. Too soon, I think to myself. But one does not question one's topside contact lest one wishes to switch occupations, so I begin my slow ascent through the soup, looking up so as not to come up under the ship, or a whale, or the RHIB (rigid hull inflatable boat) chase boat.

"Back on the surface. Blow soft ballast to get that buoyant bubble back. Disable thrusters so swimmer can hook us up to the tag lines and lifting harness. Take video as we're swung expertly aboard. They're all smiling, but my grin's widest, I have no doubt.

"It went too fast! But there's always tomorrow. Wind allowing. Now we do post-dive ops on the sub. Later we'll debrief the whole day's operations and plan tomorrow's dives in Carmel Bay Ecological Reserve. Where can we anchor safely for the ship and still be over a bottom that's safe for these 350-foot subs? We choose either the south side of Point Lobos or the area off Pescadero Point. We'll sail down there tonight and check it all out at 0400 Wednesday morning. Mike agrees to get me up at 0400. Time to hit the sack for visions of sugarplums, giant squids and 20.8% oxygen in the cabin."

Surface swimmer Dana Wilkes readies the DeepWorker for recovery by the NOAA vessel McARTHUR.

Also today, at a dive site near Moss Landing, Phil Otalora, a member of the sub ops team from DOER Marine Operations, completed the deepest dive to date in the SSE project, descending to 285 ft to make sure all systems were in good shape for dives to that depth. He returned reporting having seen some splendid bioluminescent siphonophores which we identified as some type of calycophoran. While he was under, a huge 6-8 foot long jelly, a Medusa chrysaora cruised by at the surface right next to the ship, and a pod of Dall's porpoises stopped by to feed near the stern.

All in all, a very satisfactory day of the expedition, and we're optimistic for what we will be able to accomplish in the next few days as well.

(top) **RETURN**

May 22, 1999

William J. Douros, Manager
Monterey Bay National Marine Sanctuary

Time: 10:45 am
Weather: Overcast, moderate winds, and surgy

The Big Creek coastline seen from the sea.

After having more than our fair share of winds for two weeks, we took our last few days of the Monterey Bay National Marine Sanctuary mission down the Big Sur coast to Big Creek Reserve. Mary Yoklavich of the National Marine Fisheries Service and Rick Starr of UC Sea Grant extension have conducted submersible dives at the reserve for several years and are interested in using the DeepWorker to expand on that research. They have been studying how a no-take reserve affects populations of rockfish.

The McARTHUR left the Santa Cruz area near sunset on Thursday, May 20. Another beautiful night with Venus and our Moon ballroom dancing yet again across the western sky. We sailed south for about 8 hours during the night, still only crossing about a half of the huge Monterey Bay National Marine Sanctuary.

Like all days the past two weeks, we began Friday, May 21st by snarling back at the weather. There was little wind this day. But, after nearly a month of wind off central California, the ocean had a sizeable swell -- about 6-8 ft. We tried very hard to convince ourselves that the swell was manageable, but we ultimately decided it would not allow a dive that morning.

Another daily obligation was to call KPIG radio at around 7:20 am to give the listeners in the Monterey Bay area an update of our SSE mission. Because the weather had been so miserable, constantly causing changes to dive plans, many on the sanctuary staff and other pilots kept tabs on our progress by listening to KPIG in the morning. I was surprised to get a cell phone connection from so far south along the Big Sur coast; on land, it is almost impossible in that area to use a cell phone. Another reason to live down there. The highlight of this, the final morning call with Dallas, was his

playing "Trashy Women" by Jerry Jeff Walker for Mary Yoklavich, at her request!

So, after consenting once again to the weather's wishes and aborting dive plans, we ate. We do that often on this ship. The McARTHUR crew has no credible hope of winning a slimmest sailors contest, because their cooks are so incredibly good.

We decided to salvage the day by using the rest of the morning and the afternoon to run ADCP (acoustic Doppler current profiling, I think) lines out along the coast. These data show the direction and magnitude of mid-water column currents and are very helpful to oceanographers and fishery biologists in their management decisions. Those transect lines took us to Cape San Martin, where I then took photographs of landslide areas along the coast highway. The State of California, CalTrans, continues to propose to rebuild damaged stretches of Highway 1 by pushing sediment, rocks and road debris into the ocean, into the sanctuary. Our regulations prohibit dumping any material because it is presumed to damage sanctuary resources. We have been working with CalTrans to develop alternative re-construction approaches that do not require ocean disposal. The photographs will augment our GIS database and will help monitor the fate of areas CalTrans reconstructed without using ocean disposal.

Rick Starr responds to a communication check before he dives in Monterey Bay.

To our surprise, by the time we got back north near Big Creek just after dinner, we realized the seas were now calmer than in the morning. A dive looked promising. We re-prepped our submersible, ready like an appaloosa at a Wyoming rodeo. Within a half-hour, we had Mary Yoklavich up on the A-frame and into the water. I spent her dive in the McARTHUR's rigid-hull inflatable with a second set of underwater communications. We had had problems in the past hearing the submersible while the McARTHUR's engines were operating. This time, it didn't even work to have a second set of coms in the chase boat, because we could not hear Mary and she could not hear us after about 5 minutes into the dive.

We had to abort the dive and Mary came back to the surface on her own. While waiting for the ship, she gave us her best Jerry Jeff impersonation of "Trashy Women" through the VHF radio, complete with southern twang. It was good. Too bad the underwater coms weren't.

So ended a long day.

(top)

The next morning, today May 22nd, we were back on the stern by 5:30 a.m. prepping the submersible. This day looked worse, in terms of the weather. The wind was now out of the south. The swell had lost its shape because the wind was now blowing the opposite direction.

Bill Douros receives last minute instructions about the video recorder from Dana Wilkes.

We gallantly prepped the submersible. Our team decided I should make the dive, since we had moved slightly south of Big Creek and now were off one of the landslide sights that CalTrans has wanted to dump sediment into the ocean. It was fitting that I dive in the area and determine the bottom features and Sanctuary resources.

The ship and dive supervisor decide to give the dive a shot, despite our having sea conditions difficult to predict, bad underwater coms the day before and a schizophrenic underwater tracking system. I felt it was safe though. If the coms were bad or if the tracking system was not working, I would just abort the dive and come back to the ship.

In the end, the dive went well. The "live" launch and recovery, with the ship under power and not anchored, went great. I dived to 98 feet and found a sand bottom covered with small starfish, about one every 5 meters. I saw lots of small sand dabs, flat fish like flounders and halibut, although I know not the species. I scampered about briskly in the submersible, took lots of video, scanned beyond my lights with sonar searching for rock formation, to no avail. I spent about an hour and a half all alone, except for my occasional chats with the surface. Yes, the underwater coms worked fine.

The seas while I had been down had grown more organized in that the south wind had begun to re-shape the swells. A new guerrilla leader had rallied the evil forces. The larger seas made it tough for the ship to see me on the surface and after about three or four minutes of giving them hints, I come out from behind some swells and they see me. Now the fun begins. Recoveries in rough water are better than most roller coaster rides, and this one was no exception. My job is to drive on the surface to a towline behind the McARTHUR. A diver then attaches it to the front of the submersible.

The ship pulls in on a winch and more lines are attached, including a few attached to the A-frame hoist. After a ride in salty washing machine directly behind the ship, I leap out of the water, twist wildly in the air for about a minute, and then clank down onto the deck. A coordinated event despite the crashing noises I hear from inside the submersible.

So ended our day, or second day of our Big Creek mission. We didn't get done the science we had in mind for Big Creek, and would have needed better weather for that. It was now time to tie-down the submersibles and head for Santa Barbara. Our mission was done.

Swimmer Dana Wilkes hooks DeepWorker and pilot Mary Yoklavich to the recovery lines following Mary's dive off the Big Sur coast.

A parting thought about the Monterey Bay National Marine Sanctuary SSE mission. On May 21st we saw several Black-footed albatross, a large bird with a 7 foot wingspan. At this time of the year, they come to coastal California, to the Monterey Bay Sanctuary, to feed. Not an uncommon thing for birds, or whales, or fish to do. But, they come here from Hawaii, where they have nested. Parents of chicks leave the nest for about a week and fly to California to feed on small fish and invertebrates, then return to the nest to regurgitate food for their chicks. They stay in Hawaii for a few days, then leave for another week. An amazing commitment.

When the female albatross lays an egg, it may seem like she has accomplished something significant. But, she literally and figuratively has a long way still to go. She endeavors for an accomplishment that no other species can match. In her case, to produce another albatross. The Sustainable Seas Expedition has a long ways to go in its endeavors too. Literally and figuratively. We will learn from this first year because we have to. And, we will be back next year on our long journey, with an even better program to explore and understand the Monterey Bay National Marine Sanctuary. Because we have to do that too.

(top) **RETURN**

Summary of Investigations

Exploration of a deep reef by DeepWorker in Monterey Bay National Marine Sanctuary.

The approach to the Sustainable Seas Expeditions at the Monterey Bay National Marine Sanctuary, has been to complement and build upon existing research and to work in partnership with scientists who have expertise in the deep sea and with remotely operated vehicles and other submersibles. The DeepWorker will be a valuable resource for characterizing habitats and developing monitoring programs, and the sanctuary selected research projects to take a advantage of those strengths.

One project prepared for this year's missions was furthering an existing prickly shark research program by using the DeepWorker to conduct visual transects at the heads of several major canyons in the sanctuary to estimate the distribution and relative abundance of prickly and other large sharks.

Another project planned to observe day-night migrations of small invertebrates, with a focus on gelatinous zooplankton. A third study was to help local efforts to make seasonal comparisons of deep water habitats and fishes in the Big Creek Ecological Reserve. The Big Creek Marine Reserve Project was also the subject of a successful student summit education project during the Expeditions. Specifically, Mike Guardino, the Teacher in the Sea, successfully conducted a deep water survey in Carmel Bay from DeepWorker. This was an extension of shallow water scuba surveys he is conducting with students.

The DeepWorker in Monterey Bay National Marine Sanctuary.

Unfortunately, inclement weather and technical and operational difficulties limited the amount of research on the projects during the first Sustainable Seas Expeditions visit to the sanctuary. However, by logging practice dives in the DeepWorker, honing their piloting skills, and initiating collaborations and planning, scientists have created a

solid foundation for future visits.

Dr. Steve Webster gathers an image during a DeepWorker dive.

(top) RETURN

SUSTAINABLE SEAS EXPEDITIONS
EDUCATION

SITE INDEX

Educational Opportunities for Students

Educational opportunities for students abound in the SSE, including **Student Summits**, **Web chats and Web casts**, and **Students-at-Sea**. Each sanctuary hosts several educational events during the course of an SSE mision.

Dr. Sylvia Earle speaks with presenters during the Student Summit at the Channel Islands National Marine Sanctuary.

2000 Education Opportunities

Learn more about the educational activities in these sanctuaries:

Channel Islands(June 5 - 24 / July 14 - 19)
Monterey Bay (June 26 - July 12)
Florida Keys (Sept 1 - 23)

Student Summits: Sanctuary sites work with local teachers to develop a Student Summit--a conference that brings together students and experts to discuss important conservation issues and critique student research projects. Dr. Sylvia Earle was the keynote speaker at all of the student summits in 1998 and 1999.

During the 1999 field season, Student Summits were held at many sanctuaries. Read about them in the **May 25 Channel Islands log** and the **May 17 Monterey Bay log**. The Olympic Coast National Marine Sanctuary produced a video about its Year of the Ocean Student Summit with Dr. Sylvia Earle in 1998. **View this video**.

Web Chats and Web casts: Web Chats and Web casts are live, interactive Internet events sponsored by **NASA Oceanography** in

SSE Education Program

Teacher Materials

Teacher Opportunities

Student Opportunities

The student-operations team takes a break to pose with the *DeepWorker* submersible aboard the NOAA ship *Ka`imimoana*.

partnership with NOAA. Web chats are one-hour on-line dialogues between students, scientists and sanctuary staff members. Web casts are one-hour Internet video broadcasts, during which students ask questions and receive answers in a chat room. Web casts are often delivered from underwater, and may involve a scuba diver and the *DeepWorker* submersible.

See the schedule for upcoming Web chats and Web casts, and view the archives of past live events, on the **SSE Live Events** page.

Students-At-Sea: The Students-at-Sea program enables local students to participate in an SSE mission aboard a NOAA ship or another vessel. Students collect a variety of data including water quality information, weather observations and marine mammal sightings. Students who participate aboard NOAA ships learn about dive checkout procedures for the *DeepWorker* submersibles, tracking and navigation, data management, and video editing, all of which are part of a typical SSE mission.

Student-at-Sea events were held at several of the marine sanctuaries in 1999 and early 2000. Read about the students who particpated in the Hawai`i mission in the **January 12** and **January 13 Hawaiian Islands log.**

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Informal Education

1999 Education Archive

Educational Activities

Julie Goodson, Education Coordinator
NOAA's Channel Islands National Marine Sanctuary

Julie Goodson

The underwater world of the Channel Islands National Marine Sanctuary can be considered a "final frontier," a vast wilderness still largely unexplored. From shipwrecks to ancient shorelines, the waters surrounding the Channel Islands National Marine Sanctuary conceal clues to the rich cultural heritage of this community. Extensive underwater canyons, deep ocean basins, vast mud/sand bottoms, and towering underwater reefs dominate the underwater landscape around the Channel Islands. Cryptic rockfish, burrowing angel sharks, bioluminescent lanternfish and other deepwater creatures lurk in these deep, dark, cavernous features. Seventy percent of these landscapes lie in ocean depths greater than 100 feet--depths too deep for people on scuba to explore. Through images and observations recorded during the SSE DeepWorker submersible dives, we hope to capture this community's imagination about what lies beyond the waves of the Ventura and Santa Barbara county coastline by offering them glimpses into the watery world that is the Channel Islands National Marine Sanctuary.

Visitors to the SSE Open House tour the NOAA vessel McArthur

The Sustainable Seas Expeditions (SSE) 2000 mission supports many exciting education and outreach opportunities for families and schools to participate in underwater exploration of the Channel Islands National Marine Sanctuary. Efforts are being made to create links to the SSE through interactive underwater Webcasts, Student-at-Sea/Teacher-at-

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Sea events aboard the NOAA research vessel *McArthur,* and open houses. Students will observe first-hand what it is like to be a marine scientist as the DeepWorkers gather information about underwater resources of the Channel Islands National Marine Sanctuary. The model of the DeepWorker submersible used in the SSE will be showcased at various venues along the Central and Southern California coast so that people can learn more about this latest technology. Upon completion of the SSE mission to the Channel Islands, people will be invited to an open house where they can meet SSE Project Director Dr. Sylvia Earle, the research scientists and the submersible pilots.

The DeepWorker traveling exhibit appeared at the Channel Islands SSE open house at the Santa Barbara Maritime Museum.

Outlined below is the education and outreach calendar for the Channel Islands National Marine Sanctuary. In the words of Project Director Dr. Sylvia Earle, "Onward and downward" we go!

Educational Research Dives (June 7-11, 2000)

The Channel Islands National Marine Sanctuary has designed an extensive education and outreach program for this field season. The first leg of the mission is dedicated to educational research objectives using the DeepWorker and other sampling oceanographic equipment to address student research projects. The educational DeepWorker dives will occur off Anacapa Island at three existing kelp forest monitoring sites: Cathedral Cove, Landing Cove (a marine ecological reserve to 60 ft), and Admiral's Reef. The DeepWorker will be used to explore the monitoring sites from depths of 80 to 400 ft. The tasks involved in these dives are described below.

Benthic Invertebrate Assessment Tasks

• Conduct four to six 50-meter horizontal transects at each of the three sites. All invertebrate species observed during the dive will be recorded. After each submersible dive, the videotapes will be reviewed to determine population densities of key species (urchins, abalone, sea stars, gorgonians).

• Conduct a 100 meter transect at existing Kelp Forest Monitoring site (Admiral's Reef) to compare submersible and scuba methods for assessment of benthic invertebrates.

Fish Survey Tasks

• Create a list of fish species observed during a 45-minute period of a dive. Observations will be recorded at 5-minute increments using the Great American Fish Count (GAFC) methodology.

• Estimate the number of each fish species observed in the categories of single (1 fish), few (2-10 fish), many (11-100 fish), and abundant (>100 fish).

• Collect video and still images of unknown fish species.

Student Research Team

This year, the Channel Islands National Marine Sanctuary Student Research Team includes 32 students from 10 high schools in the tri-county region. The Student Research Team project tasks are to:

1. Record the abundance, distribution, size, sex and depth of observed California sheephead (*Semicossyphus pulcher)* down to 400 ft at the three sites.

2. Observe, record and compare California sheephead day and night behavior at Admiral's Reef.

3. Assess the distribution and abundance of benthic invertebrates including the four species of Gorgonian sea fans.

Outreach Events

Underwater Broadcast from Anacapa Island -- SSE 2000 Kickoff Event (June 8, 2000)

The Channel Islands National Marine Sanctuary, together with the Channel Islands National Park, RAIN and NASA, will host a live underwater broadcast on June 8 at 11 am from Landing Cove at Anacapa Island. DeepWorker pilots will interact with underwater divers and compare the two technologies and their use in underwater research. Participants in the broadcast will learn about the underwater research techniques used in the Sustainable Seas

Expeditions. The broadcast will be transmitted live to the Channel Islands National Park Visitor Center and Santa Barbara Maritime Museum to students from area schools. The satellite link will also be transmitted over the Internet to a nationwide audience. The broadcast uplink is designed to be interactive. Participants will be encouraged to ask the divers and pilots questions. **To participate, click here.**

SSE education coordinator Laura Francis will participate in the June 8 live Web chat and video uplink.

LIVE Underwater Broadcast/Uplink with 1999 Student Summit Team at Anacapa Island

Student-at-Sea/Teacher-at-Sea Events (June 10-11, 2000)

This year, the challenge for the Channel Islands mission is to gain access to real-time data as it is collected aboard the NOAA vessel *MacArthur*. Two Student-at-Sea/Teacher-at-Sea events will give students and teachers access to SSE researchers to participate in topside data collecting efforts aboard the ship. They will rotate through four stations and get hands-on experience tracking submersible navigation and communications on the bridge, video editing, DeepWorker dive operations, and oceanographic data collection. Eight teachers and the 32 student research team members will participate in these events.

Regional Student Summit Conference (June 24, 2000)

This year, the Student Summit Conference will be held at the Santa Barbara County Planning Chambers from 6 to 9 pm. The conference will be broadcast live on Government Access Television Channel 20 (GATV-20). The Student Research Team will report their preliminary findings from the educational research dives to Dr. Sylvia Earle and a panel of experts. They will compare their observations about California sheephead and invertebrates found inside the Landing Cove Ecological Reserve to those found inside Admiral's Cove. The Student Summit Team from Monterey Bay National Marine Sanctuary will participate in the summit through videoconferencing

to share their observations about marine-protected areas in their region. A live web chat was held on May 31 to plan for this event; **view the chat transcript**.

o High School Aquarium's
vater mouse habitat
ish1 was presented at the
t Summit Conference last
s part of a discussion on
technology

Channel Islands National Marine Sanctuary Research Coordinator Sarah Fangman discusses the finer points of being an SSE pilot during an SSE Open House

Sustainable Seas Expeditions Open House at the Sea Center on Stearns Wharf, Santa Barbara, CA (June 24, 2000)

June 24 marks the end of the SSE mission to the Channel Islands National Marine Sanctuary. The Open House will feature ship tours aboard the NOAA ship *McArthur*, a family day at the Sea Center, interactive marine-themed exhibits, and a mission wrap-up with Dr. Sylvia Earle and SSE researchers. Recipients of the Channel Islands National Marine Sanctuary NOAA Environmental Hero Award will also be honored during this event. The SSE and Sea Center Open House will feature free activities for families, including an underwater diver demo station, the traveling DeepWorker 2000 exhibit, the CONQFISH1 underwater habitat, crafts, a look at the plankton and mud off the wharf, and more.

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Interview

LCDR Matt Pickett, Manager
Channel Islands National Marine Sanctuary

Click on a picture to view a short video clip of each response (Quicktime video).

Matt Pickett

Question 1: What do you hope to accomplish as manager of the Channel Islands National Marine Sanctuary?

I hope that the Channel Islands National Marine Sanctuary will serve as an example of community-based marine conservation that reaches beyond the physical boundaries of the sanctuary, so that all maritime communities--regardless of whether or not they are officially designated as "marine sanctuaries"--feel empowered to protect and sustain their marine environment for future generations.

Question 2: What makes the Channel Islands National Marine Sanctuary unique?

These uninhabited, pristine islands are located in the middle of a transition zone between the colder northern waters and the warm southern waters, which creates a rich, superproductive environment of both warm- and cold-water species. It's home to everything from lobsters to blue whales, from sea urchins to orca (killer) whales.

Question 3: What are some challeneges you face in managing the sanctuary?

Our biggest challenge is redefining the ways in which resource management agencies work, by involving and engaging the local community in determining the future of this marine environment, instead of making decisions

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in a vacuum.

Question 4: What do the Sustainable Seas Expeditions mean to the sanctuary?

The SSE brings world-class scientists and research equipment to the Channel Islands to help us better understand these resources.

Question 5: How will the Sustainable Seas Expeditions and the use of the *DeepWorker* contribute to our understanding of the sanctuary?

The use of the *DeepWorker* should allow us to observe and classify deep-water habitats and associated marine life that previously were beyond our capabilities.

Question 6: What benefits are gained by working in partnership with other agencies?

The National Park Service, University of California at Santa Barbara, U.S. Geological Survey, University of California at Santa Cruz, National Aeronautical and Space Administration--all of these agencies are cooperating to develop and improve new technologies so that we can better understand the ocean environment. The results include better efficiency across government and unforeseen technological benefits.

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Research Activities

Sarah Fangman, SSE *DeepWorker* Pilot and Site Coordinator
NOAA's Channel Islands National Marine Sanctuary

Sarah Fangman

The Channel Islands National Marine Sanctuary has designed an ambitious research plan for this year's SSE mission. The NOAA ship *McArthur* will be busy collecting data 24 hours a day. Included in these plans are submersible and non-submersible operations. Each of these efforts will allow us to collect information necessary to manage and protect the Channel Islands National Marine Sanctuary.

Submersible Operations

Geologic Assessment - Ground Truth Sidescan Sonar - The Channel Islands National Marine Sanctuary is engaged in a cooperative project with the U.S. Geological Survey Western Region to investigate nearshore benthic habitats. This project, begun in 1998, involves conducting sidescan sonar operations to characterize and map benthic habitats around the Channel Islands. To date, more than 300 sq km have been mapped around the islands. Bottom video is essential for "ground-truthing" when interpretation of the sidescan data is uncertain and when water depths exceed scuba depths. The DeepWorker will be used in areas where sidescan operations have occurred and in which visual observations are needed to interpret the sidescan data.

A sandwaves image taken off of Santa Cruz Island by the side scan sonar during the 1999 CINMS SSE.

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Principal Investigator: Guy Cochrane
Locations: One-half-mile-long transects at Anacapa (4), Santa Rosa Island (3), and South San Miguel Island (3).
Depths: 275-400 ft

Fish Assessment - Surveys for Rockfishes (Bocaccio, Cowcod, Flag and Vermillion) - Several rockfish species in Southern California have experienced population declines in recent years. One species, the bocaccio, is estimated to be at less than 7% of its 1970 biomass and is under consideration for threatened status. The DeepWorker will be used to conduct video and visual transect surveys to estimate the distribution and abundance of bocaccio, cowcod, flag and vermillion rockfish in several areas around the sanctuary.

Flag rockfish *(Sebastes rubrivinctus)*. Courtesy of Mary Yoklavich.

Principal Investigators: Milton Love and Donna Schroeder
Locations: "The Footprint"--south of the Anacapa/Santa Cruz Passage. Platform Gail--North of Anacapa Island. Time permitting, dives will be conducted at "Donna's Reef" in the Anacapa/Santa Cruz Passage or at "Milton's Reef" in the Anacapa/Santa Cruz Passage.
Depths: Depths at the Footprint range from 300-800 ft. The maximum depth at Platform Gail is 740 ft. Donna's Reef is 150-160 ft; Milton's Reef is 170 ft.

Fish Assessment--Sheephead and fish surveys - The objective of these dives will be to determine the distribution, abundance, and size frequency of California sheephead (*Semicossyphus pulcher*) at three locations on Anacapa. DeepWorker pilots will conduct roving fish surveys and timed species counts at three locations on Anacapa Island down to 400 ft. Pilots will create a running list of fish species observed during a 45-minute period of a dive. The number of each species will be estimated and categorized as: single (1 fish), few (2-10 fish), many (11-100 fish) and abundant (>100 fish)
Principal Investigator: Laura Francis
Locations: Anacapa Island at Cathedral Cove, Landing Cove--a marine no-take zone to 60 ft--and Admirals Reef.
Depths: To 400 ft.

Benthic Assessment - Invertebrate density counts of abalone, sea urchins, sea stars and gorgonians - DeepWorker pilots will extend the established National Park Service Kelp Forest

Monitoring transects at Anacapa Island to depths of approximately 400 ft. Pilots will conduct four to six 50-m horizontal transects at each of the three sites with a video camera pointed at the bottom substrate and lasers in view of the camera to record the invertebrate species observed. After each dive, pilots will review the tape to determine the densities of key species (urchins, abalone, sea stars, and gorgonians). In addition, pilots will conduct a 100-m transect at Admiral's Reef to compare submersible and scuba methods for the assessment of benthic invertebrates.

Scuba diver in the water with the DeepWorker in the Channel Islands National Marine Sanctuary.

Principal Investigator: Laura Francis
Locations: Anacapa Island at Cathedral Cove, Landing Cove and Admiral's Reef
Depths: To 400 ft.

Non-Submersible Operations

Side-scan Sonar Operations - At night, when diving operations have ceased, the NOAA ship *McArthur* will be used to conduct additional sidescan sonar operations. These data will be used as a part of the effort to investigate nearshore benthic habitats (see above).

Principal Investigator: Guy Cochrane
Location: South side of Santa Cruz Island and Anacapa gap, north portion (south portion was mapped during SSE 99). Each of these areas will require three nights of operations. Time permitting, additional areas to target would include the north side of Santa Cruz Island.

Guy Cochrane reviews some side scan sonar data as sonar operator Mike Boyle looks on.

Characterization of Santa Barbara Channel Eddy - While the adults of most nearshore reef species may be permanent residents on a reef, they produce offspring that may drift in the plankton for weeks to months, carried along by nearshoreand cross-shore flowing currents. In the Channel Islands sanctuary, however, a coastal eddy, which often manifests in the western half of the Santa Barbara Channel, may enhance the survivorship and growth of fish larvae. Very little oceanographic data is available concerning this coastal eddy, although its presence suggests a strong connectivity among the reefs. Complete data exists for only one year, 1998. The NOAA ship *McArthur* will collect ADCP and CTD data to document the hydrographic character of this interesting and potentially important feature of the sanctuary.
Principal Investigator: Libe Washburn
Locations (according to priority): The Santa Barbara Channel Eddy and three Island passes: (1) Santa Cruz Passage between Santa Rosa and Santa Cruz, (2) Anacapa Passage between Santa Cruz and Anacapa, (3) Santa Rosa Passage between San Miguel and Santa Rosa.

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Welcome to the Sustainable Seas Expeditions

by Lois Capps
U.S. House of Representatives

U.S. Rep. Lois Capps (D-CA/22), House of Representatives, Congress of the United States

I am honored to have the opportunity to welcome the 2000 Sustainable Seas Expedition to the Channel Islands Marine Sanctuary. The Marine Sanctuary is an incredible resource for gaining a deeper understanding about the wonders of the sea. The Sanctuary's Education, Research, and Cultural Resources programs combine to promote the long term conservation of the Channel Islands Marine habitat while serving as a valuable educational asset to the community.

Our oceans offer a new frontier for exploration. I am in awe of the fact that only five percent of the ocean and sea floor has been explored. It is astounding to think of the many secrets that are hidden below the ocean's surface. Within the vast depths of the sea lies the opportunity to discover new resources, cures for disease, and the answers to scientific questions. The knowledge that can be acquired about this unique ecosystem will also prove to be invaluable in gaining insight into what can be done to preserve these vital resources.

The Sustainable Seas Expedition, through its public outreach and education efforts, will go a long way in bringing the well-deserved attention and support for our National Marine Sanctuaries. The project is currently in the third year of a five year program, and I am proud that the Central Coast will host the expedition for a second consecutive year. Dr. Sylvia Earle, the Explorer-in-Residence at the National Geographic Society and Project Director for the Sustainable Seas Expeditions, and her team of experts will visit the Channel Islands June 3 through 26

Last year I had the privilege of meeting Dr. Earle and the other

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Channel Islands kelp forest

researchers at the Sustainable Seas Expedition Open House. I was impressed with the hard work and dedication that they put into their truly ground breaking field of study. I was particularly interested to hear Dr. Earle speak about how important it is for us to learn more about our nation's own aquatic backyard - our National Marine Sanctuaries.

The Sustainable Seas Expedition is funded by a public/private partnership between the National Geographic Society in cooperation with the National Oceanic and Atmospheric Administration and other government agencies, industry, and private institutions, made possible by a grant from the Richard and Rhoda Goldman Fund. This is a revolutionary partnership that I believe serves as a model for future marine conservation projects.

In reviewing the project goals - exploration and discovery, scientific research, new technologies, and raising public awareness, I was especially impressed with the emphasis put on education. This year the Channel Island's National Marine Sanctuary Student Research Team will include thirty-two students from ten high schools in the tri-county region. These students will study the California Sheephead and will assess distribution and abundance of benthic invertebrates. I can not think of a more valuable learning experience than the opportunity to observe firsthand what it is like to be a Marine Scientist.

Rep. Capps with Sylvia Earle at Channel Islands Open House

Another exciting aspect of this year's Sustainable Seas Expedition is a live underwater internet broadcast from Anacapa Island. The broadcast which is made possible through a partnership with NASA, will occur June 8 at 11:00am from Landing Cove. Viewers will be able to learn about the underwater research techniques used in the Sustainable Seas Expeditions while remaining in the comfort of their

own homes. This connection between outreach, education and technology promises to be an informational and entertaining experience for everyone involved.

I am certain that many important discoveries lie ahead for the Sustainable Seas Expeditions. Currently I am working hard in Congress to ensure that the Marine Sanctuary Program continues to thrive and expand to protect the priceless resources that our oceans hold. Programs like the Expeditions are exactly why we must support the National Marine Sanctuary Program and you can rest assured that in Congress I will continue to do just that.

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Dive Maps

View a series of dive maps produced during this expedition. Click on the reference map above to **link to the Dive Maps page**.

Three-Dimensional Fly-through

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The fly-through movie is automatically downloading in the background. To view, click the play buton.

The Channel Islands National Marine Sanctuary "fly-through" covers over 50 miles in less than a minute, faster than any known submersible technology, and will allow you to see underwater distances of 20 miles or more. This artificial visualization allows us to experience the dramatic contours of the sanctuary floor without even getting our feet wet. Your flythrough begins at a depth of about 200 meters, moving east within the Channel Islands National Marine Sanctuary along the relatively flat and shallow Santa Barbara Channel that separates the Channel Islands from the California coast. (Follow the reference map as the video streams.) You begin to turn south and come to a sharp ridge off Anacapa Island where you drop to a depth of 700 meters and begin to move westward along the southern edge of the islands. After a slight incline you pass

beyond a distinctive seamount on your left (south) and drop to 800 meters below sea level. To the south you can view the abyss that descends to more than 2000 meters below the surface. Avoiding the abyss, you continue to ride along the southern edge of the sanctuary. You turn to gaze up at the underwater cliffs that lie a few miles off the south coast of Santa Cruz Island, then begin a rapid ascent that winds you through a 5-mile long underwater canyon. After climbing to a depth of 200 meters you end safely at a point just off of the southwest shore of Santa Cruz Island.

The Sanctuary Boundary

The Channel Islands National Marine Sanctuary is located 25 miles (22 nautical miles) off the coast of Santa Barbara, California. The sanctuary is comprised of five islands -- San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara -- and the waters surrounding them, from mean high tide to 7 mi (6 nmi) offshore (indicated by dark blue on the map, above). The combination of warm and cool currents creates an exceptional breeding ground for many species of plants and animals. Forests of giant kelp are home to numerous populations of fish and invertebrates. Every year, more than 27 species of whales and dolphins

visit or inhabit the sanctuary, including the rare blue, humpback and sei whales. On the islands, seabird colonies and pinniped rookeries flourish, while overhead, brown pelicans and western gulls search the water for food.

Since the sanctuary's designation in September 1980, its objectives have focused on balancing the protection of marine animals, habitats and prehistoric tribal artifacts with the area's ever-increasing recreational and commercial activities. Major issues that affect the sanctuary include oil and gas development, busy shipping lanes in nearby waters, nonpoint source pollution, and commercial and recreational fishing.

The Mission

The Sustainable Seas Expeditions' 2000 mission to the Channel Islands will focus on the southern shores of Santa Rosa, Santa Cruz, and Anacapa Islands (indicated by yellow lines). Additional dives are planned for the north side of Anacapa.

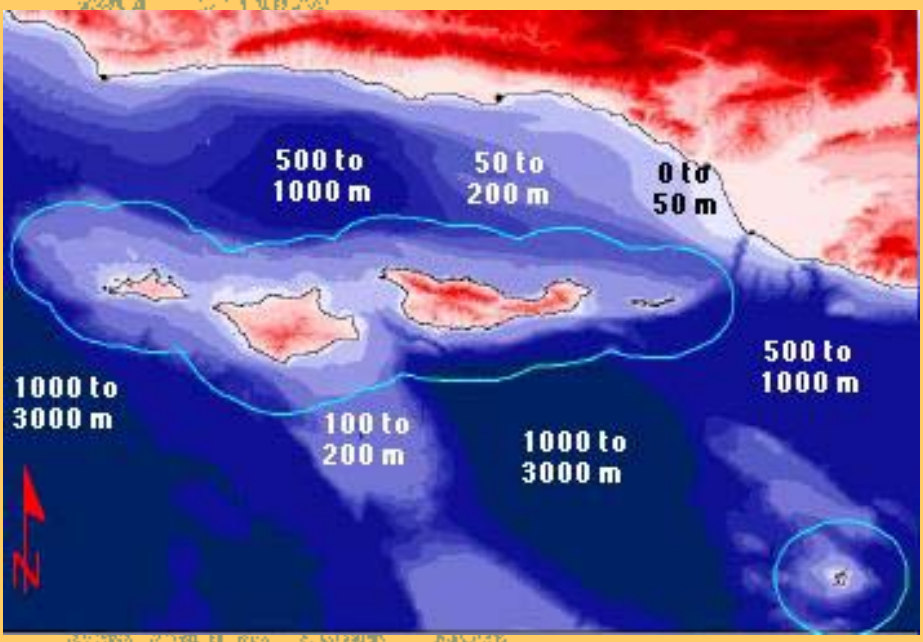
(top)

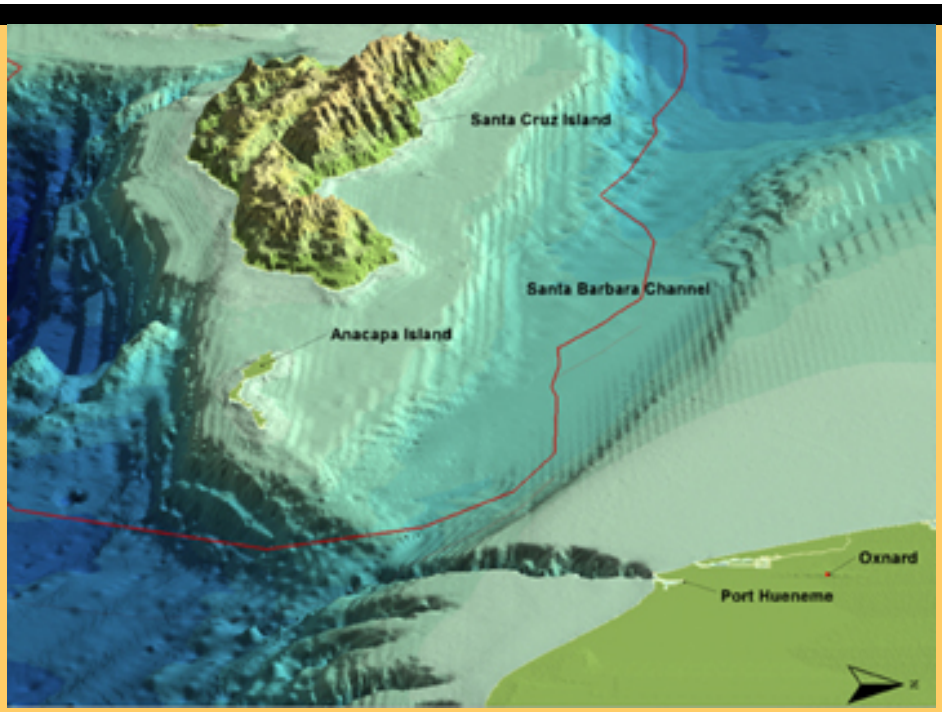
Aerial Photographs

These aerial views taken of Anacapa Island were taken in 1997. Most of this year's SSE dives will take place in the waters to the south of the island (bottom of photo). (Source: NOAA's National Geodetic Survey. NOS coastal photography is available on-line at **NOS MapFinder**.)

(top)

The Sea Floor

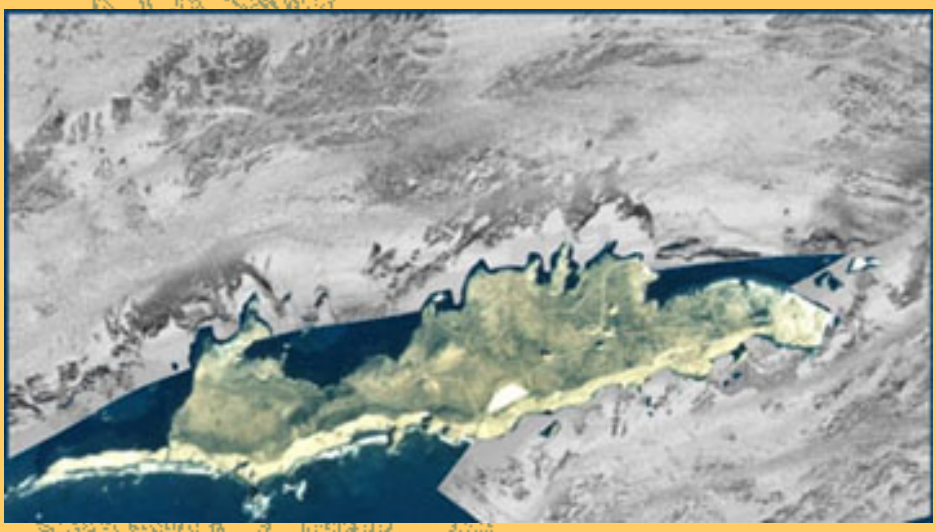




The sea floor around the Channel Islands drops precipitously to the south and west. The top image shows relative water depths surrounding the islands. (Contributed by Ben Waltenberger, Channel Islands National Marine Sanctuary) The bottom image highlights the Santa Barbara Channel in a 3-dimensional visualization. (Contributed by Robert Aguirre, NOS Special Projects Office)

(top)

Sidescan Sonar

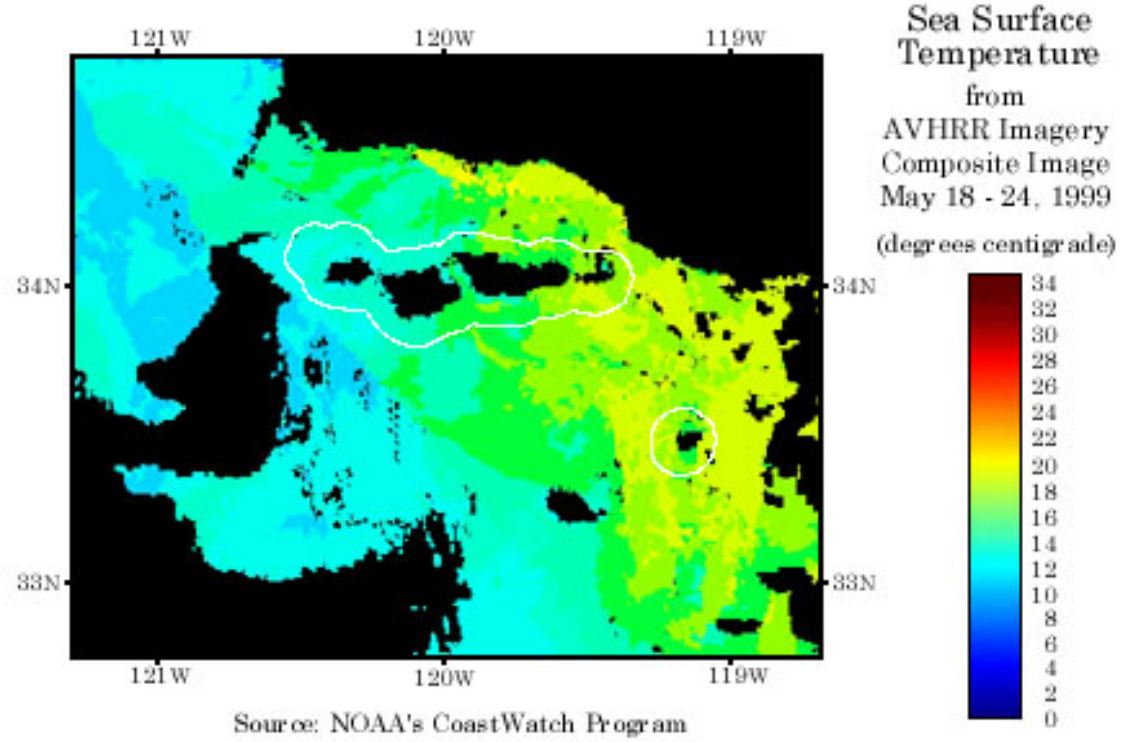


Sidescan Sonar is a mapping methodology that uses acoustic imagery to

map the sea floor. The technology can be likened to taking aerial photographs of the landscape. The sonar signal provides an "image" that helps to determine the bottom type. In the above image of East Anacapa Island, the multi-grayscale areas represent more topographically variable surfaces, such as rocky reefs. The larger areas of similar color represent less variable sea-floor types, such as sand flats. (Contributed and processed by the SSE GIS Team using original data from Guy Cochrane, U.S. Geological Survey)

(top)

Sea Surface Temperature



Relatively warm temperatures (11-18 degrees C) characterize the springtime ocean surface waters of southern California. Produced from the Advanced Very High Resolution Radiometer (AVHRR) on NOAA's polar orbiting spacecraft, this image shows that the coolest waters (11-12 ° C) occur southwest of the sanctuary, and that warmer waters (17-18 ° C) occur along the coast near Santa Barbara and Oxnard. Clouds and land appear as black.

The AVHRR sensor measures radiation reflected from the Earth's surface. Data are transmitted from the sensor to ground-receiving stations and are processed using multi-channel, atmospherically corrected algorithms.

This is a 7-day composite image of data collected from May 18-24, 1999. Compositing helps remove clouds that keep radiation from reaching the sensor. The resolution of AVHRR data is approximately one kilometer. (Image provided by NOAA's CoastWatch Program)

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What is a GIS?

Ben Waltenberger, Spatial Data Analyst
NOAA's Channel Islands National Marine Sanctuary

Sidescan sonar overlayed on an aerial "orthophoto" of Anacapa Island.

During the Sustainable Seas Expeditions' 2000 mission to the Channel Islands National Marine Sanctuary, scientists will use a geographic information system (GIS) to assist them in their work.

What *is* a GIS?

Visually displaying geographic information on maps is a communication process in the same way that language is. A geographic information system (GIS) is the "digital incarnation" of that process. In the simplest terms, a GIS contains data (information) and maps, and a computer interface ties them together to create a visualization tool. GIS is a method of representing, questioning and analyzing geographic data and other pertinent data (known as relational data) on a computer screen.

Unlike static maps (such as the roadmaps you get at the gas station), GIS not only lets you view a map, it also lets you query the map for information that is not displayed. As an example, let's say you're driving cross-country to a family reunion and you've replaced your old-fashioned paper road map with an on-board GIS. While

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Mapped results of a one-day cetacean survey mission from the sanctuary's SAMSAP program.

driving through an unfamiliar area, you notice that you need gas. Turning to your trusty GIS, you query it for all gas stations within 20 miles of your present location. Within seconds, your computer map displays all the gas stations and their distances.

Now, to illustrate the power of GIS: You decide to sort the gas stations by price per gallon. Your map now shows you that the closest gas station, 2 mi away, charges $1.90 per gallon, but a station 3 mi away charges only $1.00 per gallon. You can begin to see the potential benefits of the GIS.

How does a GIS help the Sustainable Seas Expeditions and the Channel Islands National Marine Sanctuary? One of the SSE's goals is to shed light on the patterns and processes taking place in the sanctuary. Various map and satellite information sources can be combined in a GIS to simulate the interactions of complex natural systems. The GIS allows researchers to examine variations in physical and biological processes over days, months, and years.

The entire matrix of values about one topic or factor on a map is known as a "layer" (e.g., roads are one layer, gas stations another). By putting the layers together, the original map can be recreated to address many different questions. The relational data can then be "anchored" to points, lines, and areas in geographic space that are part of a layer (gas prices are relational data that are anchored). The dimension of time can also be added as an anchor point, to track temporal change (e.g., changes in sea surface temperature over a number of years). A GIS can combine these layers and display them as maps that convey information more intuitively, and to a wider audience, than standard technical reports or traditional, static paper maps can. The pilots of the DeepWorker submersible will use GIS-generated maps to assist them in collecting data. Soon, the data gathered during this year's SSE mission will be added -- as a layer -- to the Channel Islands Geographic Information System. Thus, GIS technology fosters the goals of the SSE and the sanctuary -- to learn more about this unique area, so that it can be more effectively protected.

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The Shipwreck *Winfield Scott*

Robert Schwemmer, Cultural Resources Coordinator
Channel Islands National Marine Sanctuary
Santa Barbara Maritime Museum

Cultural resources specialist Bob Schwemmer explores a deepwater shipwreck. *(Photograph by Patrick Smith)*

The Channel Islands have witnessed a rich diversity of watercraft, from the long, canoe-like tomols of the native Chumash Indians, to the ships of exploration, trade and that made their way here through the years of Spanish, Mexican and American occupation. The Sustainable Seas Expeditions 2000 will explore submerged habitats identified through sidescan sonar and pilots of the submersibles. DeepWorker may discover sites of cultural and historic underwater significance, because more than 150 shipwrecks and aircraft are reported lost in the sanctuary. The oldest documented shipwreck is the *Winfield Scott*, a side-wheel passenger steamship that operated during the famous California Gold Rush of the mid-19th century.

With the discovery of gold at Stutter's Mill in 1848, the California Gold Rush was launched. This event would mark the single largest migration of people from around the world to California, seeking their chance to strike it rich. The great Gold Rush required the development of ships to carry people and goods to California. Many easterners from the New England states chose not to migrate to California on the overland route, but looked to ocean transportation to make the 14,000-mile journey by sea, around Cape Horn of South America. This was also true for European and Asian emigrants, who had no choice but to travel by sea. Eventually, scheduled steamer service between Panama and San Francisco offered argonauts an opportunity to avoid rounding the Cape, with

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shorter, overland routes established through Panama and Nicaragua.

The *Winfield Scott*

The *Winfield Scott* was launched on October 22, 1850, and was built of wood with double iron bracing, that included white oak, live oak, locust, cedar and georgia yellow pine. An American eagle with a coat of arms was mounted to her round stern, and forward, she had a bust carved in the likeness of General *Winfield Scott*. The steamer had accommodations for 165 cabin and 150 steerage passengers, although she would ultimately carry numbers exceeding 400. Her registered length was 225 feet from the round stern to the straight stem, and she had a 45-ft beam. In 1851, *Gleason's Pictorial* provided a detailed description: "Her lines partakes somewhat of the 'hollow' kind, beautifully swelling to her extreme width, and as beautifully tapering off again as they approached her stern. On deck are the captain and clerk's offices, and also the kitchen--all very commodious. Between decks, aft, is the general drawing room, with sofas along the entire length, and staterooms on each side, each furnished with two berths. The forward saloon is similarly arranged. Beneath the drawing room is the dining saloon, in which more than 100 persons can be comfortably seated; it also has staterooms at each side, all thoroughly ventilated and well lighted."

The *Winfield Scott* was not immediately dispatched to the Pacific Coast, but was engaged in servicing the New York to New Orleans route under the flag of Davis, Brooks and Company. In 1852, ownership transferred to the New York and San Francisco Steamship Company Line, and she arrived in San Francisco, via Cape Horn, on 28 April 1852. She was advertised as "doubled engined," and connected with the steamer *United States* for New York. The line changed its name in May 1853 to the New York and California Steamship Company, and retained ownership of the *Winfield Scott* until the company folded, whereby she was sold, in July 1853, to the Pacific Mail Steamship Company. The steamer had become quite popular on the Panama to San Francisco route, and not only provided passenger service, but carried important intelligence, mail, newspapers, and express freight, which included gold mined from the mother-lode to be sent east.

Passenger Asa Cyrus Call noted in his diary, in December 1853, the

Winfield Scott Survivor Asa Cyrus Call kept a diary of the ship's final voyage. *(Photograph provided by the Call Family)*

steamer met her match near Anacapa Island. "I embarked on the steamer *Winfield Scott* last Thursday, and at 12 o'clock we left Vally's [sic] St. Wharf for Panama. We had fine weather till Friday evening when it became foggy. One of the boilers had been leaking through the day, which had retarded our progress, and the *Sierra Nevada* had passed us, but it was repaired on Friday afternoon, and we were running about 12 miles an hour, when I went to bed on Friday night."

Passenger Edward Bosqui picked up the chain of events. "At midnight I was suddenly awakened from a sound sleep by a terrible jar and crashing of timbers. Tumbling out of my berth, I was confronted by the horror-stricken visage of my toothless and bald-headed stateroom companion, who had not time to secure his wig and false teeth and was groping about to find them. Leaving him paralyzed with fear, I hurried out on deck, where my attention was fixed on a wall of towering cliffs, the tops of which were hidden by the fog and darkness and appeared about to fall and crush us. All round was the loud booming of angry breakers surging about invisible rocks."

The *Winfield Scott* floundered in the surf of Anacapa Island, and more than 400 passengers were stranded. The next day, the side-wheel steamer *California*, on her northbound run to San Francisco with a full complement of passengers, arrived at the island. She took on some of the women and children, and the all-important cargo of gold bullion. The remaining survivors stayed on the island for eight long days until the *California* returned from San Francisco.

Now well provisioned, the crew of the *California* rescued the remaining passengers and continued the voyage to Panama. The *Winfield Scott's* crew stayed behind to recover what they could of the remaining mail and passenger baggage still submerged in the hull.

Today, the submerged

The most apparent artifact is the paddle-wheel hub and paddle-wheel shaft. *(Photograph by Robert Schwemmer)*

remains of the *Winfield Scott* lie within NOAA's Channel Islands National Marine Sanctuary and Channel Islands National Park. The site continues to be studied by archaeologists representing both agencies, who get assistance from Coastal Maritime Archaeology Resources (CMAR), a group of underwater archaeology hobbyists. Although the site has seen commercial salvage over the years, including as late as World War II, components of the ship's side-lever machinery still remain to be studied. Since extensive literature research has not yielded historic records on her machinery, these artifacts provide substantial evidence of mid-19th century engineering.

Channel Islands National Marine Sanctuary and Santa Barbara Maritime Museum

Little remains of the *Winfield Scott's* wooden hull on the seafloor surface, but a portion of her outer hull exists, with visible copper sheathing and yellow metal drifts. *(Photograph by Robert Schwemmer)*

The unique and non-renewable resources of the sanctuary, and the knowledge that archaeologists and historians gain about them will be presented to the public through a cooperative partnership with the Channel Islands National Marine Sanctuary and the Santa Barbara Maritime Museum. The museum will feature five exhibits on the shipwrecks of the region, two of which will focus on the history of the *Winfield Scott*. One exhibit will feature *Winfield Scott* survivors' first-person accounts of the wreck and the eight days they spent on Anacapa Island. Another exhibit will illustrate current field studies and provide information on the sanctuary's underwater archaeology program.

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Recreation Uses of the Sanctuary

Jim Brye, Recreation Chair
Sanctuary Advisory Council
NOAA's Channel Islands National Marine Sanctuary

Jim Brye

A seabird swoops over the rigging while a sea lion frolics near the transom, almost begging you to join him for a swim. These are just a few of the sights and sounds of a typical day boating at the "islands". Indeed, the recreational opportunities at the Channel Islands National Marine Sanctuary make a mariner's heart sing.

The Sanctuary offers a dazzling array of things for boaters, divers and fishers to do...all within easy access from one of the major population centers in the world. For example, for the boating enthusiast, there are scores of pristine, quiet and beautiful anchorages tucked into numerous coves and inlets. Once settled in with the anchor secure in a sandy bottom, these boaters can enjoy the serene and primitive surroundings in stark contrast to the hustle and bustle of LA's noise and traffic only a few miles away. Nestled at "Smugglers" or

"Prisoners" or "Little Scorpion" (popular anchorages near Santa Cruz Island), boaters can bask in the noonday sun on flat water in easy view of the swells and breaking waves of nearby "Windy Lane" in the Santa Barbara Channel. The afternoon might bring a refreshing dip in the ocean or a snorkeling adventure to a nearby reef followed by glass of chilled wine on deck while dinner sizzles on the BBQ. For these relaxing moments, the Channel Islands are a boater's paradise. But many other recreational activities are within easy reach, too.

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A sailboat heads for Anacapa Island.

For example, fishing in the Sanctuary provides a wide choice of game fish including species from the cold water environment and warm water environment that converge in a transition zone in the Sanctuary. Even when the fish aren't biting there are few more beautiful surroundings to enjoy the warm California sun almost year around.

Divers find the Sanctuary a wonderland with miles and miles of shoreline that attract sea creatures of all descriptions. When diving it is not unusual to get "buzzed" by a curious sea lion or gazed upon by colorful Garibaldi. The kelp beds near the islands form a protective habitat for juvenile marine life that in turn attracts a full range of the food chain. Whether scuba diving with a camera or a speargun or snorkeling near the shoreline, the recreational divers will find each dive in the Sanctuary a memorable one. The water is cold, but crisp and clear with a vast array of habitats and scenery to engage beginners as well as the most experienced divers.

One thing most recreational users have noticed in the last few years, though, is a change in the marine environment. The fish are more scarce, the abalone are almost non-existent, and there is starkness to the underwater world as compared with years ago. The causes of these changes are not well understood, but clearly these changes signal a wake-up call. In order to keep their vibrancy our valuable marine resources need the same attention as our terrestrial resources.

Giant kelp attracts marine life which draws recreational users to the sanctuary.

In our work with the Channel Islands National Marine Sanctuary Advisory Council (SAC) it is clear that we still have much to learn about the condition of our marine environment. The Sustainable Seas Expeditions are an important element for helping us understand the world below the surface of our ocean. For example, with tools such as the DeepWorker submersibles we can better study the marine habitats around our islands. And as an added

benefit these tools and technology are used in a broad educational outreach program to include young students in the marine research, working hand-in-hand with experienced scientists and researchers. This creative program offers the best of all worlds...helping us understand our marine environment while exposing young students to the wonders of life beneath the sea.

A diver encounters a garibaldi, a familiar resident of Channel Islands National Marine Sanctuary.

As recreational users of the Marine Sanctuary we treasure its resources. More importantly, we welcome and support programs that will help us understand and sustain our marine environment for generations to come.

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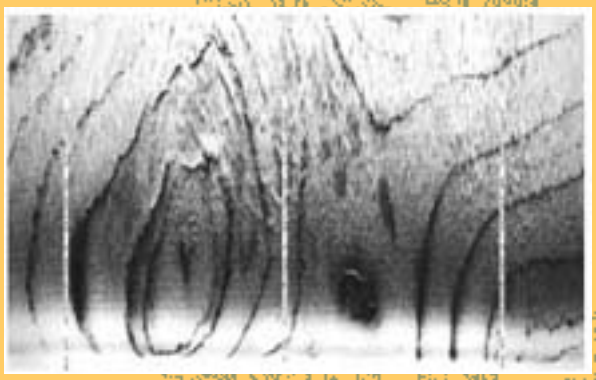
SSE and Sea Floor Mapping

Dr. Guy R. Cochrane, Marine Geophysicist
Coastal and Marine Geology Research Program of the
U.S. Geological Survey

Guy Cochrane

During the Sustainable Seas Expedition project dives are planned in an area north of Anacapa Island, where a joint U.S. Geological Survey and Channel Islands National Marine Sanctuary habitat mapping project is underway. The dives will use a combination of DeepWorker exploration and remote sensing techniques (sonar) for sea floor mapping.



USGS side-scan sonar record north of Anacapa Island, June 1998. This is a one square kilometer image of the seafloor surface. Dark areas indicate hard rock layers, while lighter areas show softer rock. The tree-ring pattern on the sea floor is the result of wave erosion.

Submersibles are valuable tools for exploring the ocean environment. Many discoveries in the fields of marine biology and geology would not have been made without them. However, exploration with submersibles suffers from the same problem that beset early exploration of the Earth's surface: limited visibility.

On land, aerial photography and satellite remote sensing solve the visibility problem. Unfortunately, these techniques do not apply well to the undersea domain except in very shallow or very clear water. The solution for ocean exploration is the same one present in a variety of marine mammals: sonar.

The word "sonar" is an acronym for "sound navigation and

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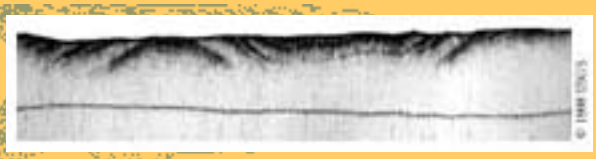
ranging." The first patent for an echo ranging sonar was filed at the British Patent Office by L. F. Richardson, one month after the sinking of the Titanic. The theory behind sonar is that echoes are stronger when sound bounces off hard surfaces or surfaces that are at right angles to the sound source. Marine mammals produce high energy sound waves naturally and interpret the echoes they hear directly. However, because humans are visually oriented creatures, we use specialized electronics to produce sound signals and then convert the echoes to visual images.

The first working sonar system was designed and built in the United States by R. A. Fessenden in 1914. The Fessenden sonar could detect icebergs up to two miles away, and it was also used for signaling submarines. Sonar systems evolved slowly until World War II, when they came into use for locating enemy submarines. The science of interpreting sound echoes developed along with the technology. After the war, many well-trained sonar scientists left the military and applied their skills in nonmilitary pursuits, including depth soundings for nautical charts, side-scan sonars for imaging objects on the seafloor, fish finding, sub-seafloor echo profiling for locating offshore oil and geologic structures, and acoustic marking and tracking of moving objects.



USGS side-scan sonar record north of Anacapa Island, June 1998. This sub-seafloor layer image is a geologic structural profile of the ocean bottom down to about 30 meters. The sub-floor profile reveals the thickness of sediment types over bedrock.

The sidescan sonar fish that is used to collect data during the CINMS Sustainable Seas Expeditions.

For each of these tasks, and others, specialized sonar instruments are now available. A combination of side-scan sonar and sub-seafloor profiling is being used to map the nearshore benthic habitat of Channel Islands National Marine Sanctuary. The side-scan sonar provides a continuous seafloor surface image by emitting a cone of sound outward and detecting the strength of the returning sounds from all directions as it is towed behind a boat. The sub-seafloor profiler focuses sound straight down so that some

of the sound penetrates the seafloor and echoes off deeper layers of the Earth's crust, revealing the thickness of sediments over bedrock.

When we combine these images with navigation data, we will have completed the first part of a map of the benthic habitat. The final habitat maps will include the side-scan imagery along with an interpretive layer where the distinct types of habitat--rocky to muddy, steeply sloping to flat bottom, thin sediment cover to thick, etc.--are delineated.

A sandwaves image taken off of Santa Cruz Island by the side scan sonar during the 1999 CINMS SSE.

Originally published in CINMS quarterly Alolkoy, Spring 1999

The DeepWorker submersible will be used to examine areas where interpretation of the sonar image is in question. In addition, counts of fauna will add to our knowledge about habitat features essential for the survival of key species. For example, knowing the type, location and amount of habitat available for commercially valuable benthic fish and other fauna will greatly improve the ability of Channel Islands National Marine Sanctuary to manage its resources.

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Weather

Channel Islands National Marine Sanctuary

A mariner checks the weather on the sanctuary's Internet Weather Kiosk before venturing out into the sanctuary.

The **Internet Weather Kiosk** is a pilot project conceived by the Channel Islands National Marine Sanctuary and sponsored by NOAA's National Ocean Service and National Weather Service. The sanctuary installed this 24-hour public access touch screen (above) at the fuel dock in Santa Barbara Harbor in October 1998. Mariners access the latest weather data from the Internet while they are fueling up. The kiosk links to some 35 on-line Web sites that provide satellite, radar, buoy, swell model, and wind information for the Southern California Bight.

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EXPEDITION UPDATE

June 5 - 24, 2000 / July 14 - 19, 2000

Follow the Channel Islands expedition on this page. To learn about planned education and research activities, plus other interesting facts, select a background essay of your choice. You can also visit the **Channel Islands sanctuary SSE Web offering**.

Special Note to Students: You can track the recent ship location and weather conditions for this mission on the **location page**.

June 5 The team from the Sustainable Seas Expeditions (SSE) has boarded the NOAA Ship *McArthur* to review safety procedures, conduct pilot refresher training, and reorient themselves with their floating 3-week home. Read **Jean-Michel Cousteau's welcome**.

NOAA Ship *McArthur*

June 6 The *McArthur* crew, scientists, and technicians ventured out into the Channel Islands for launch and recovery exercises today. After a 4- hr, 18,000-gal fuel-up, they were able to do some practice training. The primary focus of the day was to test launch and recovery procedures using practice

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June 5 Welcome to SSE

June 7 SSE Teacher Perspective

June 8 Student & Diver Perspective

June 8 Perspective from Land

June 10 Student-At-Sea Day

June 11 Investigating Circulation

June 18 Mapping the Sanctuary Floor

June 24 Sanctuary

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A web of lines attached to the test sub control its movement during launch and recovery.

submersibles. Two exercises were conducted: (1) outfitting the lift and tow lines with floats, stringing them aft while under way to insure they did not present an entanglement problem; and (2) the launch and recovery of practice submersibles to assess existing procedures as well as the effectiveness of personnel. Both exercises were a success, and the launch and recovery practice resulted in a number of recomendations to improve the process. **Track the location** of the *McArthur*.

June 7 Launch-and-recovery exercises, as well as pilot safety drills, continued. **Track today's ship location.** Also, **read a teacher's perspective** on participating in the SSE.

June 8 High school students from Ventura, Santa Barbara, and San Luis Obispo Counties ventured over choppy waters to Anacapa Island to participate in a video uplink, coordinated by NASA, the SSE, the National Park Service and NOAA. Students at the National Park Visitor Center in Ventura, CA, joined others over the Internet to direct questions to Dr. Sylvia Earle (on Anacapa Island) and Laura Francis (underwater off Anacapa Island). Students participated in a fish count during the dive, and later, Park Service Ranger Tom More gave them a tour of the island.

Students assembled on Anacapa Island to review fish count data materials prior to the video uplink.

Dr. Sylvia Earle observes divers during the video uplink.

Students and a research divers recorded their perspectives in **today's log**. **Track today's ship location.**

June 9 The *McArthur* is off

Open House

July 14 "Magnificent" Rockfish

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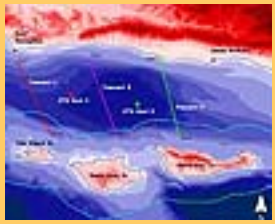
June 17 - July 18 Dive Maps

July 19 Summary Log

Santa Rosa Island until Wed., June 14, travelling transects to measure ocean currents and water characteristics. During this time, the DeepWorker has been undergoing practical exercises, including emergency drills with the pilots, in preparation for submersible work. **Track today's ship location.**



The SSE research team is collecting data nightly. View today's planned transects. (Click image for larger view.)

Students and teachers surround the DeepWorker during the Students-at-Sea program at Port Hueneme Navy Base.

June 10 The *McArthur* continued its transect operations off of Santa Rosa Island. Dockside, the Students-at-Sea program gave students an opportunity to interact with submersible technicians, pilots, and other members of the mission team. The DeepWorker and a remotely operated vehicle (ROV) were the focus as students communicated live with a pilot during a dive and monitored life- support readings. Read about the Students-at-Sea program in **today's log**. Also, **track today's ship location.**

June 11 The *McArthur* and crew continue to collect oceanographic data during transects between Anacapa and Santa Cruz Islands. They did seven transects through the night. Read **today's log** to learn about ocean circulation in the Santa Barbara Channel. **Track today's ship location.**

June 12 The *McArthur* began transit to the Santa Barbara Channel and did one last research run on the middle transect line. The *MacArthur* will resume side-scan transects between Anacapa and Santa Cruz

Islands in the evening and continue them through the morning of June 14. **Track today's ship location.**

The bow of the *McArthur* points to Santa Cruz Island during research transects.

June 13 The *McArthur*conducted side-scan transects for the entire 24-hr period at Anacapa Island. DeepWorker pilots and technicians continued launch- and-recovery and safety drills at Port Hueneme. **Track today's ship location.**

June 14 The *McArthur*finished side-scan transects at 3 am and returned to Port Hueneme at 8 am. Safety and launch-and-recovery drills with DeepWorker technicians and pilots continued dockside. **Track today's ship location.**

June 15 The *McArthur*will be at Port Hueneme until further notice, continuing launch-and-recovery and safety drills. **Track today's ship location.**

June 16 The *McArthur*remains at Port Hueneme.

June 17 The *McArthur*departed Port Hueneme at 10:30 am and transited to Anacapa Island for launch-and-recovery practice. A launch-and-recovery exercise with DeepWorker pilot Kip Evans was completed on the north side of Anacapa Island; then the ship transited to the south side of Santa Cruz Island for a second practice. Side-scan transects began at 8 pm and continued until 7 am. **Track today's ship location.**

June 18 Completed side-scan sonar transects at 7 am. The crew saw two humpbacks and approximately 100 common dolphins while switching side-scan rigging to submersible rigging. One sub dive took place in the morning (Kip Evans, pilot) on the south side of Santa Cruz Island, and one sub dive took place in the afternoon (Guy Cochrane, pilot) at the same location. **Track today's ship location.**

June 19 NOAA Corps Lieutenant Commander Matt Pickett, the Sanctuary Manager and a pilot,

Click on this image to see the GIS data gathered during the flight over the sanctuary.

flew over the sanctuary with GIS specialist Ben Waltenberger and observed Risso's dolphins, humback whales and a blue whale. While in the air they entered their observations in a laptop, and generated the image at left, charting what they observed.

June 20 The *McArthur* crew, pilots and technicians left Port Hueneme at 6 am. Guy Cochrane completed a dive in the DeepWorker that tested the systems. The ship returned to Port Hueneme in the evening and will go back out tomorrow. **Track today's ship location.**

June 21 The *McArthur* left Port Hueneme at 10 am. Guy Cochrane did a 3-hr dive, reaching a depth of 450 ft, and completed one transect. The visibility was great. He explored several types of habitats and also collected ground-truthing side-scan data. The ship did transects all night and collected side- scan sonar data. **Track today's ship location.**

June 22 Donna Schroeder will be piloting the DeepWorker for a morning dive, and Sarah Fangman will dive in the afternoon. **Track today's ship location.**

Sarah Fangman, research coordinator at the sanctuary, prepares for her DeepWorker dive off of southwest Anacapa Island.

June 25 The SSE team heads north aboard the *McArthur* to conduct the **next expedition** in the Monterey Bay National Marine Sanctuary. They will return to the Channel Islands sanctuary in mid-July.

July 14
Sarah Fangman and the SSE team departed Port Hueneme at 9 am aboard the *McArthur* and headed to a dive location known as "The

A cowcod rockfish observed by Donna.

Footprint." Once there, Donna Schroeder will dive to study rockfish and their habitat. Tonight, they travel to a point north of Santa Cruz Island to conduct side-scan transects. They plan to continue this research throughout the weekend. **Donna shares her dive experience.** Also, **track today's ship location.**

July 15 Two dives were completed today. This morning, Sarah Fangman completed a dive on the footprint reef to a depth of 675 ft. In the afternoon, Sylvia Earle dove on the Footprint to 355 ft. Side-scan sonar efforts continued until 11:30 pm, but were then postponed due to heavy seas. **Track today's ship location.**

July 16 Dr. Sylvia Earle completed a dive today, on the south side of Anacapa Island, to 2,000 ft! **Track today's ship location.**

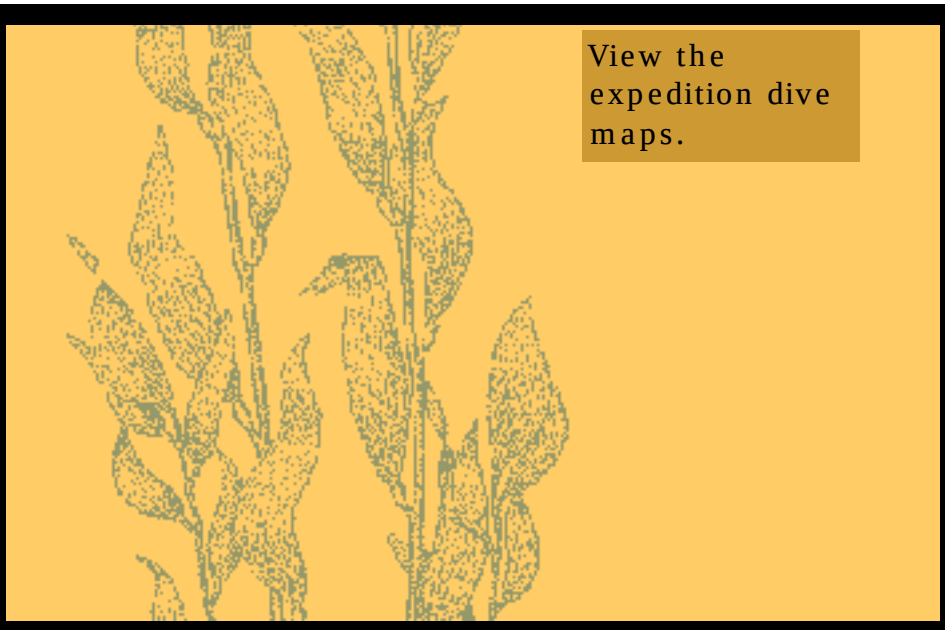
Dr. Earle is ecstatic after a 2,000-ft dive.

July 17 The SSE team remains off Anacapa Island. Guy Cochran completed a 3-hr dive at depths of 150 ft to ground-truth the nightly side-scan sonar information he is receiving. Donna made a 1.5-hr dive to a depth of 950 ft in a successful search for rockfish. **Track today's ship location.**

The SSE team

July 18 Today is the final day for submersible operations. A morning dive by Dr. Guy Cochrane and an afternoon dive by Sarah Fangman are planned, after which the team will return to Point Hueneme. **Track today's ship location.**

Retrace the Channel Islands Expedition by **viewing the SSE Photo Log** and **dive maps.**


View the expedition dive maps.

Tracking the Expedition: Ship Location, Weather and Sea State

This page was developed to allow students to track ship locations and weather conditions during the Channel Islands mission.

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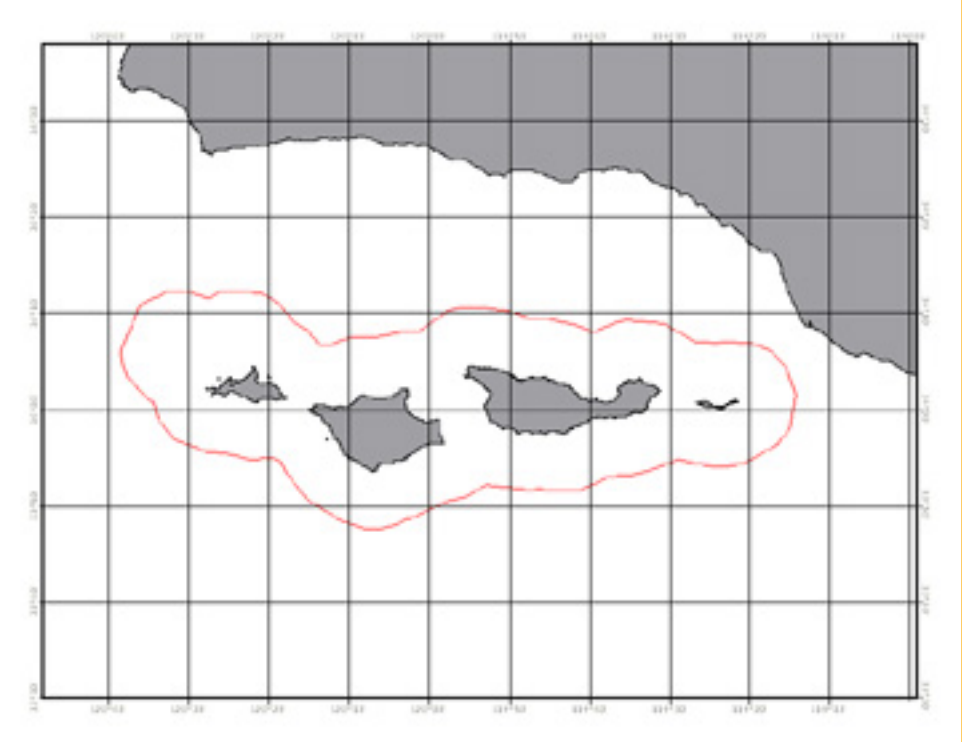

Two maps of the Channel Islands National Marine Sanctuary are provided: a reference map with islands and land masses identified (top), and an area grid with latitude and longitude lines (bottom). Click on the bottom map for an 8.5 x 11 inch version.

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June 6

Ship location and weather at 5 pm:

34 degrees 09.1 minutes N
119 degrees 12.4 minutes W
Wind had picked up and there were whitecaps (the day began sunny, clear and in the low seventies)

June 7

Morning weather:

Clear, light breeze 5-10 knots, temperature 65 ° F

June 8

Weather and sea state: choppy waters, overcast in the am with a

light breeze. By afternoon, the sun was out but the wind picked up and by 4 pm, the seas were choppy.

June 9

Ship's position and weather conditions at 9 am:

34 degrees 07.7N
119 degrees 20.4 W
Clear Skies 10 NM visibility
Wind 22 knots from SW
Swell 5ft from SW

Ship's position and weather conditions at 5 pm:

34 degrees 20.54 N
120 degrees 26.18 W
Clear Skies 10 NM visibility
Wind 34 knots from SW
Swell 6ft from 2.95 degrees

June 10

Weather: hot, sunny, not a cloud in the sky anywhere to be seen, 85 ° F

Ship's position and weather conditions at 6 am:

34 degrees 07.69N
119 degrees 55.23 W
Clear skies 10 NM visibility
Wind 23 knots from 280 degrees
Swell 5-6' from 290 degrees

Ship's position and weather conditions at 5 pm:

34 degrees 19.7 N
120 degrees 21.3 W
Clear skies 8 NM
Wind 32 knots from 308 degrees
Swell 6-8" 280 degrees

June 11

Ship's position and weather conditions at 5 am:

34 degrees 16.7N
120 degrees 07.4 W
Clear skies 10 NM visibility
Wind 4 knots from 330 degrees
Swell 4-5' from 270 degrees

June 12

Ship's position and weather conditions at 6 am:

34 degrees 0.2 N
119 degrees 27.7 W
Partly cloudy 10 NM visibility
Wind 4 knots from 320 degrees
Swells 3' from 280 degrees

June 13

Ship's position and weather conditions at 6 am:

34 degrees 01.8 N
119 degrees 27.0 W
Clear and hazy 6NM visibility
Wind 8 knots from 148 degrees
Wave 1 ft, swell 2 ft from 310 degrees

Ship's position and weather conditions at 5 pm:

34 degrees 03.1 N
119 degrees 23.8 W
Clear 10NM visibility
Wind 10 knots from 310 degrees
Wave 1-2 ft, swell 2 ft from 295 degrees

June 14

Ship's position and weather conditions at 6 am:

34 degrees 01.9 N
119 degrees 25.8 W
Clear 5NM visibility
Wind 6 knots from 167 degrees
Wave 1 ft, swell 1 ft from 085 degrees

June 15

Ship's position:

34 degrees 09.0 N
119 degrees 12.4 W

June 16

Ship's position and weather conditions at 12 pm:

34 degrees 09.0 N
119 degrees 12.4 W
10NM visibility

June 17

Ship's position and weather conditions at 11 am:

34 degrees 02.7 N
119 degrees 19.1 W
Partly Cloudy 10NM visibility
Wind 4 knots from 223 degrees
Wave <1 ft, swell 0-2 ft from 225 degrees

Ship's position and weather conditions at 5 pm:

33 degrees 57.0 N
119 degrees 34.8 W
Clear 10NM visibility
Wind 15 knots from 235 degrees
Wave 1 ft, no swell

June 18

Ship's position and weather conditions at 6 am:

33 degrees 57.0 N
119 degrees 46.1 W
Clear 10NM visibility
Wind 4 knots from 140 degrees
Wave 1 ft, no swell

Ship's position and weather conditions at 5 pm:

33 degrees 56.5 N
119 degrees 44.0 W

Partly Cloudy 10NM visibility
Wind 9 knots from 260 degrees
Wave 1 ft, swell 1ft from 215 degrees

June 20

Ship's position and weather conditions at 9 am:

34 degrees 01.7 N
119 degrees 20.2 W
Cloudy 10NM visibility
Wind 4 knots from 315 degrees
Wave <1 ft, swell 2 ft from 50 degrees

Ship's position and weather conditions at 3 pm:

34 degrees 02.4 N
119 degrees 19.2 W
Partly Cloudy 10NM visibility
Wind 10 knots from 100 degrees
Wave <1 ft, no swell

June 21

Ship's position and weather conditions at 6 pm:

34 degrees 59.3 N
119 degrees 21.8 W
Partly cloudy 8NM visibility
Wind 12 knots from 326 degrees
Waves 1-2 ft, swell 3 ft from 260 degrees

June 22

Ship's position and weather conditions at 6 am:

34 degrees 02.27 N
119 degrees 18.87 W
Cloudy 5NM visibility
No wind
Waves 1 ft, no swell

Ship's position and weather conditions at 1 pm:

34 degrees 00.00 N
119 degrees 24.4 W

7NM visibility
Wind 3 knots from 240 degrees
Waves 1 ft, no swell

June 23

Ship's position and weather conditions at 6 am:

34 degrees 04.6 N
119 degrees 42.9 W
Wind 6 knots from 60 degrees
Waves 1 ft, swell 3 ft from 260 degrees

Ship's position and weather conditions at 9 am:

33 degrees 55.573 N
119 degrees 59.262 W

July 14

Ship's position at 6 am:

33 degrees 57.99 N
119 degrees 29.741 W

Ship's position at 6 pm:

34 degrees 03.63 N
119 degrees 35.919 W

July 15

Ship's position and weather conditions at 6 am:

34 degrees 04.9 N
119 degrees 32.9 W
Wind 6 knots from 120 degrees
Waves 1 ft, swell 2 ft from 295 degrees
Partly cloudy, 10 NM visibility

Ship's position and weather conditions at 6 pm:

33 degrees 58.0 N
119 degrees 29.6 W
Winds calm
Waves 1 ft, swell 1 ft from 240 degrees

Partly cloudy, 8 NM visibility

July 16

Ship's position and weather conditions at 6 am:

33 degrees 55.1 N
119 degrees 26.4 W
Wind 8 knots from 215 degrees
Waves 1 ft, swell 1 ft from 285 degrees
Cloudy, 10 NM visibility

Ship's position and weather conditions at 6 pm:

33 degrees 58.7 N
119 degrees 21.1 W
Wind 18 knots from 310 degrees
Waves 1 ft, swell 3 ft from 295 degrees
Partly cloudy, 10 NM visibility

July 17

Ship's position and weather conditions at 6 am:

34 degrees 03.716N
119 degrees 39.627W
Clear skies, 9 NM visibility
Wind 21 knots from 265 degrees
Waves 2 ft

Ship's position and weather conditions at 6 pm:

33 degrees 57.5 N
119 degrees 28.6 W
Clear skies, 10 NM visibility
Winds calm
Waves 1 ft, swells 3-4 ft from 230 degrees

Guy Cochran's dive transects (he was launched at drop A, and proceeded to each drop location)

Guy's dive today:

A drop
33 degrees 59.742 N
119 degrees 29.886 W

B drop
33 degrees 59.82 N
119 degrees 29.568 W

C drop
33 degrees 55.922 N
119 degrees 29.568 W

D drop
34 degrees 00.048 N
119 degrees 28.71 W

E drop
53 degrees 00.306 N
119 degrees 28.83 W

F drop
34 degrees 0.444 N
119 degrees 28.866 W

July 18

Ship's position and weather conditions at 6 am:

34 degrees 02.2 N
119 degrees 39.8W
Clear skies, 10 NM visibility
Winds calm
Waves 2 ft, swells 2-3 ft from 210 degrees

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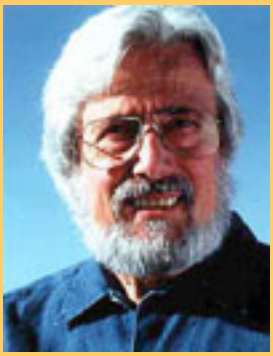
June 5, 2000
Welcome to the Sustainable Seas Expeditions

Jean-Michel Cousteau, President
Ocean Futures Society

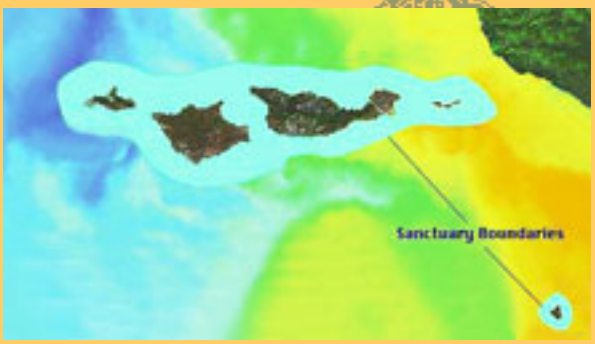


Jean-Michel Cousteau is a member of the Channel Islands National Marine Sanctuary Advisory Council and a frequent diver in sanctuary waters.

As a lifelong ocean environmentalist and president of the **Ocean Futures Society**, it is with great pleasure that I welcome my good friend, Dr. Sylvia Earle, and the Sustainable Seas Expeditions (SSE) to Santa Barbara, my hometown community. For the next two-and-a-half weeks, Sylvia and her team will lead a unique endeavor to discover, understand and share the life that dwells in the depths of the Channel Islands National Marine Sanctuary. This 19-day research project is part of a five-year study to survey all of the U.S. national marine sanctuaries.

I not only endorse the work being conducted by the SSE, but also urge people, especially children and students, to take an active interest in following the progress of this remarkable scientific journey. It brings together marine science experts and local high school student researchers, who will work together aboard the NOAA ship *MacArthur*in our own watery "backyard." Using the DeepWorker submersible and remote technologies, the team will broadcast its discoveries to millions of people via the World Wide Web. For the first time, the living resources, habitats and conditions of one of the world's great marine biosphere reserves will be revealed to us.

The SSE provides us all with a rare glimpse of the deep sea. It is an opportunity to learn more about our sanctuary, which encompasses



In the Channel Islands National Marine Sanctuary, the warm waters of the south meet cold northern waters to create a transition zone that is home to many unique species.

the convergence zone of the warm and cold Pacific currents. The protected boundary encircling the northernmost Channel Islands holds within it a rich array of plant and animal life. As my father once said, "People protect what they love." But to do so, we must first be educated about these natural treasures in a way that moves us to action. The SSE experience will deliver the lessons we need to better appreciate the ocean. It is my hope that it will also lead us toward sustainable management of this invaluable national asset, protecting it for generations to come.

Respectfully yours,

Jean-Michel Cousteau

"Protect the ocean and you protect yourself"

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June 7, 2000
A Teacher's Perspective on Sustainable Seas

Carpinteria High School teacher Juanita Lorenzana with her students on Anacapa Island.

Juanita Lorenzana, Teacher
Carpinteria High School

I first heard about the Sustainable Seas Expedition Project through the wonderful gals in the Career Center on our campus. My interest in SSE stems from three areas: 1) I am a former field biologist prior to becoming a science teacher and look for opportunities to become involved with projects like these; 2) I recently completed my master's degree and placed my emphasis on researching the factors which tend to keep young women from entering the fields of math, science, and engineering fields (of many factors the literature cites, the lack of women role models and the lack of hands-on experience for girls are two key issues); and 3) I am an advisor to a new Math and Science Club (MASC) on our campus. This club for young women promotes an awareness and interest in math, science, and engineering fields by weekly visits to women scientists to learn about a specific science-related career and to meet a role model who can encourage and inspire them.

One of our many MASC field trips was to the Marine Science Institute at the Univ. of CA at Santa Barbara to learn more about careers in oceanography. I thought the SSE project would be an ideal extension to all of the work the girls have done through MASC. I am hoping our participation in SSE will

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Juanita, Julie Goodson, Shauna Bingham, Laura Francis, Sarah Fangman, and Christina at the dive station before the uplink broadcast.

further increase their awareness of the many careers available in the marine sciences. Not only will these young women get to participate in real hands-on research, they will get to see a wide variety of women scientists doing science. The women we met at the orientation meeting were awesome. What wonderful role models they make for all the students involved.

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June 8, 2000 Student and Diver Perspectives on Trip to Anacapa Island, Video Uplink and Meeting Sylvia Earle

Rosa Corral, Student-at-Sea
Ventura High School

Shauna Bingham, Outreach/Volunteer Coordinator
Channel Islands National Marine Sanctuary

Shannon Service and Dorothy Littell, Students-at-Sea
Oxnard High School

Ventura High School SSE Team onboard the National Park Service vessel *Ocean Ranger*

Student Perspective From Rosa Corral:

Hi, my name is Rosa Corral and I'm from Ventura High School. I recently went on a trip to Anacapa Island with the Channel Islands National Marine Sanctuary Sustainable Seas Expeditions, Student-At-Sea team. This is the second year for SSE. Last year the high schools in Ventura County received a letter from SSE inviting students from each high school to participate in the project. When I was told about the project, I jumped at the opportunity because some day I would like to be a marine biologist. Last year we researched certain kinds of fish and the effects of commercial fishing and El Nino on these fish. This year we hope to collect even more data using the *DeepWorker*.

Julie Goodson and National Park Service Ranger Tom More on Anacapa Island, sharing its history before going on a hike.

Our trip to the islands was a fun yet educational experience. While on the island, we participated in a fish count. We met the divers involved and had the pleasure of meeting Sylvia Earle who has lots of experience with *DeepWorker*. We watched the fish count on land by TV from the underwater cameras. The fish count was also broadcast on the Internet where people could ask questions about the dive. After the fish count, we went on a tour of the island where we learned about Channel Island National Marine Sanctuary and National Park. We learned how the islands used to be, and who used to live on them. We also saw how the island has changed and what we are doing to keep the Channel Islands as safe and preserved as possible. After eating lunch, we headed home to get ready for our next trip to the Channel Islands National Marine Sanctuary.

Diver Perspective from Shauna Bingham:

The Channel Islands are one of the most beautiful dive locations in all of the world's oceans. Having the opportunity to share the wonders of this incredible underwater realm with thousands of people from around the nation and around the world was a unique and exciting opportunity.

Divers Laura Francis and Shauna Bingham hold the masks they will wear during the video uplink. Photo by Joe Valencic.

Preparing for a live underwater video uplink is like choreographing a play. The technology used to bring the ocean to your computer screen live from an island in the Pacific Ocean is a whole fascinating story in itself. We wanted to instill a sense of appreciation in our audience on what it takes to research, explore, and understand the marine resources and habitat found within the Channel Islands National Marine Sanctuary and the

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Channel Islands National Park. Comparing the difference between scuba diving and the *DeepWorker* submersible was an important theme in our underwater program.

NPS Diver Dave Stoltz confers with Digital Diver Joe Valencic and Dr. Sylvia Earle concerning the logistics of the day's dive.

Over 70 percent of the Sanctuary is in depths greater than 100 feet. Use of both of these forms of marine technology empower scientists to gather important information necessary to manage the resources found within the sanctuary. As a diver I have gained a sense of stewardship for the marine environment, and through our live underwater video webcast, I feel that many other people were able to get a sense of the awe and inspiration I feel every time I dive beneath the surface of the ocean.

Student Perspective From Shannon Service and Dorothy Littell:

A mother gull and her three chicks stood their ground as SSE students and staff took their hike around Anacapa Island.

On Thursday, June 8, 2000 our group of SSE students took off to Anacapa Island at 8:30 in the morning. The ride over was a bit rough, but not too bad. We managed to stay aboard despite the metal-chain railings. When we docked, we participated in an underwater broadcast, which lasted an hour. It was interesting and educational to witness the diver's experiences underwater. We wished that we could have joined them under the sea! We took part in a fish survey, using a quadrant, that we watched through the underwater cameras. After that we hiked up the seemingly endless flights of stairs and had time to socialize and eat. We then took a hike, led by one of the park rangers, Tom, who taught us a lot about the island's main inhabitants, the sea gulls. We happened to visit the island during the gull's nesting season, so they were fairly irate as they protected their chicks.

The ride back to Ventura aboard the National Park Service's *Ocean Ranger* was wild and wonderful!

After our hike, we went back to the landing dock and boarded our trusty boat once again for our return trip home. The ride back was certainly more rocky than the way there. Overall, we had a blast! We learned so much about underwater exploration through our first-hand experiences.

More perspectives are offered in the **June 10 log**.

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June 8, 2000 Perspective from Channel Islands National Park Visitor's Center During Uplink from Anacapa Island

Bob Schwemmer,
Cultural Resource Specialist
NOAA's Channel Islands National Marine Sanctuary

Robert Schwemmer and Claire Johnson showing students the full-size "DeepWorker" mockup at Visitor's Center in Ventura

International Oceans Day was recognized "in depth" at the Channel Islands National Park visitor's center. The auditorium was flooded with questions from participants of the NASA Oceanography uplink Webcast, along with sixty 4th and 5th grade students of Blanche Reynolds School from Ventura, California. Prior to the live broadcast, students had the opportunity to see a full-size mockup of *DeepWorker* and learn from one of the pilots how the submersible operates to a depth of 2000 feet. Broadening their understanding of the unique marine environment in the sanctuary and park, three other interpretive exhibits were presented. These included kelp forest monitoring equipment and a three-dimensional model of the deep ocean bathymetry surrounding the islands. The third was a marine life exhibit identifying live species and showing a chart with monitoring sites and trends seen in monitoring these species.

Students witnessed the live underwater broadcast which was projected on a large screen in the auditorium. An additional screen featured the NASA Webcast so that Blanche Reynolds' students could view the questions from other students participating in the

Blanche Reynolds students watching divers at Anacapa Island during NASA Oceanography uplink broadcast.

worldwide uplink. A team of experts stayed busy at the computers answering many questions. They included "Why are national marine sanctuaries important?" "What is the maximum depth your research sub can go?" and "What's the weirdest animal you have ever seen?" The panel of experts included Claire Johnson of the NOAA SSE and David Kushner and Derek Lerma of the Channel Islands National Park.

Carol Peterson and Yvonne Menard of the National Park coordinated questions between visitor center students and Webcast participants directing them to Dr. Sylvia Earle and divers at Anacapa Island, linking the virtual underwater experience. Students filled out data sheets as divers Laura Francis and Shauna Bingham pointed out the marine life encountered on this dive as underwater cameraman Dave Stoltz recorded the dive. Francesca Cava, SSE Education Program Director, provided additional information on the SSE mission at Channel Islands National Marine Sanctuary and future events planned for June.

David Kushner, Claire Johnson and Derek Lerma were the panel of experts during the uplink and fielded question from Web chat participants.

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June 10, 2000
Student -At-Sea Day

Claire Johnson, Program Specialist
National Ocean Service, Special Projects Office

Oxnard High School students got a chance to communicate with DeepWorker pilot Guy Cochrane (seen in background) via underwater telephone.

Today, 11 students and 3 teachers from Rio Mesa, Oxnard and Carpinteria High Schools joined the Sustainable Seas Expeditions (SSE) for a modified Students-at-Sea program, dockside at the Port Hueneme Navy base in California. We had originally anticipated having groups of students and teachers out on the NOAA ship *McArthur* and Anacapa Island for a day full of excitement and learning. One portion of the day was to entail shadowing scientists, pilots, technicians and the ship's crew while a normal day of submersible operations was underway. The second part was going to include a kayak and snorkeling adventure in the sheltered Landing Cove of Anacapa Island, to literally immerse students into the cool waters around the Channel Islands.

Unfortunately due to weather conditions out at the islands and practical demonstrations for operational safety, the two *DeepWorker* submersibles were dockside at the East End of the Navy base for maintenance and pilot refresher training. The snorkeling and kayak portion of the trip has been rescheduled for the fall, however through a modified program, students and teachers still had an opportunity today to interact with submersible technicians, pilots and other members of the mission team for a few hours this afternoon. The focus was on two types of underwater technology, a manned submersible, the *DeepWorker 2000*, and a Remotely Operated Vehicle (ROV). Students learned first-hand what

Students got to discuss ROV technology with Dr. Sylvia Earle and compare its use with that of manned submersibles.

it takes to check out a submersible to ensure that both the pilot and the submersible are ready for a dive, and we discussed, as a group, what the advantages and disadvantages are of manned submersibles versus ROVs. The students were able to communicate with the pilot and ask questions through the underwater telephone, as well as assist technicians with recording life support readings approximately every ten minutes.

DeepWorker and Dr. Guy Cochrane were hoisted onto the Pt. Hueneme dock after an interactive harbor dive with students and teachers.

One important aspect of today was to get the students to understand that when dealing with the wild ocean, even with thoroughly laid out mission planning and the best intentions, there are still some things out of everyone's control. In this field, one must always remember the power and immensity of this mysterious, watery realm and keep in mind that flexibility is a key word when dealing with the marine environment and oceanographic research. The students had a great time as you will see reflected in the logs that they wrote in the afternoon. I believe that it was a truly enriching experience and opportunity for these young students who are soon to step out into the "real" world and face many career decisions down the road. You begin to realize the magnitude of what SSE offers students when some of the them are giving up riding roller coasters at Six Flags Magic Mountain on a sunny Saturday afternoon in order to hang out with scientists, educators and submersible technicians on a hot, asphalt-covered parking lot at a local Navy base to learn hands-on about underwater technology.

Enjoy reading what the students have to say about their experiences as SSE Students-at-Sea for the Channel Islands National Marine Sanctuary SSE mission.

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Eric C.
Student-at-Sea, Rio Mesa High School

As a Student-at-Sea, I have had a chance to participate in submersible operations and several educational experiences with NOAA. It has been very rewarding working alongside professionals in the fields of marine biology and science. The hike at Anacapa Island, and the operations at the island helped give me a greater respect and connection with the topics that have concerned people today. Standing on the island where the Chumash stood 10,000 years ago moved me, and the SCUBA dive operations at the Landing Cove made a link between the distant past and the present.

On the dock, we witnessed a pre-dive check and some of the operations used with the *DeepWorker 2000* submersible. Guy Cochrane (the pilot) and the staff were very friendly and helpful, and they provided an opening into the scientific aspects of submersible operations with the *DeepWorker*. We were encouraged to take readings on our own data sheets alongside the staff. Overall it was a very rewarding experience and I would hope to participate again someday.

Wendy T.
Student-at-Sea, Oxnard High School

This program really shows a great future on how the ocean needs to be explored and how new things are being discovered. In my opinion, I really enjoyed being part of this group and I look forward to going snorkeling/kayaking during the fall of 2000!

Corinne J.
Student-at-Sea, Rio Mesa High School

I have really enjoyed being a part of the Sustainable Seas Expeditions. This is a really neat program and I think you should continue to make students a part of it. I am really grateful for the opportunity you guys give the students from the tri-counties. Thanks so much for the experience.

Andrew L. & Nick T.
Students-at-Sea, Oxnard High School

During our Students-at-Sea research in California, we were able to learn about many life support systems, such as the DeepWorker 2000 submersible, SCUBA diving and Remotely Operated Vehicles

(ROVs). We participated in many types of research, such as fish counts.

Tiffany B.
Student-at-Sea, Oxnard High School

I never thought I could see one of these submersibles in person, so that is why I think it is a good project to get the kids involved that are interested in marine life.

Christina C. & Marissa A.
Students-at-Sea, Carpinteria High School

Today we got to witness a pilot of the DeepWorker 2000 complete a pre-dive check. This enabled Guy Cochrane, the pilot, to have a safe journey down to the bottom of the ocean. This made me realize just how much is involved in keeping the pilot and DeepWorker safe during a real research dive.

Leah K.
Student-at-Sea, Rio Mesa High School

As a second year member of the Sustainable Seas Expeditions Student-at-Sea program, it's been a great experience to be able to take part in something involving the ocean communities. I have been debating about a career involving marine biology/oceanography and this has given me an opportunity to see if this is really what I want to make a career out of. With each excursion, there have been so many different aspects of the program that have piqued my interest further into this field. The trips to Anacapa Island have been a real treat and SSE gives you a greater appreciation for all the hard work the researchers, mission planners and everyone else has to go through to preserve such areas as the Channel Islands National Marine Sanctuary. I hope to be part of any upcoming expeditions and possibly work in this field in the future.

Shannon S. and Dorothy L.
Students-at-Sea, Oxnard High School

Today was awesome. Although we were saddened to learn that our SSE experiences are now coming to a close, we know our memories and visions of this project will never leave us. Thank you Julie Goodson, Dr. Sylvia Earle and everyone at SSE that made this possible!

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June 11, 2000
Circulation in the western Santa Barbara Channel

University of California at Santa Barbara Oceanographic Survey Group: Libe Washburn (principal investigator), Brian Emery, David Salazar, Edwin Beckenbach, and Thor Egland

Dr. Libe Washburn checks the instrument package between transects.

The primary objective of this SSE component is to investigate circulation processes in the western Santa Barbara Channel. Understanding this circulation is important because the life stages of many marine fish and invertebrate species found in the Channel spend from a few days to a few months in the plankton. While in the plankton these organisms are subject to transport and dispersal over long distances due to ocean currents. To complete their development into adults, they must return to suitable near shore habitats. We hope to identify circulation processes responsible for transport of juvenile fishes and other organisms to nearshore environments. Additionally we will look for features such as fronts and eddies which might retain planktonic organisms in the Channel.

Our experiment involves three interdisciplinary components:

1) **Observation of surface currents using high frequency radars.** We currently have an array of five high frequency radars producing hourly current maps out to 40 km offshore. The radars span the coast from Coal Oil Point near Santa Barbara to Pt. Sal. We are using these radars for identifying important transport and retention features.

Instrument package including the TOWYO fish

2) **Transects to map water masses and velocity structure.** From 9-11 June 2000 we have been conducting oceanographic surveys across sections of the Channel to determine water mass distributions and sub-surface current patterns. These transects have been conducted on the NOAA ship *McArthur* to depths of 200 m. Several important oceanographic variables are measured during the surveys including temperature, salinity, density, chlorophyll fluorescence and turbidity.

3) **Trawling surveys for juvenile fishes.** A colleague, Mary Nishimoto of the Marine Science Institute of UC Santa Barbara, is conducting surveys to determine abundance patterns of juvenile and late stage larvae of several fish species including rockfishes and hake. Much of this work will occur during or within a few days of our oceanographic sampling. During post-cruise analysis, we will merge the oceanographic and trawling survey data to explore the causes of the observed fish abundance patterns.

Leroy and Thor retrieve the instrument package

Our previous research has revealed that a counter clockwise eddy often occupies the western Channel. In June 1998 large concentrations of juvenile fishes were found in the eddy. Our current work with SSE should provide valuable insights into the role circulation patterns play in governing fish populations.

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SANCTUARY LOG

CHANNEL ISLANDS

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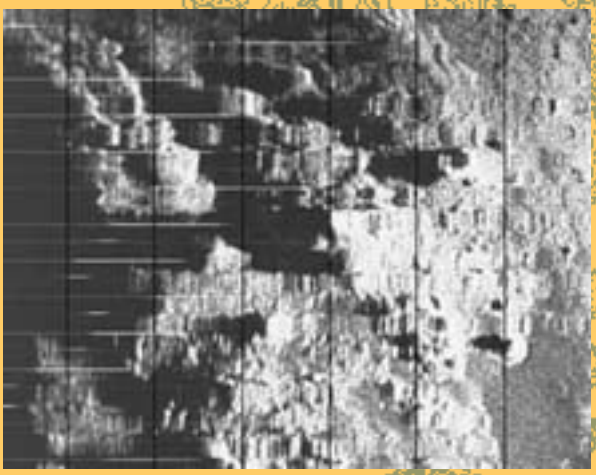
June 18, 2000
Mapping the Sanctuary Floor

Guy Cochrane
Research Geophysicist
U.S. Geological Survey

Guy Cochrane (far right) joins with crew and divers to go chart the next day's dives and review the transect locations.

At this time Fred Payne and I have collected sidescan data for 48 hours. We first collected a 35 square km grid of lines in the Northern Anacapa Gap. Data collected last year in the southern Anacapa Gap revealed spectacular rocky rills where erosion resistant layers of the Monterey formation stand above the sandy bottom and support a variety of benthic fauna. This area is known to be good rockfish habitat. The new data shows that the Northern Anacapa Passage has less of this rocky habitat. Next we shot a few lines in 100 m deep waters north of Anacapa Island to image a poorly understood geologic structure that may be a dive site in the future. We have also collected most of a 25 square km grid of lines on the south side of Santa Cruz



Island. This area is of interest to biologists studying the squid fishing industry, and is east of a grid we shot last year. There are a variety of rock types outcropping on the seafloor in this area. Some of the outcrops are clearly layered sedimentary rocks of the Monterey formation. Others, such as the ones shown in the section of sidescan image below, have an irregular outcrop

LOG

This side scan image from the south side of Santa Cruz Island will assist biologists in understanding benthic habitats and what kind of marine life they can support. Please note that the horizontal white streaks were caused by noise from a bad bearing on the ship's propeller shaft.

pattern that suggests they may be older vocanic rocks that underlie the Monterey formation elsewhere. Our next grid will probably fill a gap in coverage on the southeast side of the Island. It is possible that by the end of this cruise we will have over 75% of the southern Santa Cruz Island nearshore seafloor mapped.

For more information on side scan sonar technology, read the **background essay** written by Dr. Cochrane.

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June 24, 2000
Channel Islands National Marine Sanctuary Open House

by Shauna Bingham
Channel Islands National Marine Sanctuary
Outreach/Volunteer Coordinator

Children are the reason we have these events. Through our actions we can encourage them to become stewards of the earth's resources.

The Channel Islands National Marine Sanctuary Sustainable Seas Expeditions Open House was made possible through important partnerships in our community. Members of the Marine Educator's Regional Alliance (MERA) joined forces to provide an educational and fun-filled day for visitor's to Stearns Wharf. The mission of MERA is to act as a catalyst to focus attention on the extraordinary diversity of the transition zone between the southern and northern California coastal ecosystems.

Several MERA members were represented at the SSE Open House, including Ocean Futures, Santa Barbara Maritime Museum, RAIN Network, CONDOR Charters, US Forest Service, Cabrillo High School Aquarium, Sea Center, Santa Barbara Museum of Natural History, and the Chumash Maritime Association. Some of the activities included SCUBA diver presentations provided by Sea Center staff, a Remote Operated Vehicle (R.O.V.) demonstration, and a model of the Nuytco *DeepWorker* one person submersible. Members of the Chumash

The Chumash tomol *'Elye'Wun* approaches NOAA R/V MacArthur for a reunion visit

Maritime Association paddled the *'Elye'Wun* tomol, a traditional Chumash canoe, over to the *McArthur* to demonstrate their continued support for research necessary to understand and conserve the resources found within the sanctuary. During last years SSE open house the *'Elye'Wun* escorted the *DeepWorkers* into Santa Barbara Harbor.

The public also enjoyed free tours aboard the NOAA research vessel *McArthur*. Passengers were shuttled to the McArthur aboard Captain Don's motor vessel *Rachel G*. At 90 feet the *Rachel G* was dwarfed as it pulled alongside the 175-foot *McArthur*. Santa Barbara Maritime Museum volunteers assisted with the loading and unloading of 168 passengers throughout the day. During the tours the McArthur crew discussed the functions and capabilities of the ship. Sanctuary staff and researchers provided background information on expedition projects and *DeepWorker* submersible technology used to understand the complex marine environment found in the Channel Islands National Marine Sanctuary.

Sanctuary Manager Matt Pickett and CINMS Education Coordinator Julie Goodson with our Environmental Heroes and their families.

Following the ship tours, the crew and scientists, including Dr. Sylvia Earle, joined together for an expedition wrap-up and an award ceremony for two important young women. The Channel Islands National Marine Sanctuary nominated Allison Barkyoumb and Kayla Gennrich for NOAA's Environmental Hero Award this year, a very special award given to individuals who have helped the sanctuary program achieve its environmental stewardship mission. Allison and Kayla, both currently in 7th grade, have been corresponding regularly with the Channel Islands National Marine Sanctuary since October 1998. They are both budding marine biologists and conservationists interested in lending their support to save the whales. Allison and Kayla are active fundraisers in their hometown of Milton, Vermont, raising money for their cause to save the whales. On Earth Day 2000 they received the Environmental Hero Award, along with a letter from Vice President Al Gore. They made a special trip to California for the Sustainable Seas Expeditions Open House to receive an official plaque from LCDR Matt Pickett, Channel Islands National Marine Sanctuary manager.

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Dr. Sylvia Earle with CINMS staff and interns, LCD Wade Blake, and the CINMS Environmental Heroes.

In addition to the presentation of these very special awards, we learned from Dr. Earle how the *DeepWorker* submersible has helped Guy Cochrane, US Geological Survey scientist, ground truth side scan sonar data collected on a variety of habitat found within the sanctuary. We also heard from LCDR Wade Blake, current *McArthur* Commanding Officer, on his experiences during the expedition. Ed Cassano, Director of the Santa Barbara Maritime Museum, and Eric Solomon, Sea Center Manager, provided inspirational commentary emphasizing the importance of fostering stewardship and partnerships in order to continue education and exploration in the Channel Islands National Marine Sanctuary.

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July 14, 2000
"Magnificent" Rockfish

by Donna Schroeder, Biologist
Marine Science Institute at the University of California, Santa Barbara

Donna Schroeder

Rockfish belong to the Genus *Sebastes*, which means "magnificent" in Greek. I think there is no better title for this collection of fishes. Their magnificence lies in their extraordinary species diversity and number of habitats in which they reside. Worldwide, over 100 species of rockfish have been described, and about 70 of these have been recorded along our Pacific coast. Because rockfish look morphologically similar to each other, common names are often based on the variety of color patterns they sport. Vermilion, blue, black, olive, rosy, canary, black-and yellow, and greenspotted rockfish are just a few species that live in the Channel Islands National Marine Sanctuary. Rockfish are found virtually everywhere.

They inhabit all rocky habitats from the intertidal to depths of a couple thousand feet. Some species occupy midwater habitats, while other species hunker down over sand and mud bottoms. Another remarkable fact that makes rockfish so interesting is that many species live a very long time, some to over 140 years.

For the last twelve years my research has focused on reef fishes in general, and rockfishes in particular. Along with Milton Love and Mary

The rare cowcod rockfish was observed in its rocky habitat during Donna's dive. Cowcod rockfishes are estimated to be at population levels between 2 to 7% of their biomass in the 1970s. The spotting of juveniles was significant, and could aid in determining essential fish habitat. (Photo courtesy of Donna Schroeder)

Nishimoto, my colleagues at the Marine Science Institute at the University of California, Santa Barbara, I seek to relate patterns and changes in the environment to patterns and changes in fish populations. Intense fishing pressure combined with unfavorable climate conditions have caused drastic declines in large-bodied rockfish populations over the last two decades. The decline is such that two species, the bocaccio and cowcod rockfishes, are estimated to be at population levels between 2 to 7% of their biomass in the 1970s. To determine how to best conserve and enhance these populations, we need to first determine where the remaining bocaccio and cowcod are, and then estimate how many are left. Since both species live in deep water as adults, we use submersibles to perform our population surveys.

On the fantail of the *McArthur*, we approach launching time. The bustling activity of pre-dive submersible checks concludes with *Deepworker's* acrylic dome closing over me and engaging the hatch locks. Outside voices and other noises now fall silent and only the soft whir of the CO2 scrubber fan remains.

The ray swims past Donna as she slides across the bottom. (Photo courtesy of Donna Schroeder)

The free fall descent to the seafloor is perhaps my favorite part of the dive experience. I look upwards through the dome to watch the water display ever deepening shades of blue-green and I wonder, how many shades of blue does the sea possess? As the ambient light diminishes, the air temperature inside the sub grows cooler to match that of the surrounding water. Long chains of gelatinous salps and jellyfish perform a bioluminescent ballet as I fall through the water column. I find myself breathing quietly, transfixed by the spectacle. After about eight minutes, I set *Deepworker 7* on the seafloor at a depth of 465 feet. I glance around and make notes of the habitat: a cobble bottom densely populated by feather stars, or crinoids.

These are strange, ancient creatures, the crinoids. At this particular site, most individuals are gripping onto the hard substrate with

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A crinoid flutters its way through the water column to a new perch. (Photo courtesy of Donna Schroeder)

their claw-like appendages and extending their arms to collect current-borne bits of food. Other crinoids have decided to take to the water column and swim in a most comical manner towards some new perching point. Small rockfish, startled by the submersible lights, take refuge among the modest crevices provided by the cobbles. After checking my life support readings and adjusting the video camera system, I contact the surface to get the right compass bearing so that I can begin my transect line. Topside relays back the call: 120 degrees.

Transects are a standard sampling method used by marine biologists to document the natural pattern of sealife. Along this particular transect, I observe a transition in common invertebrates from crinoids to basket stars to sponges, even though my transect depth does not vary that much. Small-bodied fishes, such as pinkrose, swordspine and squarespot rockfish, numerically dominate the fish assemblage. However, I do see a number of cowcod juveniles.

This is an important finding, as we have not had previous opportunities to identify juvenile cowcod habitat within the sanctuary. This simple yet significant discovery will aid us in identifying the essential fish habitat of this rare rockfish species, and perhaps assist us in designating appropriate locations for marine protected areas.

Despite her depth remaining constant along her dive transect, Donna observed a transition in common invertebrates from crinoids to basket stars to sponges. A basket star is pictured. (Photo courtesy of Donna Schroeder)

I continue my dive, documenting the diversity and abundance of deep reef creatures for another three hours, and then ascend to the surface. The fish population survey is another success, and was

made possible by the efforts of many people, including my fellow pilots Sarah Fangman and Guy Cochrane, the folks working at the sanctuary, the professional crew of the *McArthur*, the National Geographic Society, and the fabulous technicians from Nuytco, who keep the *Deepworker* submersibles diving safely.

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SUSTAINABLE SEAS EXPEDITIONS
SANCTUARY LOG

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Photo Log

Assembled by Kathryn Hintergardt, WebMaster
Channel Islands National Marine Sanctuary

Hundreds of photos were taken during the Channel Islands National Marine Sanctuary Sustainable Seas Expedition. This collection contains some of the best, and represents a visual log of the entire mission. Click on the category of your choice to share their experience. Unless credited otherwise, photos were taken by CINMS staff.

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Photo Log: Research

Dr.Libe Washburn preparing the TOWYO, which is towed through the water column as the McARTHUR crosses the Santa Barbara Channel.

Launching the TOWYO

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June 7 SSE Teacher Perspective

June 8 Student & Diver Perspective

June 8 Perspective from Land

June 10 Student-At-Sea Day

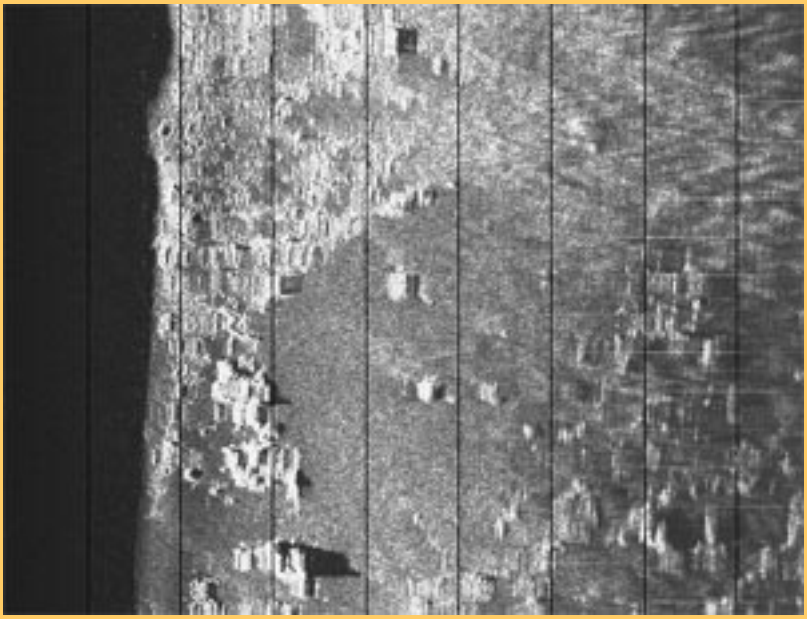
June 11 Investigating Circulation

June 18 Mapping the Sanctuary Floor

June 24 Sanctuary

Preparing to lauch the sidescan sonar fish, which sends sound to the bottom to determine bottom type.

Lacey looks on as Fred mans the computers that collect the sidescan data.



Some of the sidescan sonar data collected.

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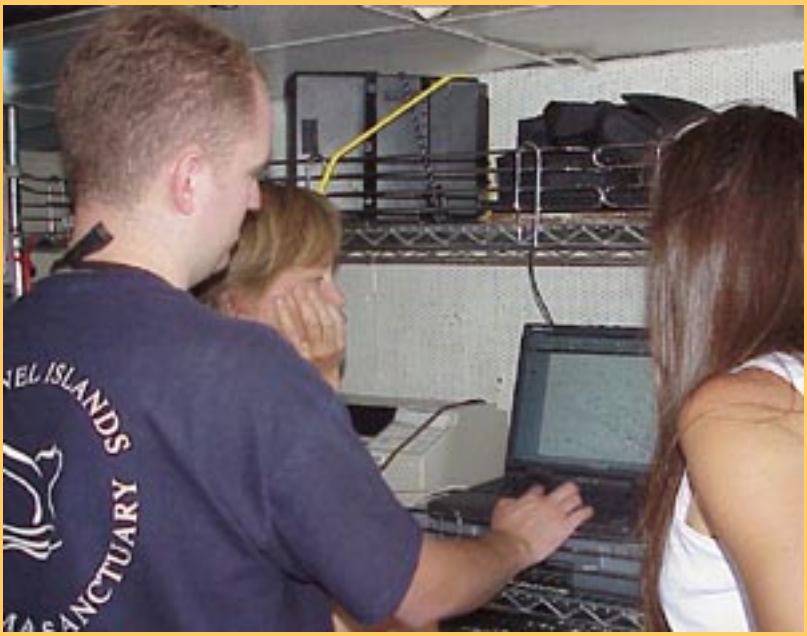
Dr. Guy Cochrane descending to groundtruth (verify) the sidescan data that he collected nightly.

Watching the video from Guy's dive!

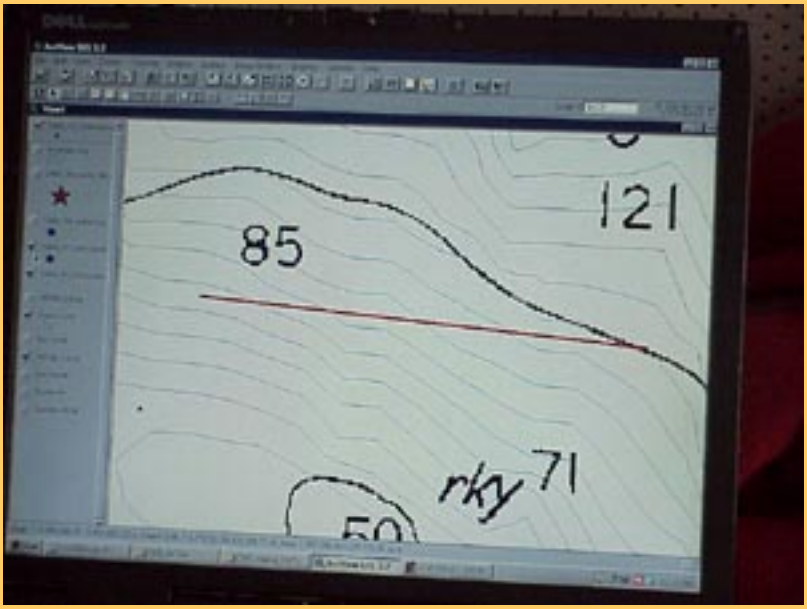
Donna Schroeder being launched for a dive in search of rockfish (Kip Evans)

A rare rockfish captured by Donna's quick eyes! (Donna Schroeder)

The most amazing of creatures... a swimming crinoid observed during one of Donna's dives (Donna Schroeder)



Craig Russell, Sarah Fangman and Donna Schroeder choose the transects that Sarah will follow for her dive



Prior to their dives, the pilots planned tracks were plotted on charts to assist the pilots in navigation once underwater.

Sarah about to descend was greeted by friendly sea lions!

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June 17 - July 18, 2000
Dive Maps & Videos

Maps: GIS specialists from NOAA's National Ocean Service tracked and mapped the *DeepWorker* submersible during the the SSE mission to the Channel Islands sanctuary. Using a combination of GIS and sonar technologies, they produced this series of dive maps. The maps depict the underwater track of each *DeepWorker* dive, and include depth readings, life-support readings and pilots' comments. Together, they represent a critical component of the underwater log of the expedition.

Videos: SSE participants from the Channel Islands sanctuary viewed hours of underwater video footage captured during the expedition. They selected seven 30-second clips that capture the highlights of what *DeepWorker* pilots witnessed during their dives. Click on the video of your choice to dive beneath the surface. **Requires QuickTime**.

During the Channel Islands mission, from June 17 to July 18, 2000, pilots completed Dives 1 to 11, and Dives 31 to 39. The yellow dots on the reference map below approximate where these dives occurred in the sanctuary. The sanctuary boundary is outlined in red. **Click on any dive number or individual map to view a large-scale version of that specific dive.**

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June 7 SSE Teacher Perspective

June 8 Student & Diver Perspective

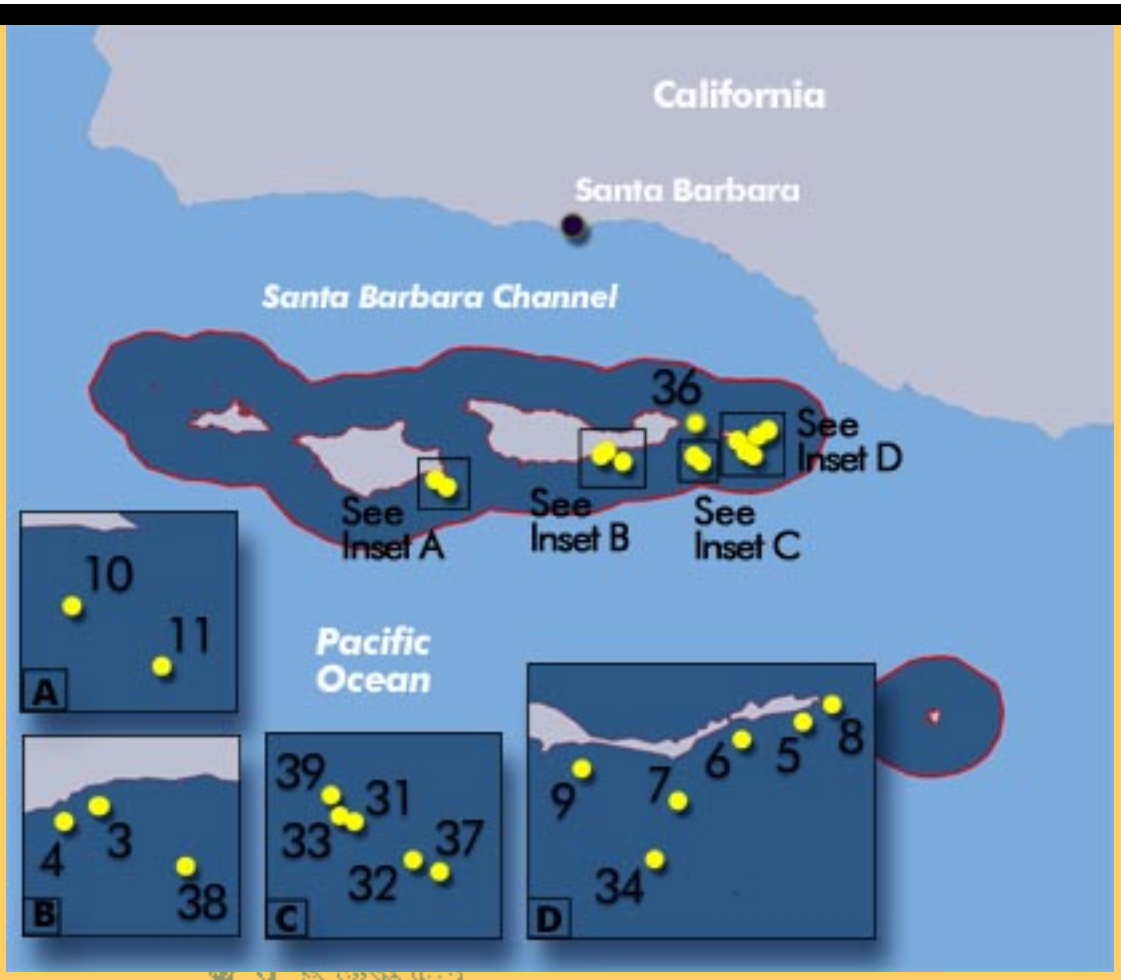
June 8 Perspective from Land

June 10 Student-At-Sea Day

June 11 Investigating Circulation

June 18 Mapping the Sanctuary Floor

June 24 Sanctuary



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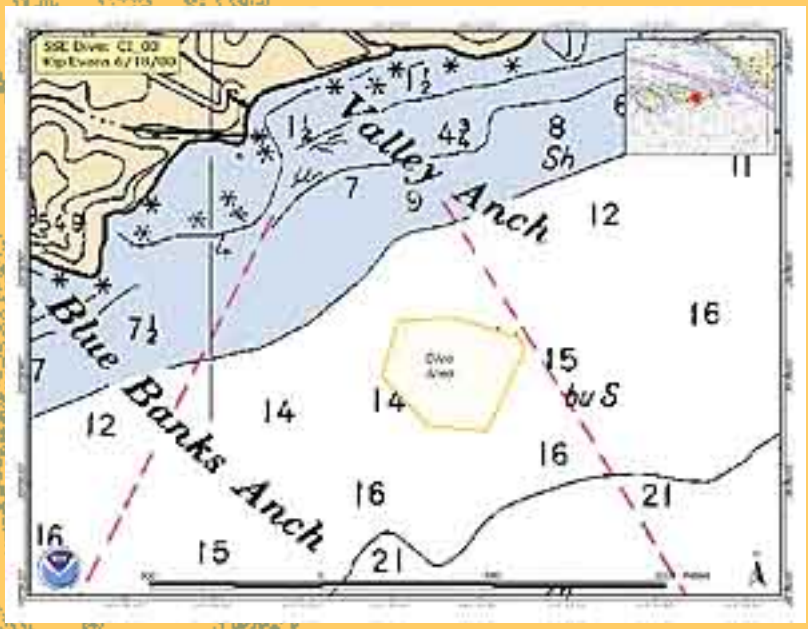
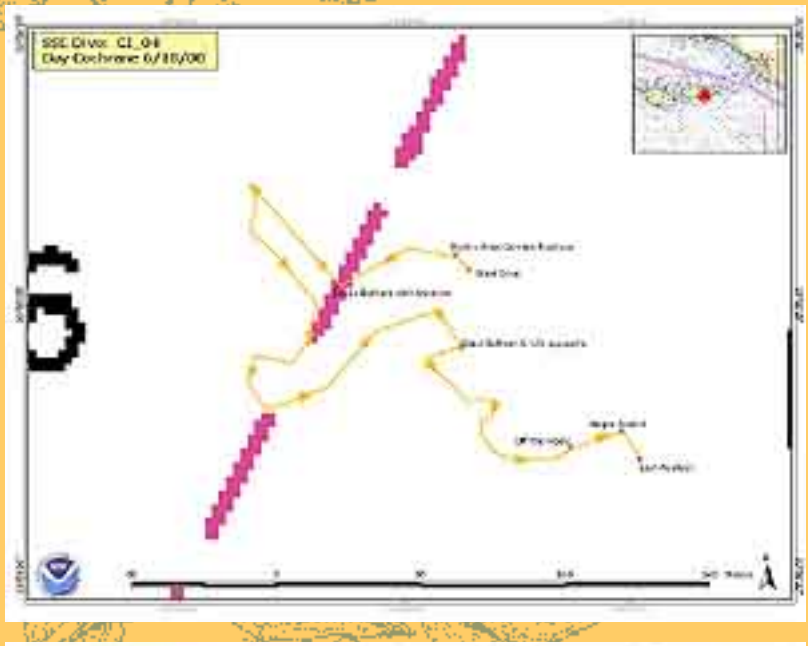
Dives 1-2
June 17, 2000,
Pier-side,
Santa Barbara

No maps made, check-out dives

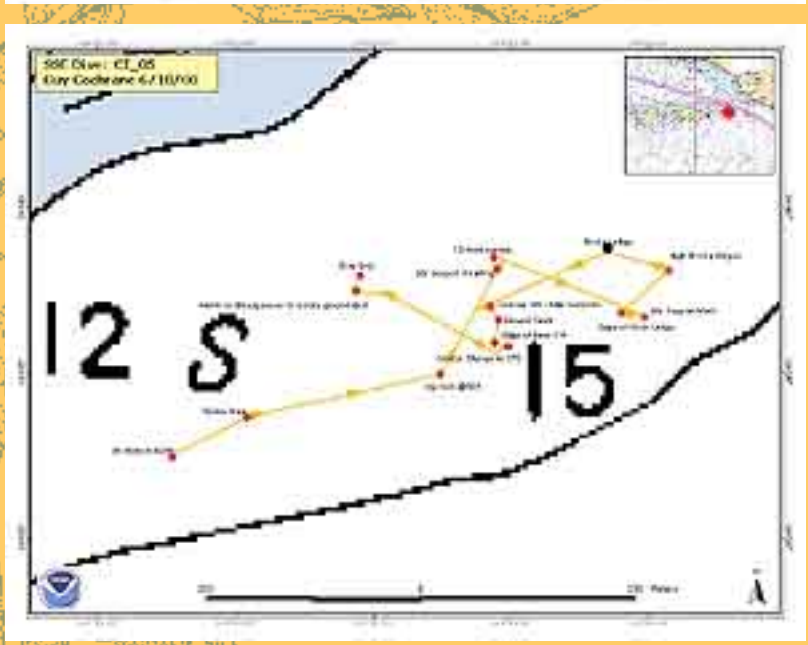
Dive 3
June 18, 2000
South of Santa Cruz Island



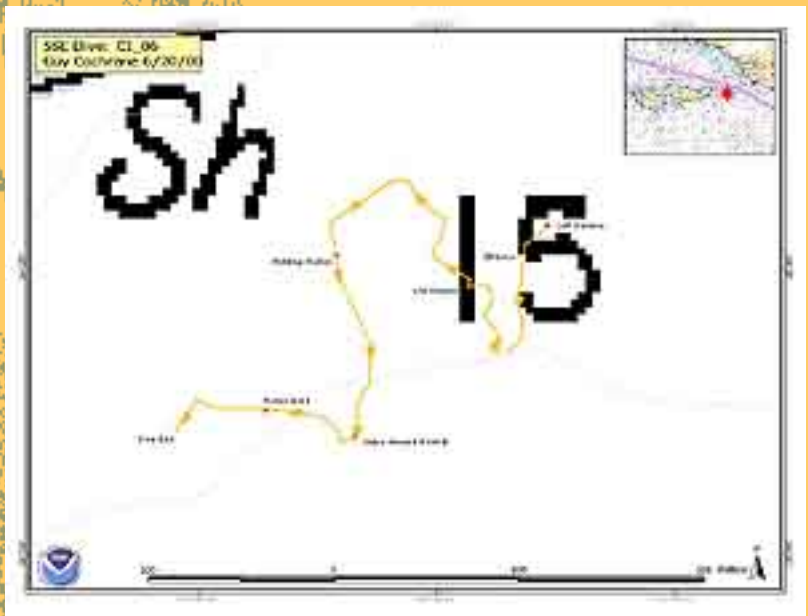
Dive 4
June 18, 2000
South of Santa Cruz Island



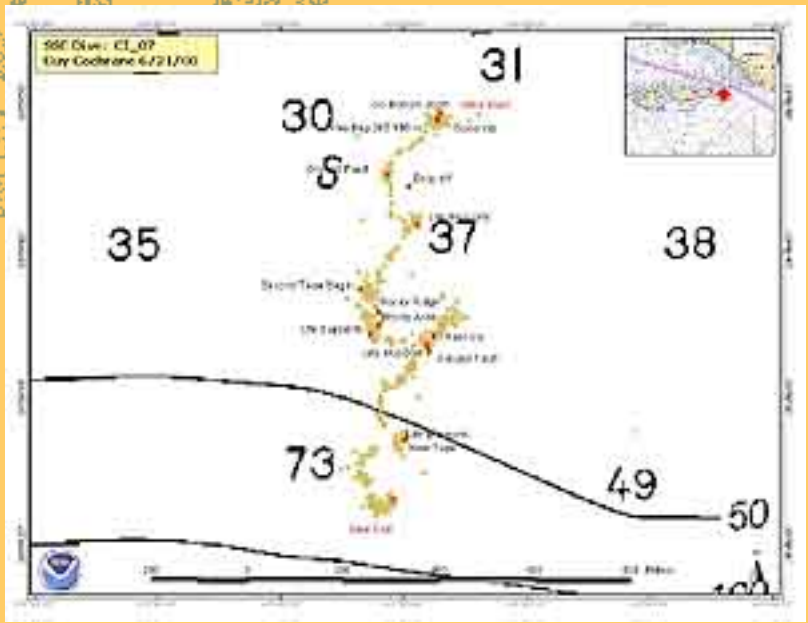
Dive 5
June 19, 2000
South of Anacapa Island



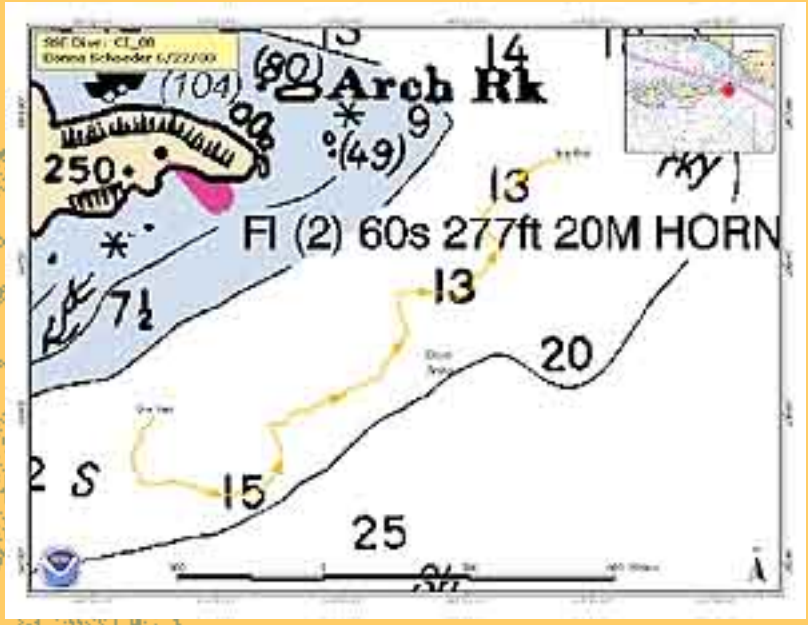
Dive 6
June 20, 2000
South of Anacapa Island



Dive 7
June 21, 2000
South of
Anacapa
Island



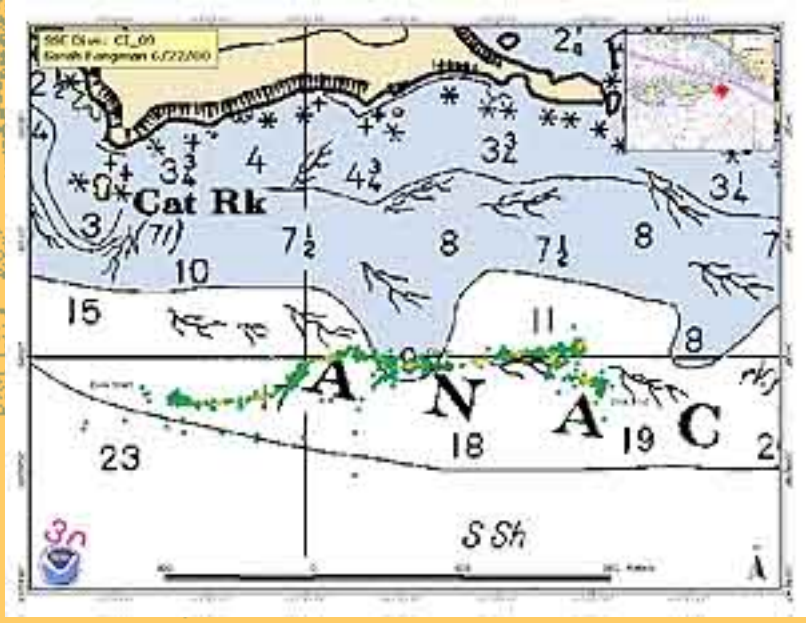
Dive 8
June 22, 2000
South of
Anacapa
Island



[View Dive Video](#)
(3.2 MB,
QuickTime)

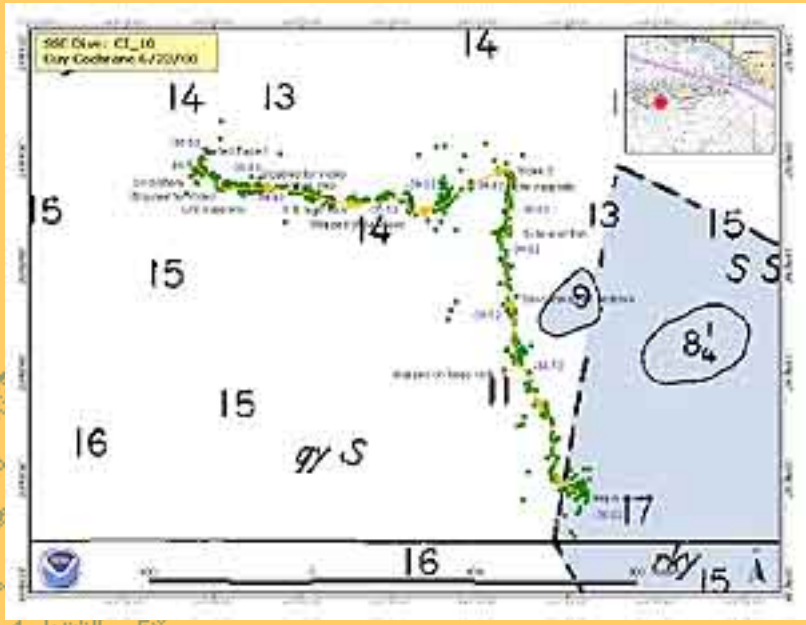
Dive 9
June 22, 2000
South of
Anacapa
Island

[View Dive Video] (3.7 MB, QuickTime)

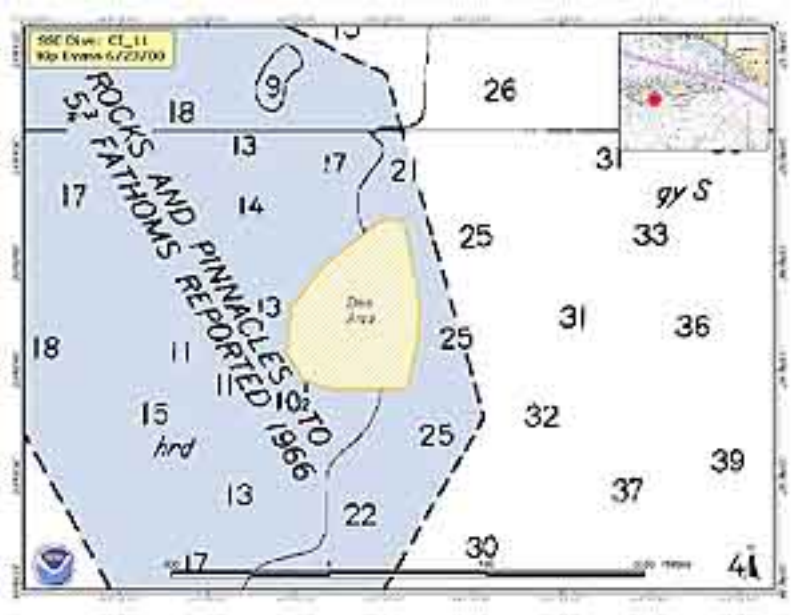


Dive 10
June 23, 2000
South of Santa Rosa Island

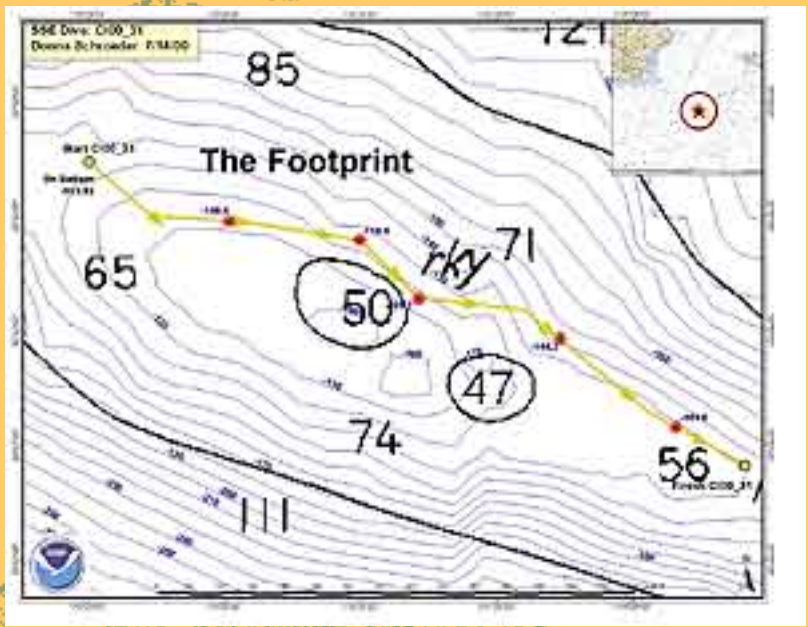
[View Dive Video] (2.9 MB, QuickTime)



Dive 11
June 23, 2000
South of Santa Rosa Island

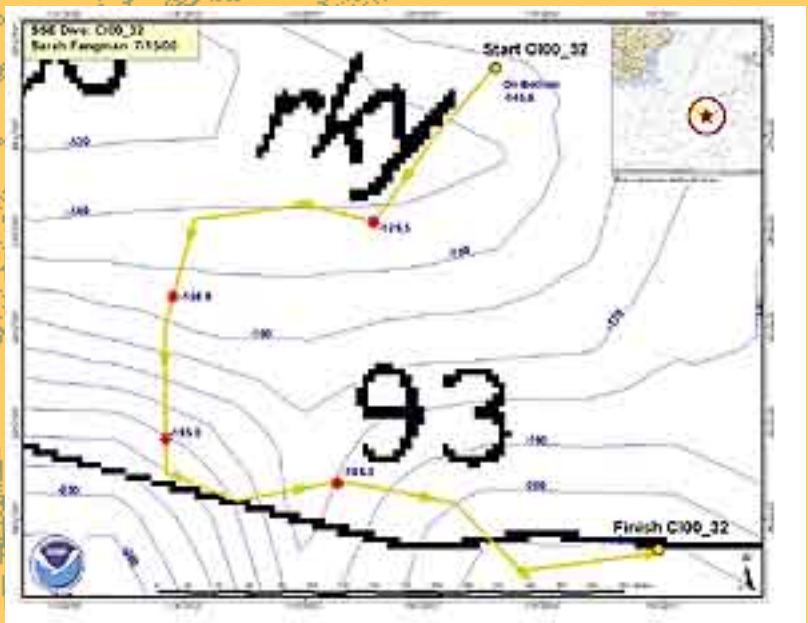


Dive 31
July 14, 2000
"The Footprint"



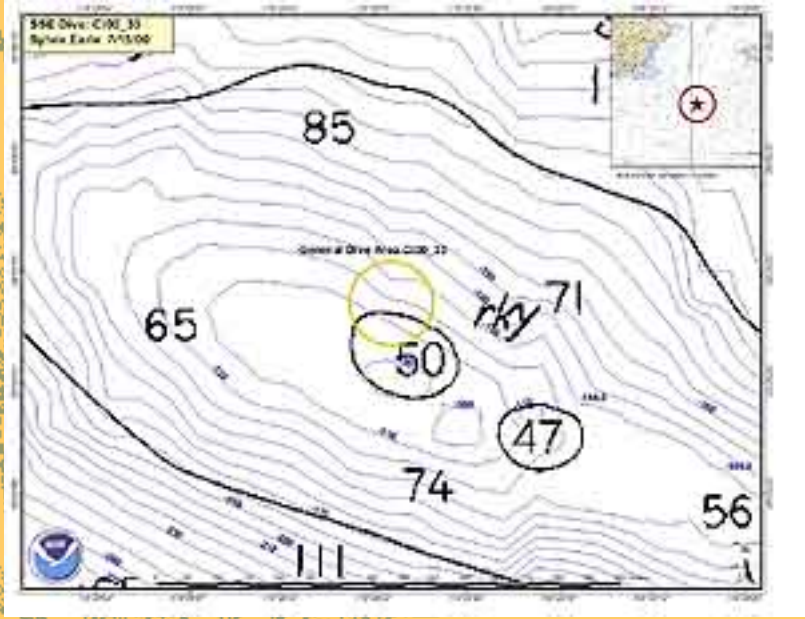
View Dive Video
(2.8 MB, QuickTime)

Dive 32
July 15, 2000
"The Footprint"

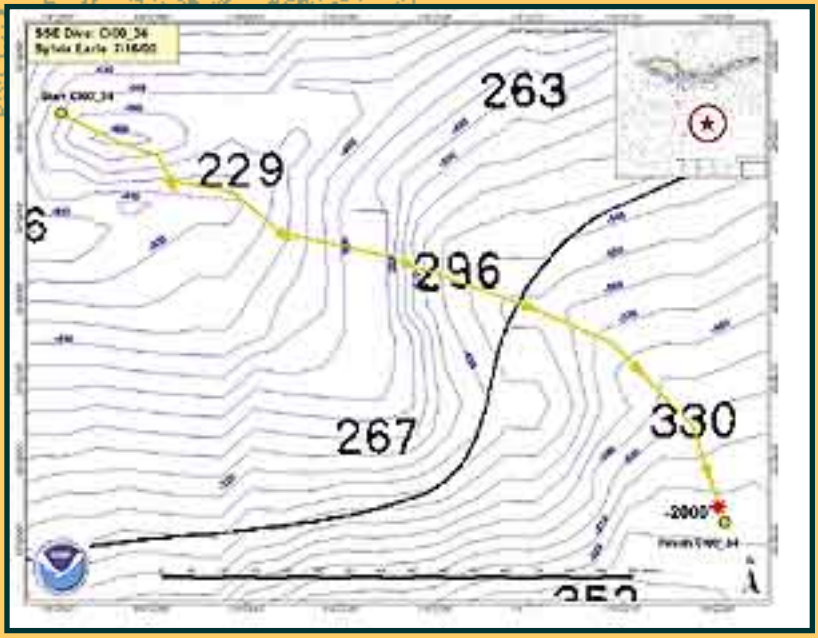


View Dive Video
(2.9 MB, QuickTime)

Dive 33
July 15, 2000
"The Footprint"



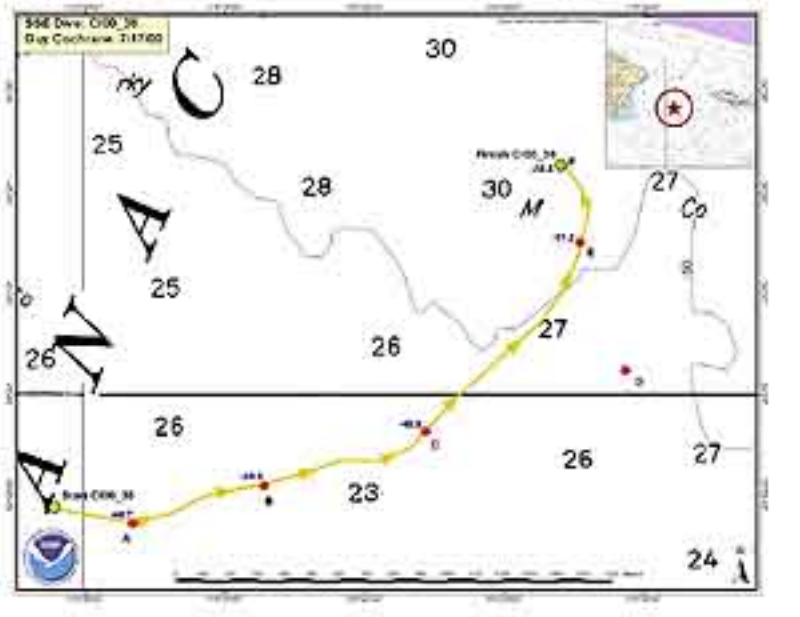
Dive 34
July 16, 2000
South of
Anacapa
Island



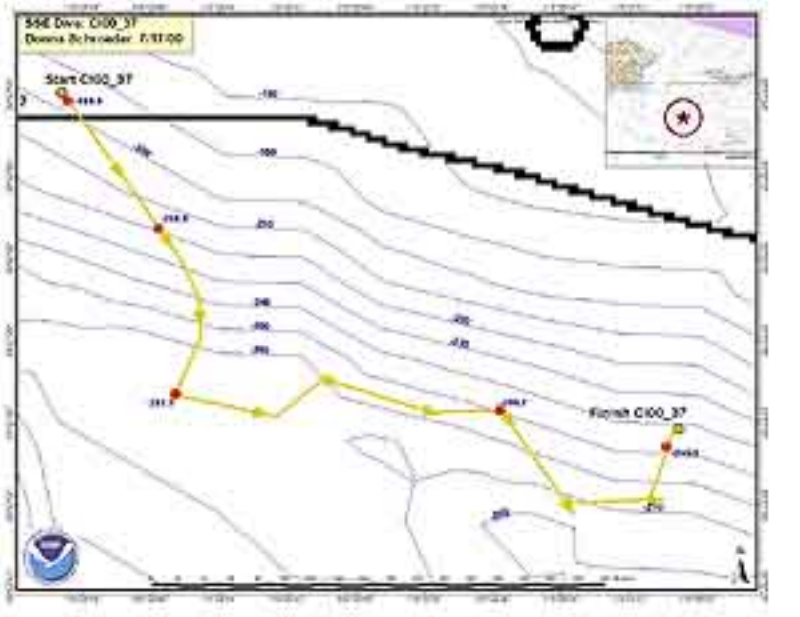
Dive 35
July 16, 2000
South of
Anacapa
Island

No map, dive aborted

Dive 36
July 17, 2000
Anacapa
Island passage

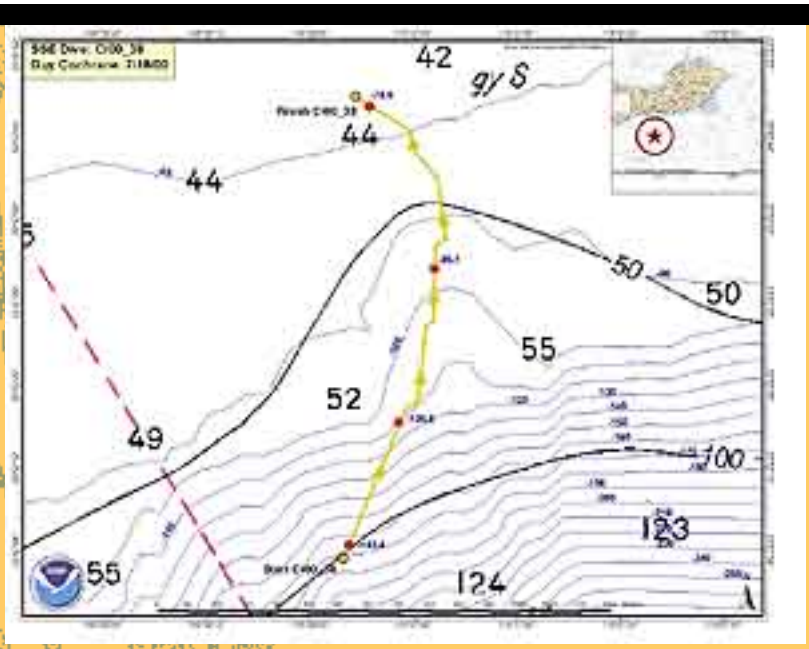


Dive 37
July 17, 2000
"The Footprint"



Dive 38
July 18, 2000
South of Santa
Cruz Island

View Dive Video
(1.9 MB,
QuickTime)



Dive 39
July 18, 2000
"The Footprint"

[View Dive Video](#) (11.4 MB, QuickTime)

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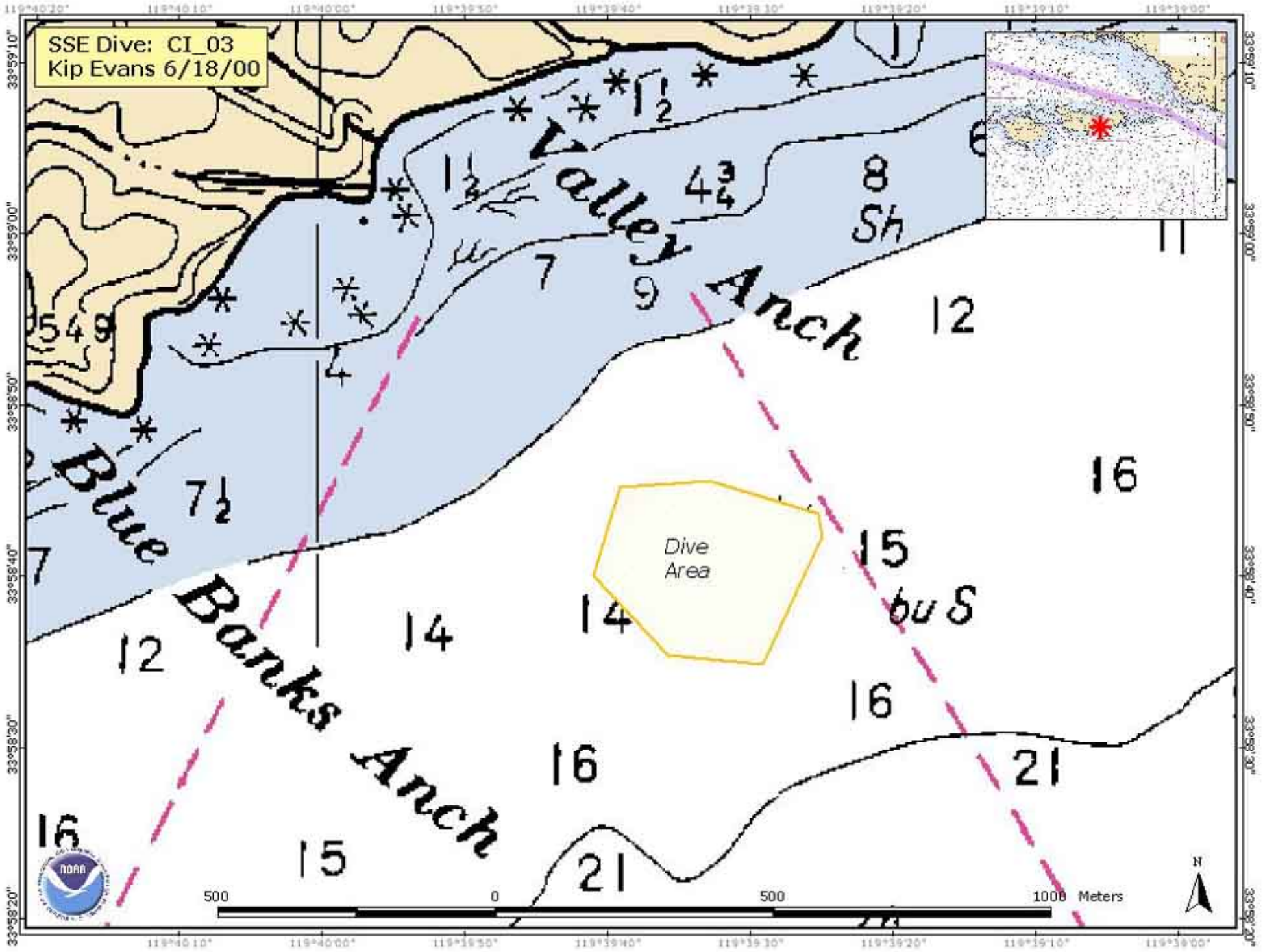
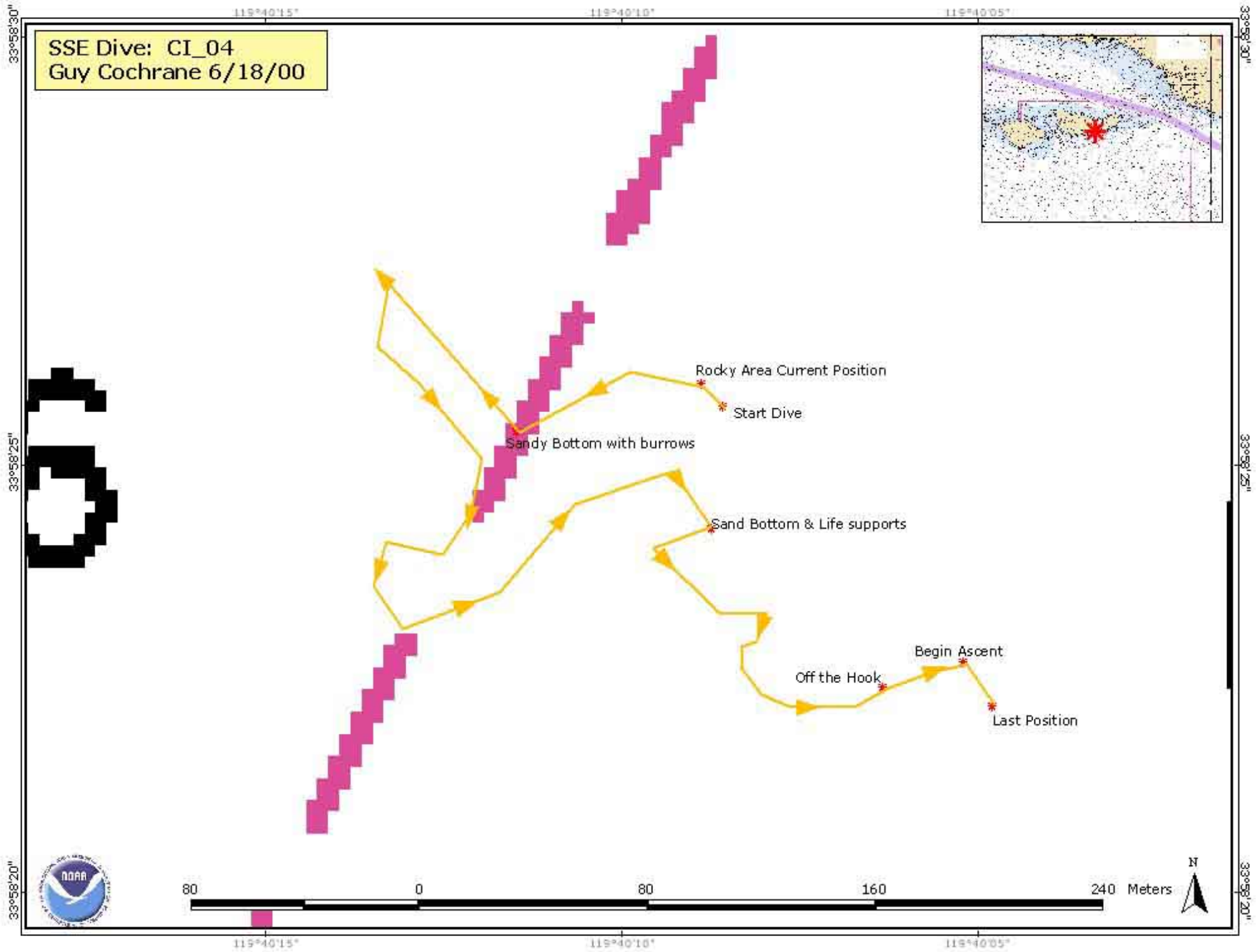
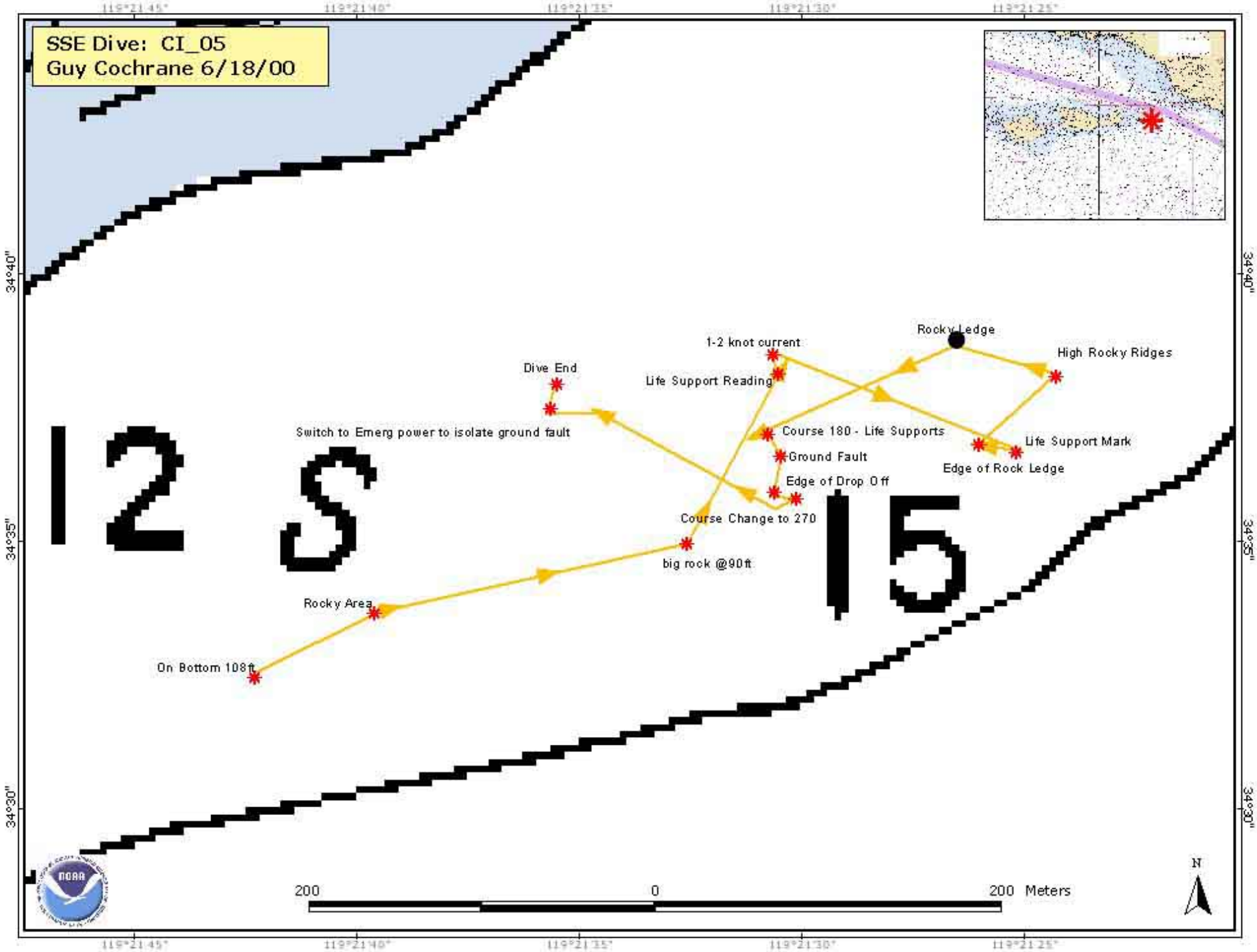
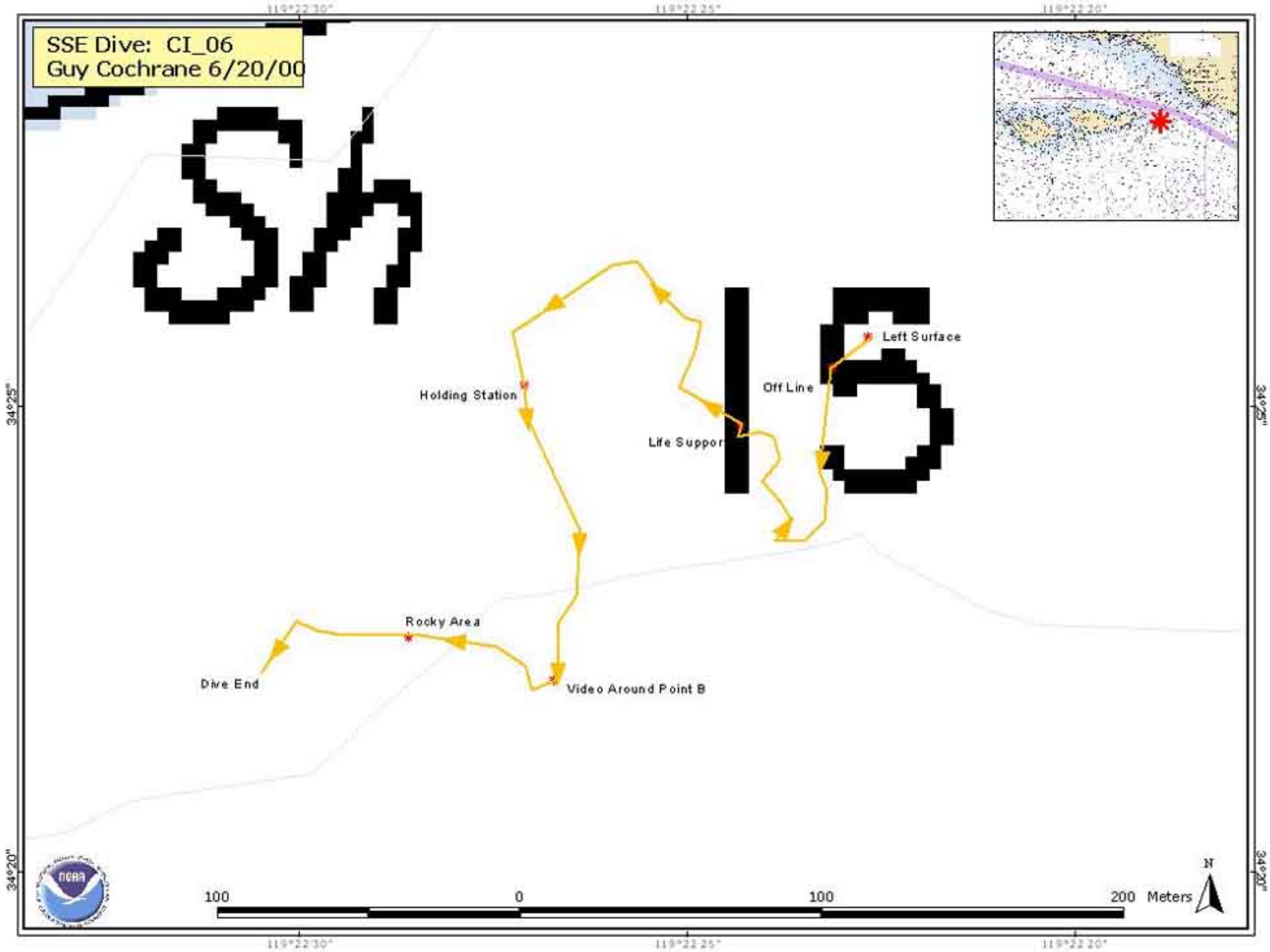
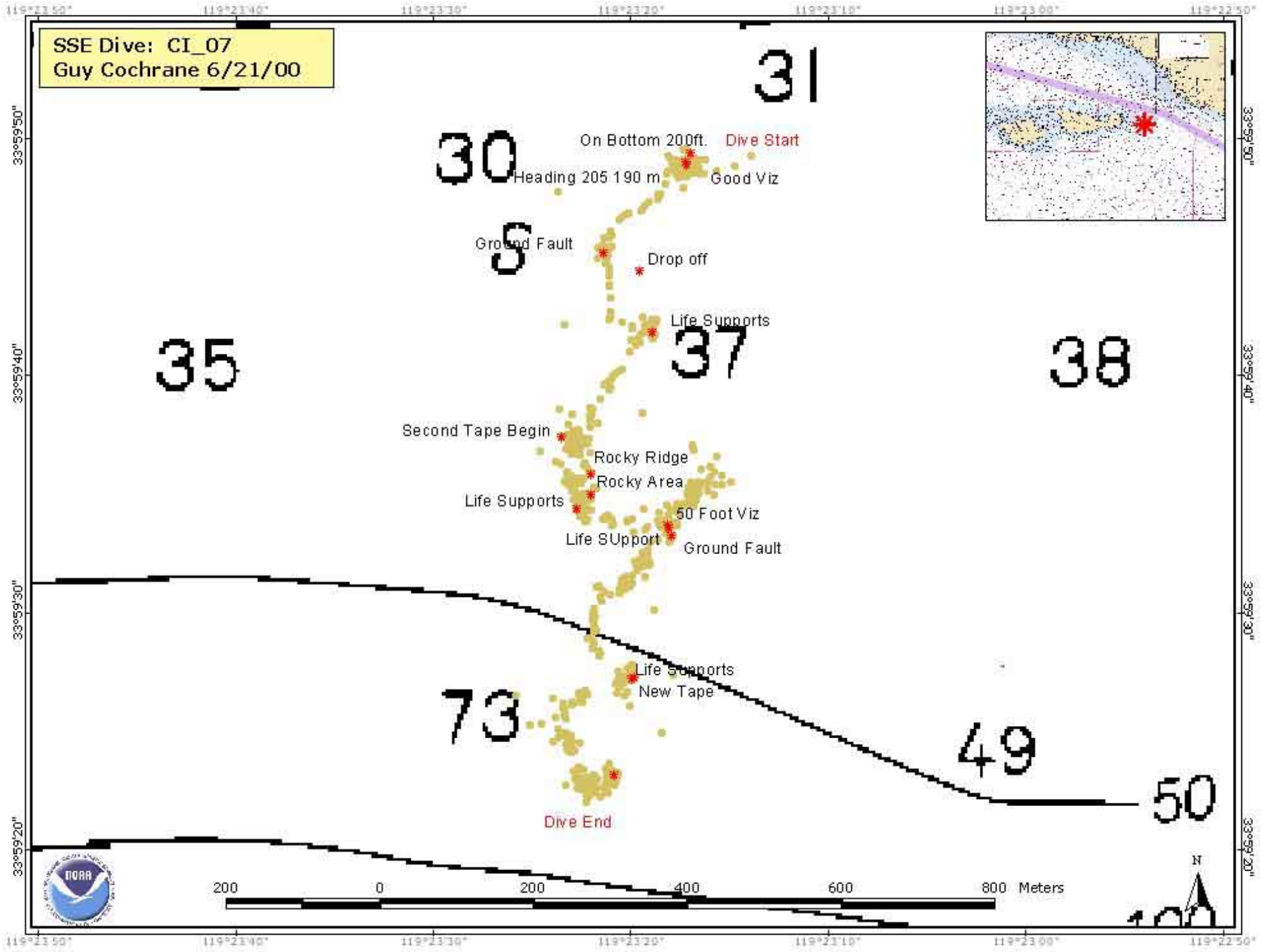
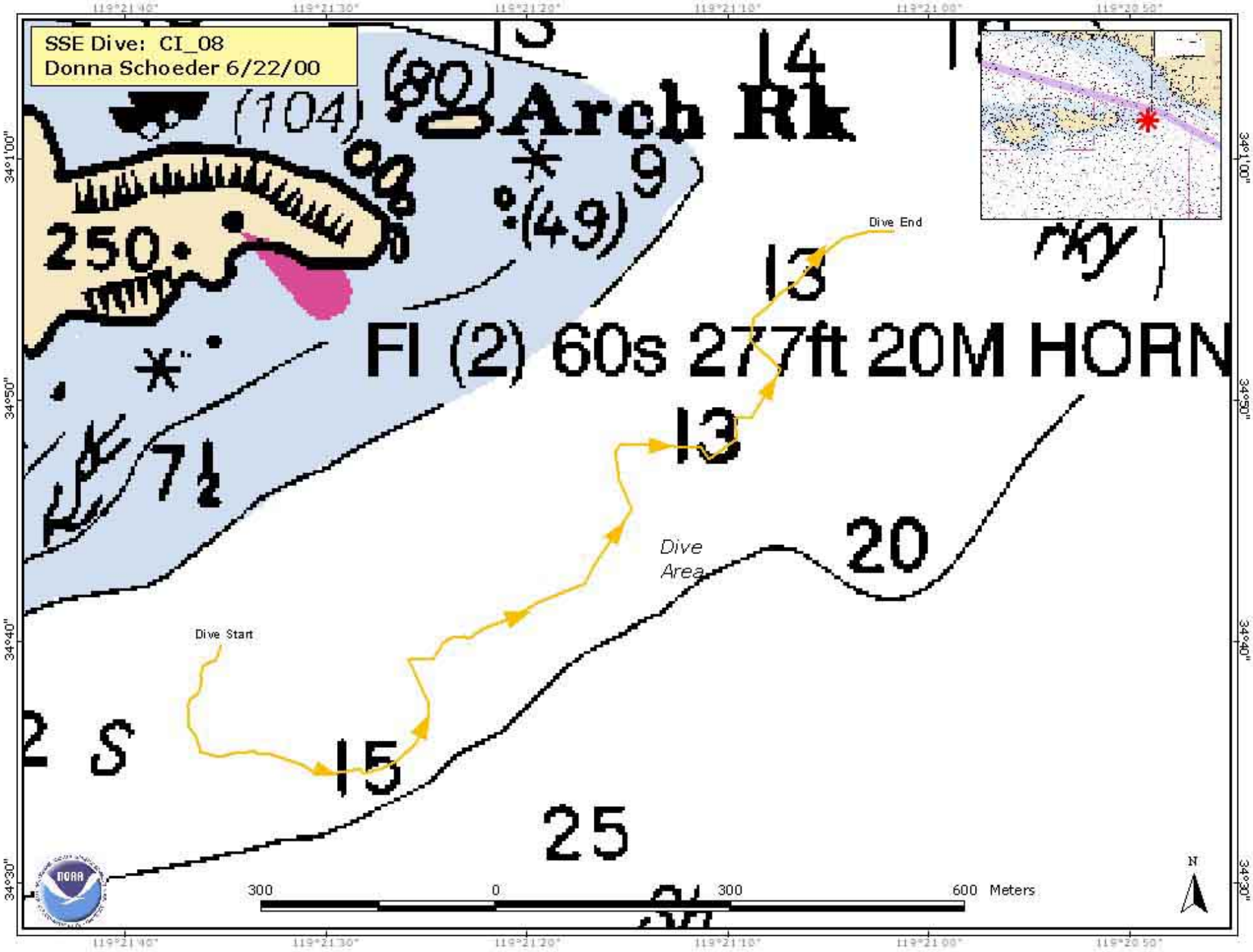

SSE Dive: CI_03
Kip Evans 6/18/00
Valley Anch
Blue Banks Anch
Dive Area
500
0
500
1000 Meters
N

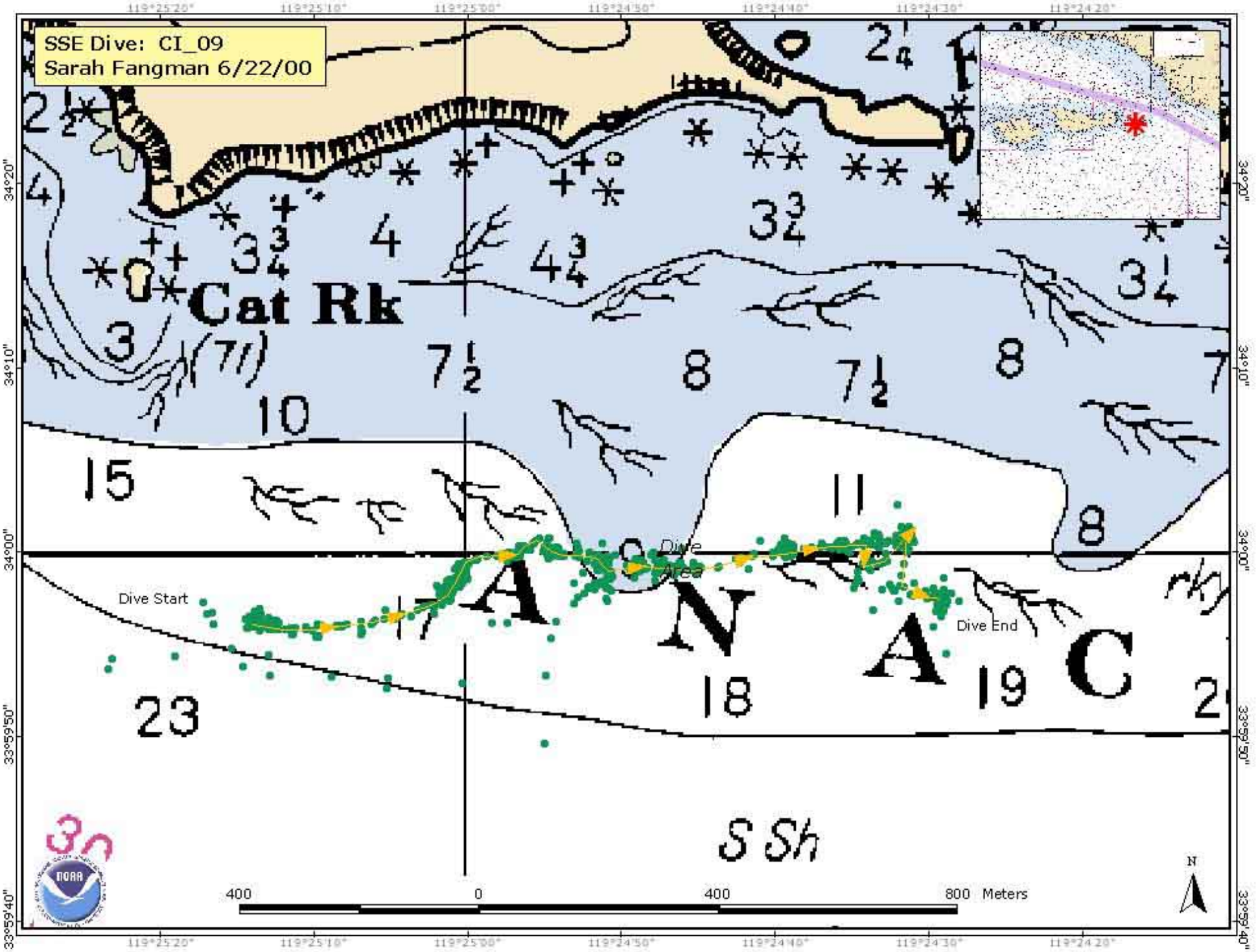

SSE Dive: CI_04
Guy Cochrane 6/18/00
119°40'15"
119°40'10"
119°40'05"
33°58'30"
33°58'25"
33°58'20"
Rocky Area Current Position
Start Dive
Sandy Bottom with burrows
Sand Bottom & Life supports
Begin Ascent
Off the Hook
Last Position
80
0
80
160
240
Meters
N

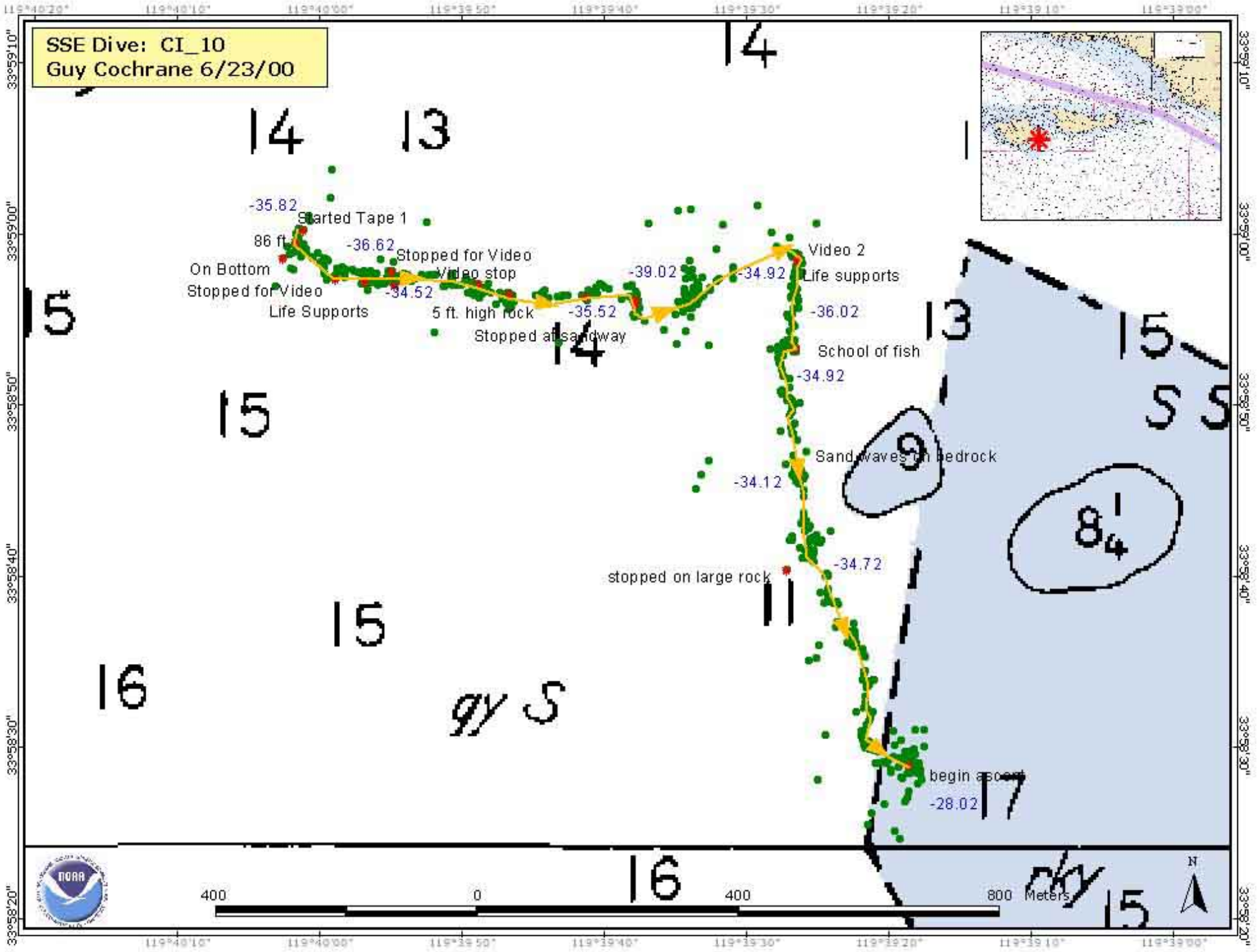

SSE Dive: CI_05
Guy Cochrane 6/18/00
119°21'45"
119°21'40"
119°21'35"
119°21'30"
119°21'25"
34°40"
34°35"
34°30"
Rocky Ledge
1-2 knot current
High Rocky Ridges
Dive End
Life Support Reading
Switch to Emerg power to isolate ground fault
Course 180 - Life Supports
Life Support Mark
Ground Fault
Edge of Rock Ledge
Edge of Drop Off
Course Change to 270
big rock @90ft
Rocky Area
On Bottom 108ft
12S
15
200
0
200 Meters
N

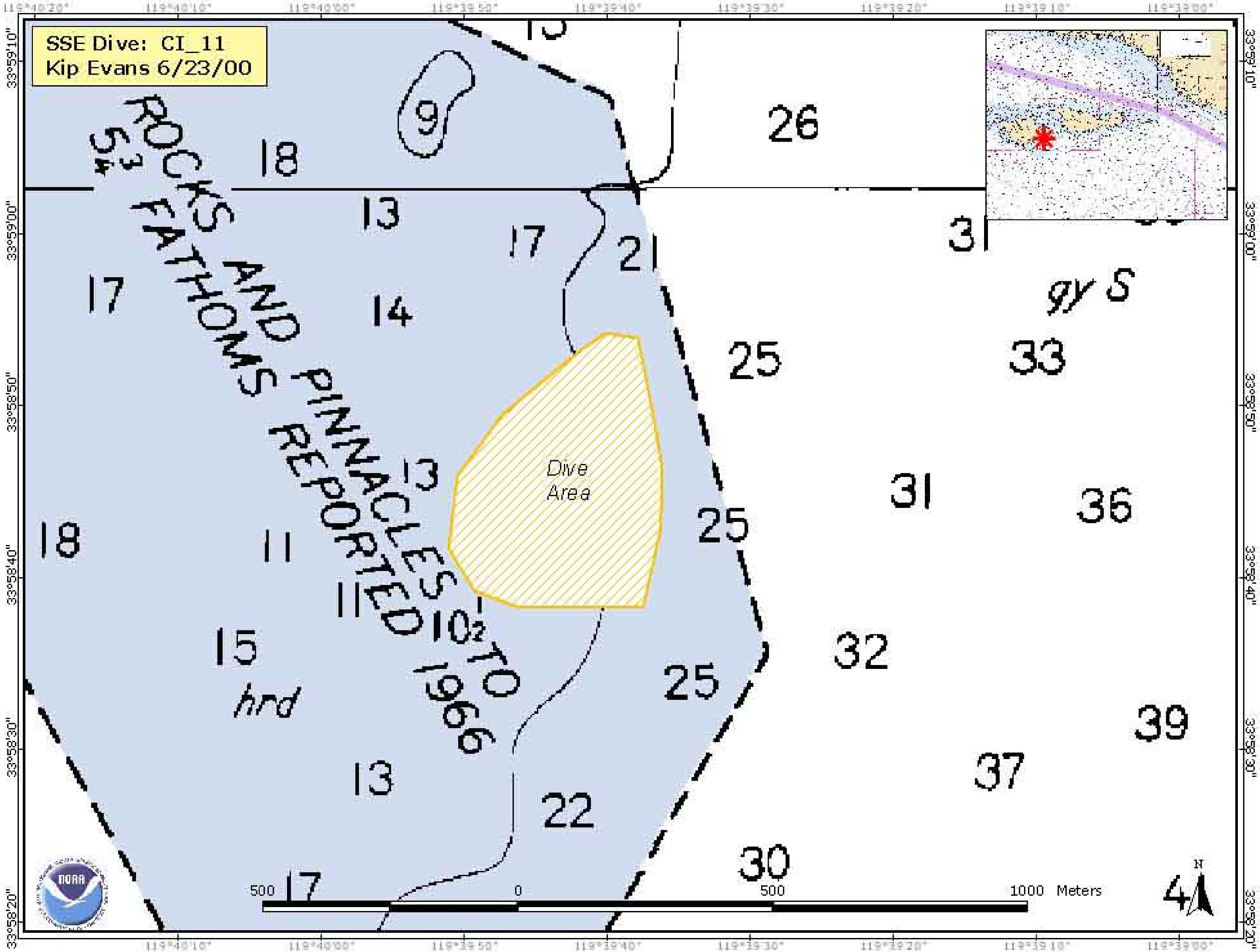

SSE Dive: CI_06
Guy Cochrane 6/20/00
Left Surface
Off Line
Holding Station
Life Support
Rocky Area
Dive End
Video Around Point B
119°22'30"
119°22'25"
119°22'20"
34°25"
34°20"
100
0
100
200 Meters
N

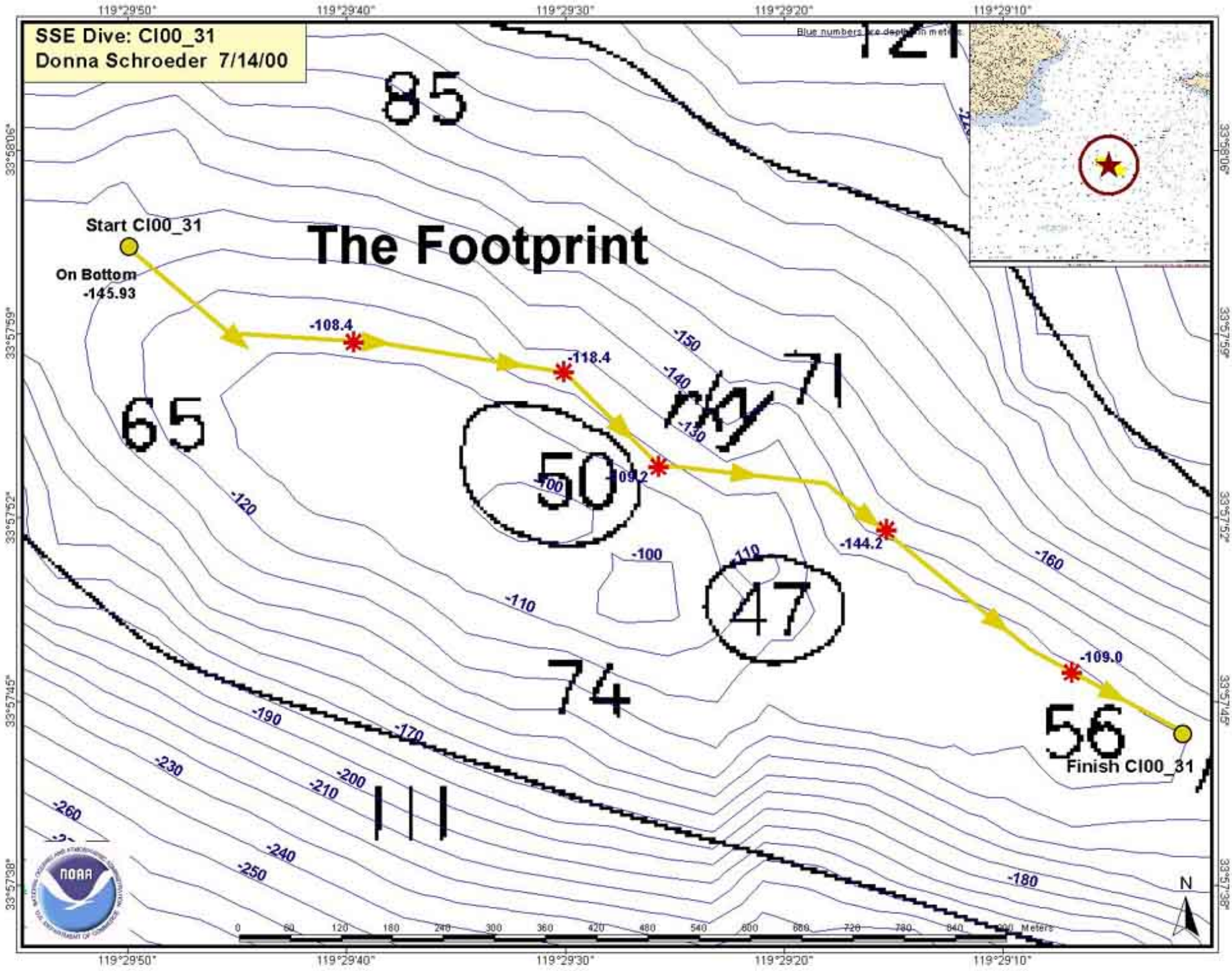

SSE Dive: CI_07
Guy Cochrane 6/21/00
31
30
On Bottom 200ft.
Dive Start
Heading 205 190 m
Good Viz
Ground Fault
Drop off
Life Supports
35
37
38
Second Tape Begin
Rocky Ridge
Rocky Area
Life Supports
50 Foot Viz
Life SUpport
Ground Fault
Life Supports
New Tape
73
49
50
Dive End
200 0 200 400 600 800 Meters
N
33°59'50"
33°59'40"
33°59'30"
33°59'20"
119°23'50"
119°23'40"
119°23'30"
119°23'20"
119°23'10"
119°23'00"
119°22'50"

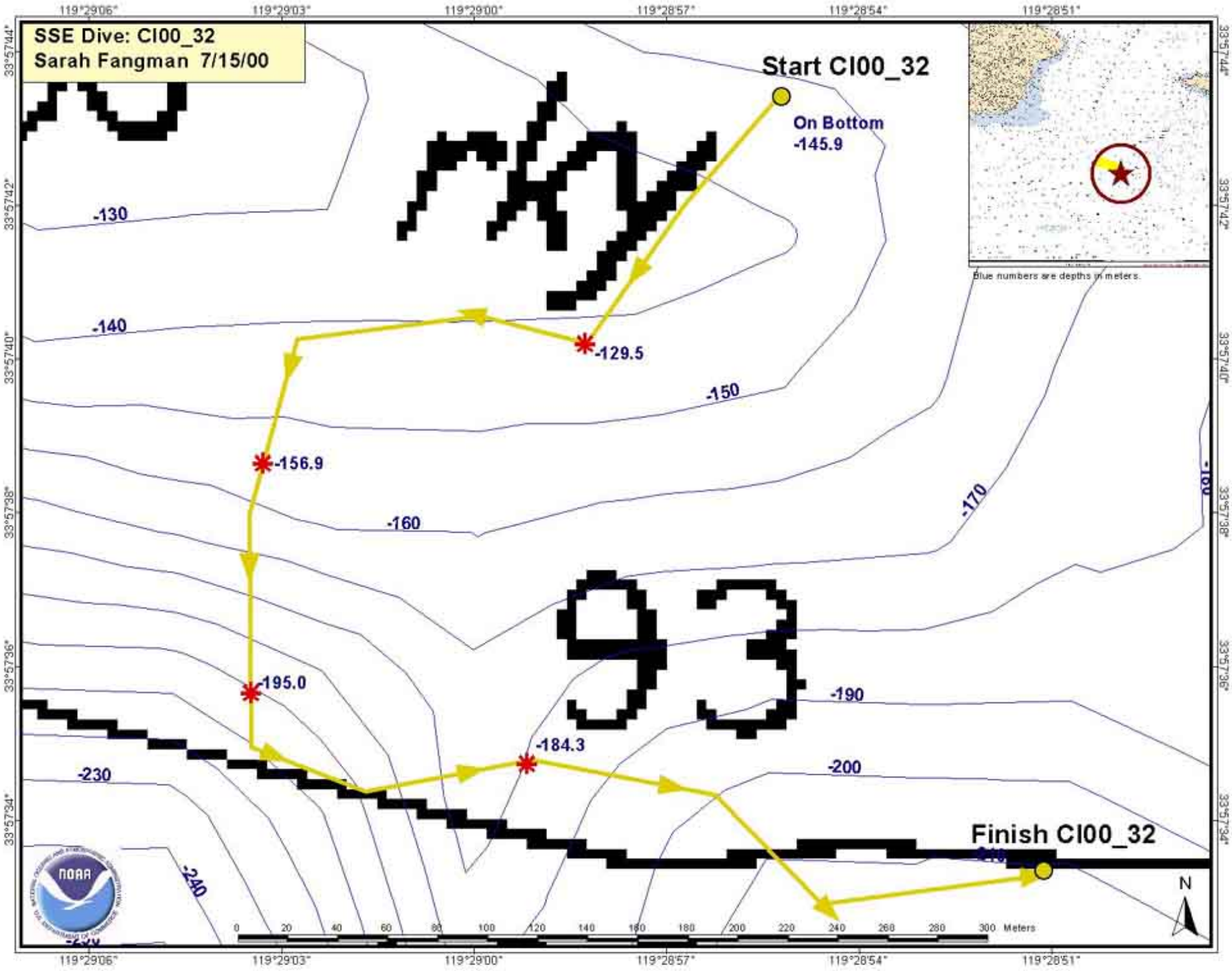

SSE Dive: CI_08
Donna Schoeder 6/22/00
Arch Rk
Fl (2) 60s 277ft 20M HORN
Dive End
Dive Start
Dive Area
300 0 300 600 Meters
N

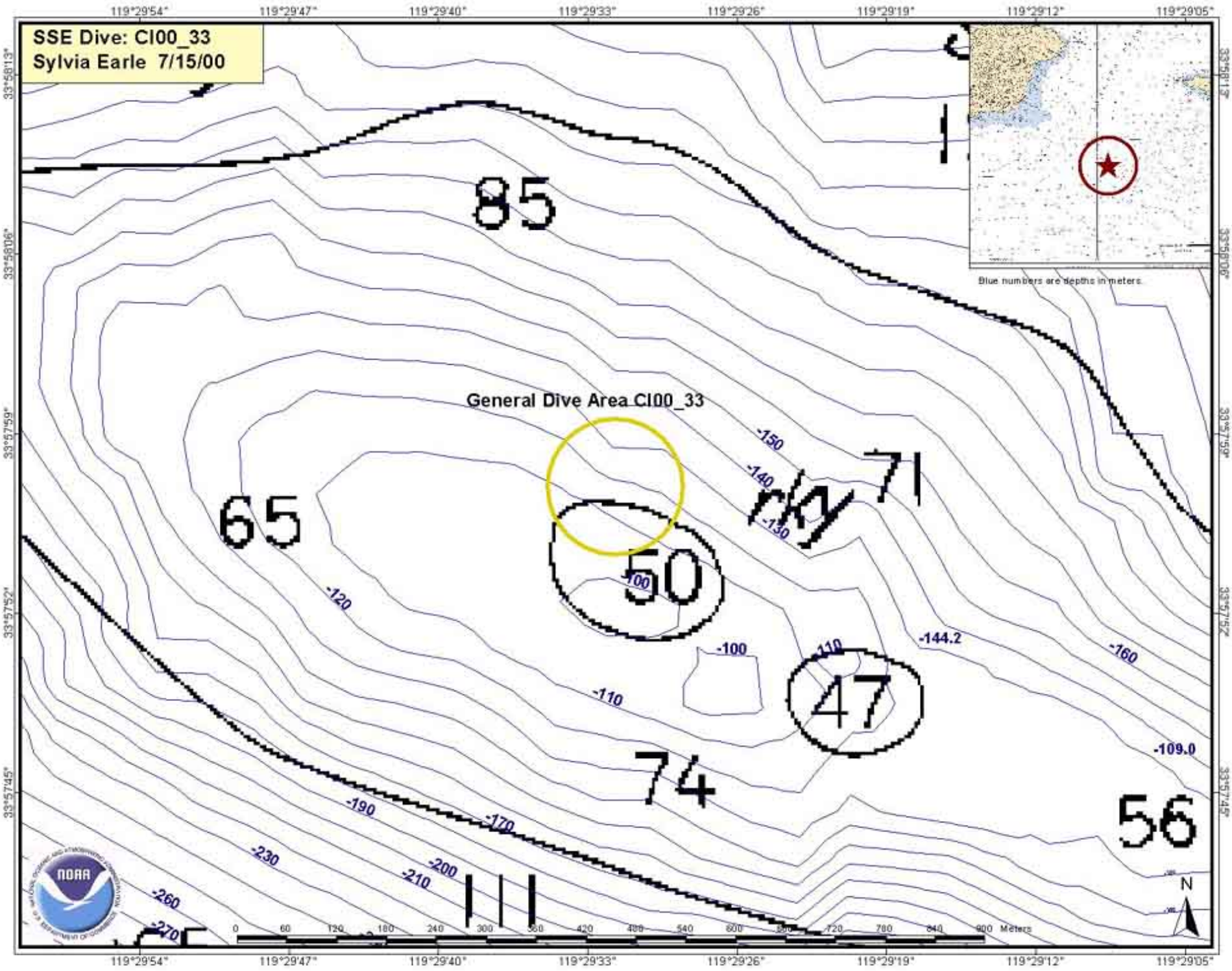

SSE Dive: CI_09
Sarah Fangman 6/22/00
Cat Rk
Dive Area
Dive Start
Dive End
S Sh
400
0
400
800 Meters
N

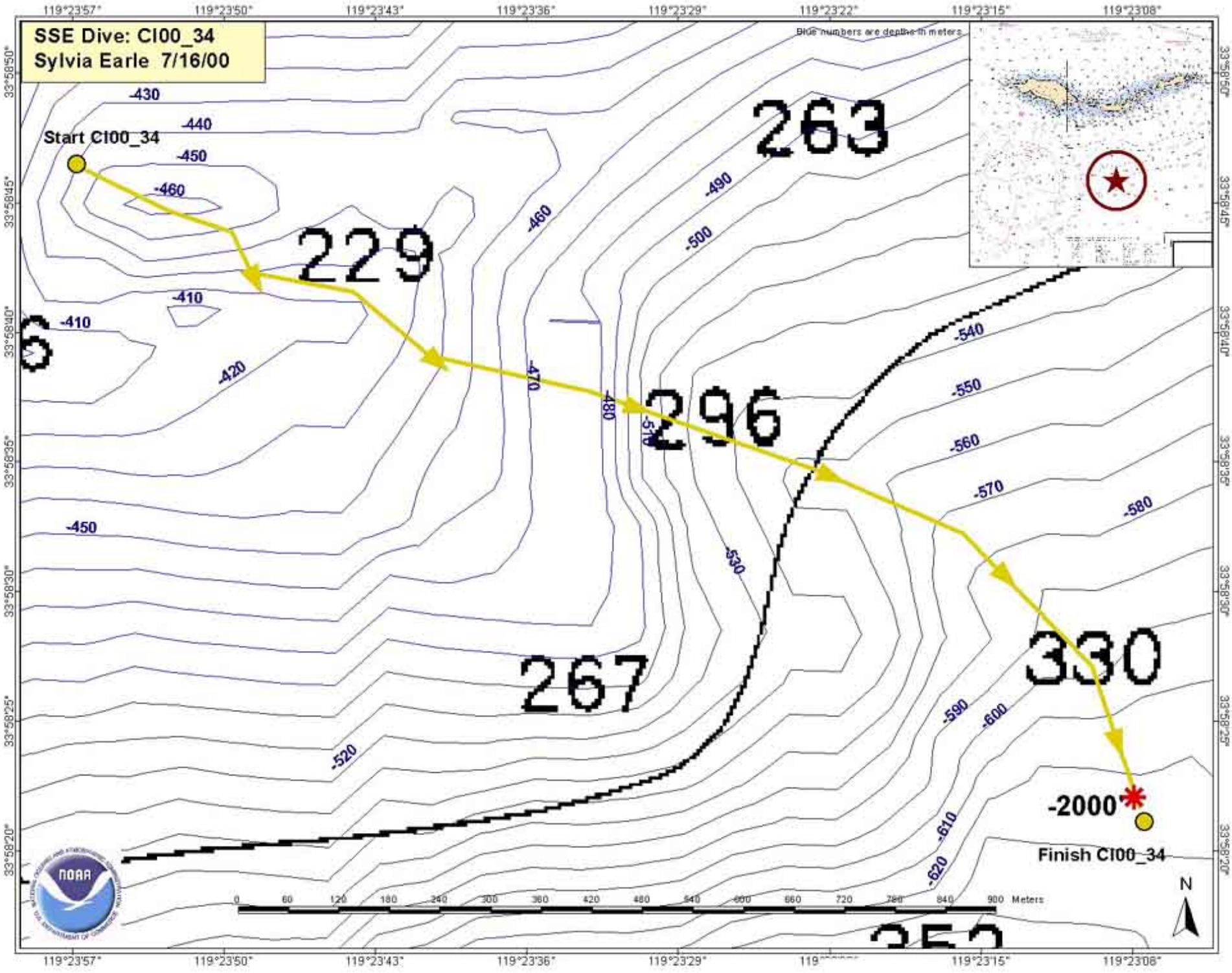

SSE Dive: CI_10
Guy Cochrane 6/23/00
-35.82
Started Tape 1
86 ft
-36.62
Stopped for Video
On Bottom
Video stop
Stopped for Video
-34.52
Life Supports
5 ft. high rock
-35.52
Stopped at sandway
-39.02
-34.92
Video 2
Life supports
-36.02
School of fish
-34.92
Sand waves on bedrock
-34.12
-34.72
stopped on large rock
begin ascent
-28.02
400
0
400
800 Meters
N

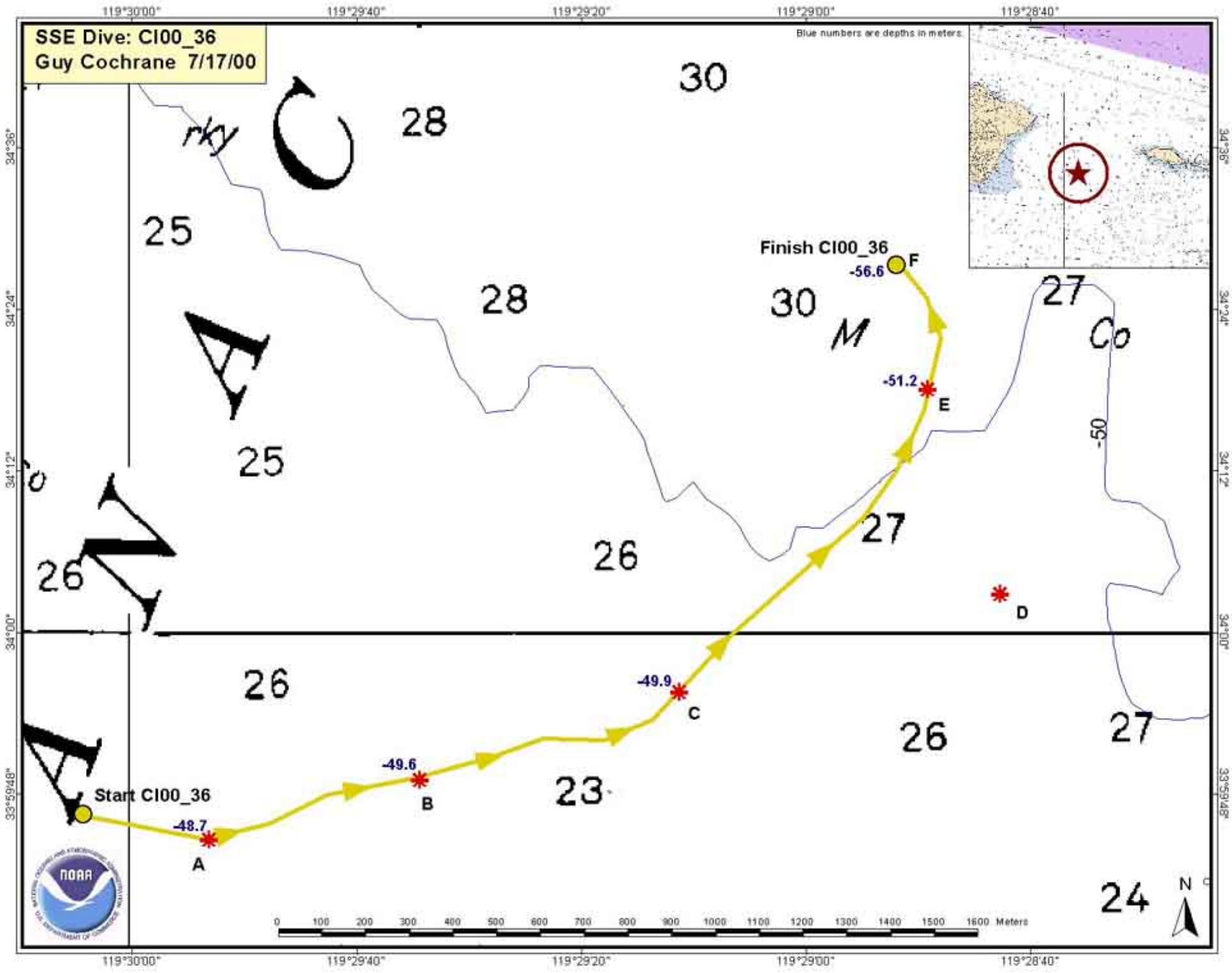

SSE Dive: CI_11
Kip Evans 6/23/00
ROCKS AND PINNACLES TO 5¾ FATHOMS REPORTED 1966
Dive Area
hrd
gy S
500
0
500
1000 Meters
N

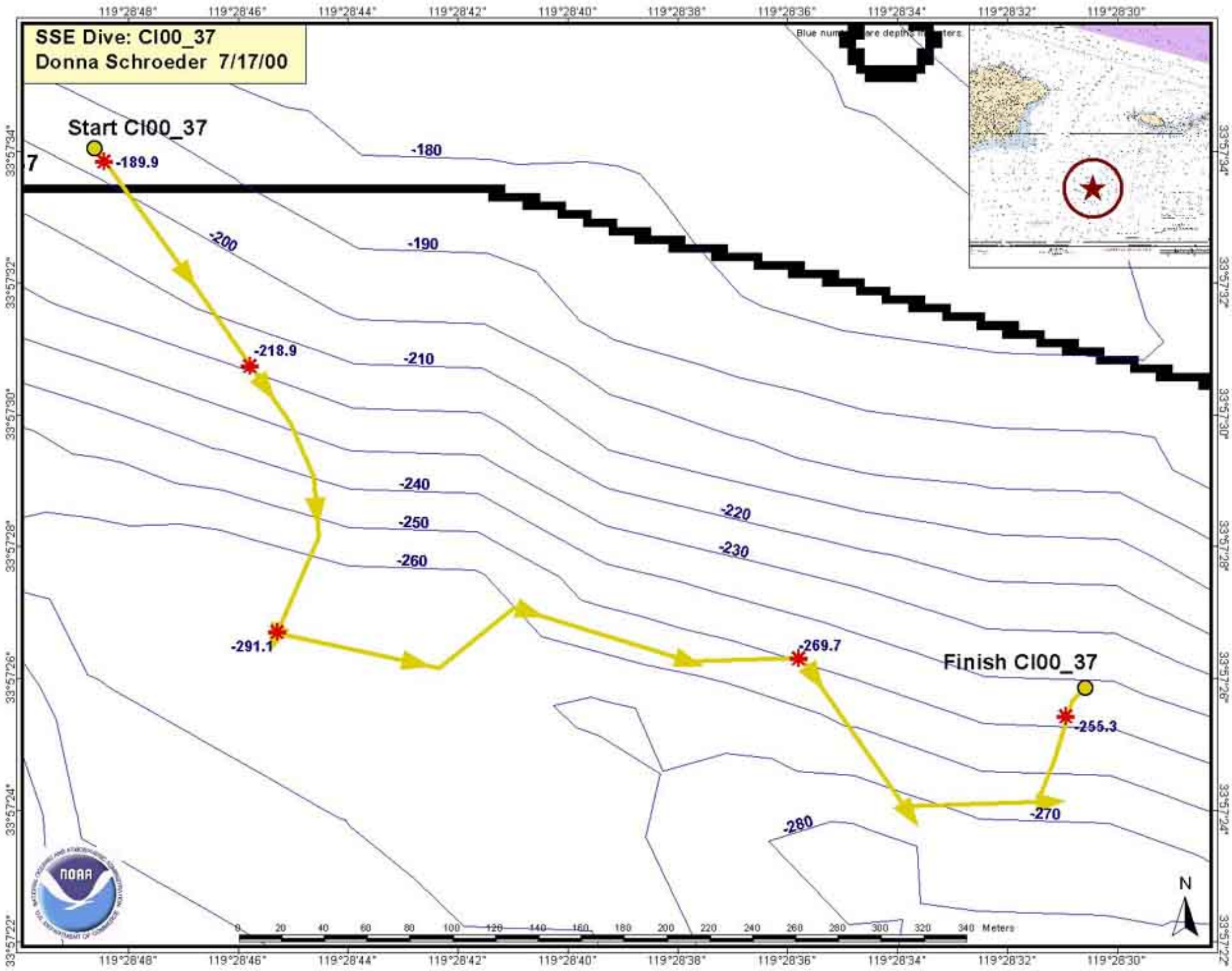

SSE Dive: CI00_31
Donna Schroeder 7/14/00
Blue numbers are depth in meters
The Footprint
Start CI00_31
On Bottom
-145.93
-108.4
-118.4
-109.2
-144.2
-109.0
Finish CI00_31
85
65
50
71
47
74
56
111
-120
-100
-110
-150
-140
-130
-160
-190
-170
-230
-200
-210
-260
-240
-250
-180
N
0 60 120 180 240 300 360 420 480 540 600 660 720 780 840 900 Meters
119°29'50"
119°29'40"
119°29'30"
119°29'20"
119°29'10"
33°58'06"
33°57'59"
33°57'52"
33°57'45"
33°57'38"

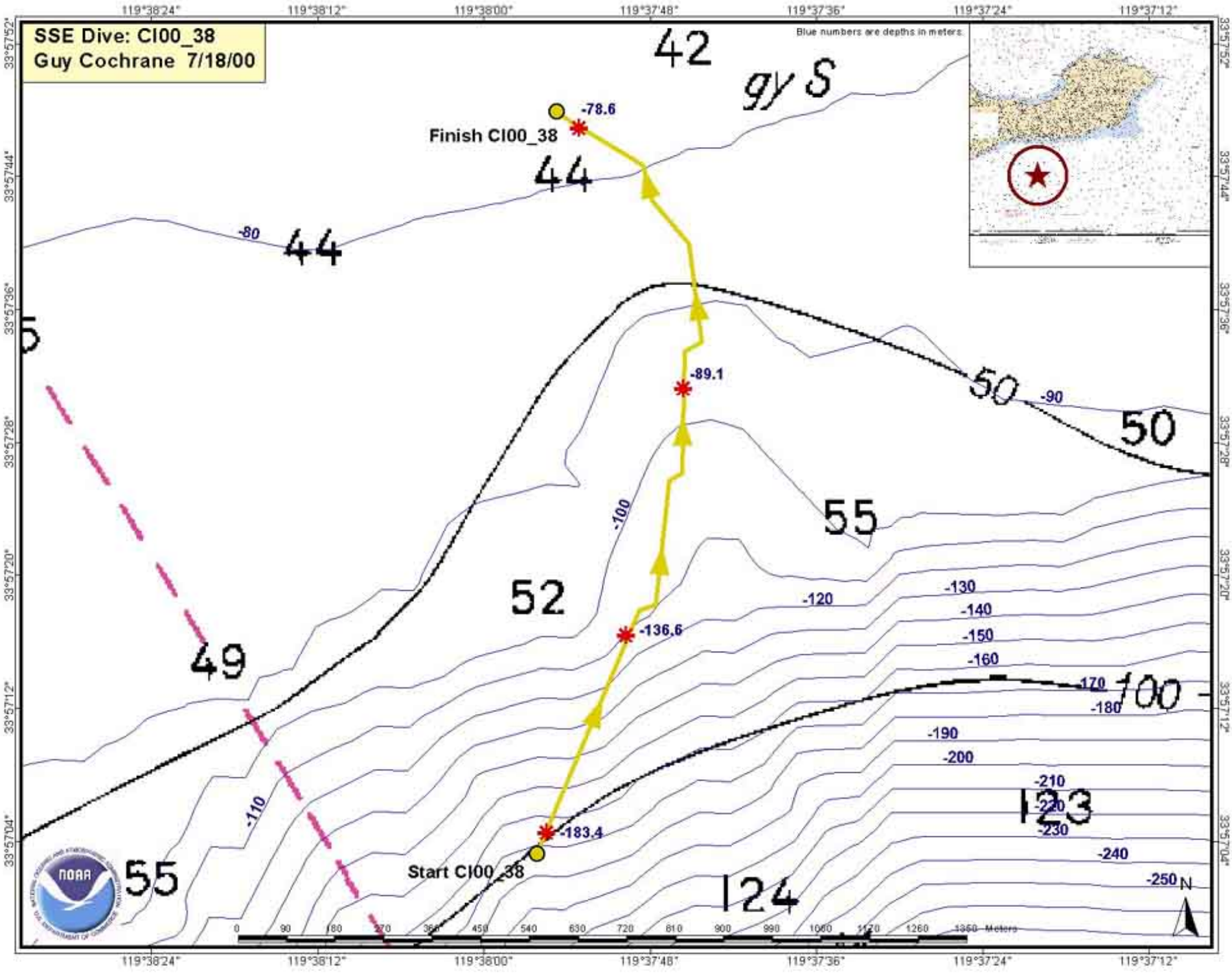

SSE Dive: CI00_32
Sarah Fangman 7/15/00
Start CI00_32
On Bottom
-145.9
-129.5
-156.9
-195.0
-184.3
Finish CI00_32
-130
-140
-150
-160
-170
-190
-200
-230
-240
Blue numbers are depths in meters.
119°29'06"
119°29'03"
119°29'00"
119°28'57"
119°28'54"
119°28'51"
33°57'44"
33°57'42"
33°57'40"
33°57'38"
33°57'36"
33°57'34"
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 Meters
N
NOAA

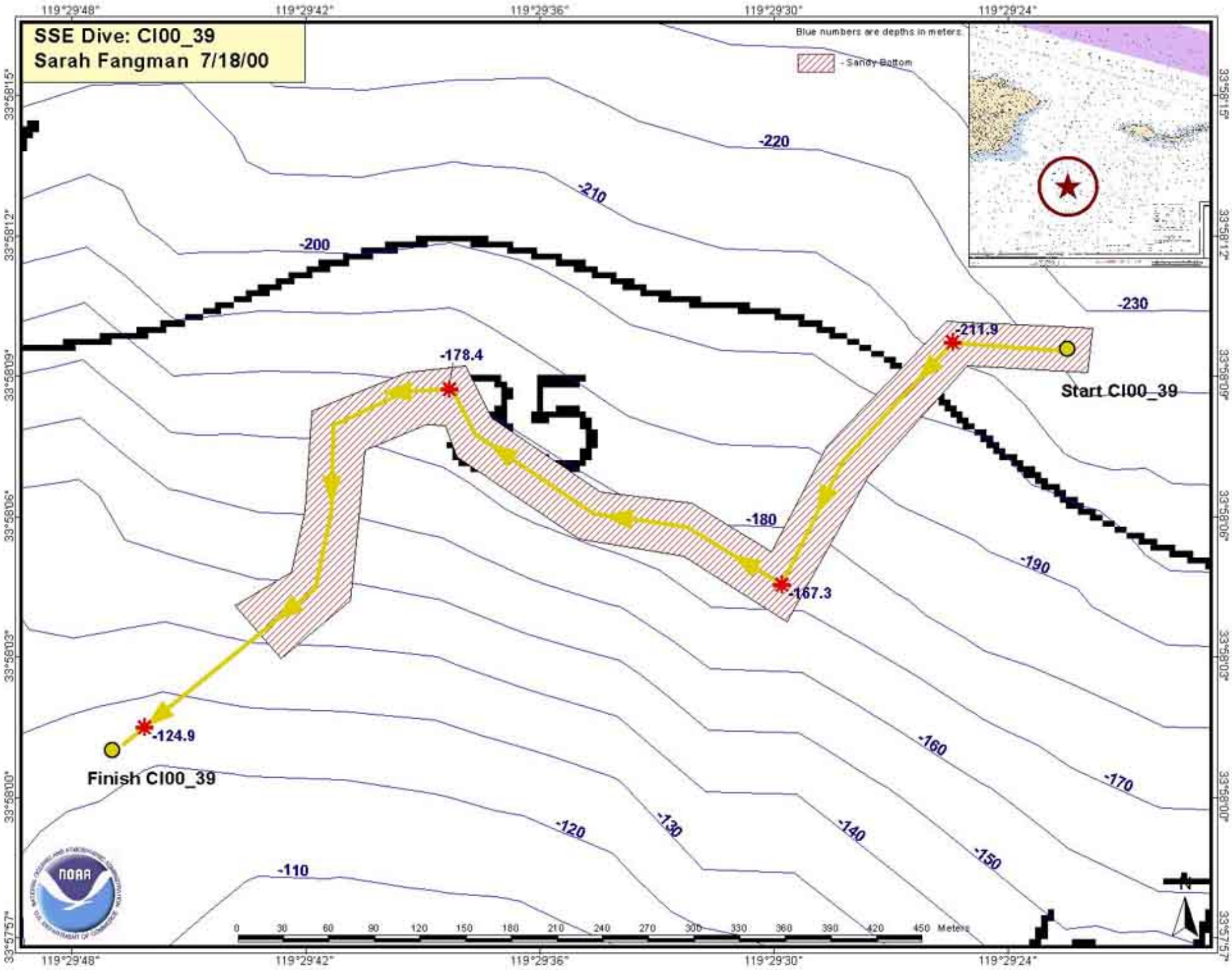

SSE Dive: CI00_33
Sylvia Earle 7/15/00
General Dive Area CI00_33
Blue numbers are depths in meters
85
65
50
71
47
74
56
-150
-140
-130
-120
-100
-110
-144.2
-160
-109.0
-190
-170
-230
-200
-210
-260
-270
119°29'54"
119°29'47"
119°29'40"
119°29'33"
119°29'26"
119°29'19"
119°29'12"
119°29'05"
33°58'13"
33°58'06"
33°57'59"
33°57'52"
33°57'45"
0 60 120 180 240 300 360 420 480 540 600 660 720 780 840 900 Meters
N


SSE Dive: CI00_34
Sylvia Earle 7/16/00
Blue numbers are depths in meters
Start CI00_34
263
229
296
267
330
-2000
Finish CI00_34
N
0 60 120 180 240 300 360 420 480 540 600 660 720 780 840 900 Meters
119°23'57"
119°23'50"
119°23'43"
119°23'36"
119°23'29"
119°23'22"
119°23'15"
119°23'08"
33°58'50"
33°58'45"
33°58'40"
33°58'35"
33°58'30"
33°58'25"
33°58'20"


SSE Dive: CI00_36
Guy Cochrane 7/17/00
Blue numbers are depths in meters
119°30'00"
119°29'40"
119°29'20"
119°29'00"
119°28'40"
34°36'
34°24'
34°12'
34°00'
33°59'48"
Start CI00_36
-48.7
A
-49.6
B
-49.9
C
D
-51.2
E
Finish CI00_36
-56.6
F
30
28
25
26
27
23
24
-50
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 Meters
N
NOAA


SSE Dive: CI00_37
Donna Schroeder 7/17/00
Start CI00_37
-189.9
-218.9
-291.1
-269.7
Finish CI00_37
-255.3
-180
-190
-200
-210
-220
-230
-240
-250
-260
-270
-280
119°28'48"
119°28'46"
119°28'44"
119°28'42"
119°28'40"
119°28'38"
119°28'36"
119°28'34"
119°28'32"
119°28'30"
33°57'34"
33°57'32"
33°57'30"
33°57'28"
33°57'26"
33°57'24"
33°57'22"
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 Meters
N
NOAA


SSE Dive: CI00_38
Guy Cochrane 7/18/00
Blue numbers are depths in meters
Finish CI00_38
Start CI00_38
-78.6
-89.1
-136.6
-183.4
42
44
44
50
50
55
52
49
55
124
123
100
gy S
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
-230
-240
-250
N
0 90 180 270 360 450 540 630 720 810 900 990 1080 1170 1260 1350 Meters
119°38'24"
119°38'12"
119°38'00"
119°37'48"
119°37'36"
119°37'24"
119°37'12"
33°57'52"
33°57'44"
33°57'36"
33°57'28"
33°57'20"
33°57'12"
33°57'04"


SSE Dive: CI00_39
Sarah Fangman 7/18/00
Blue numbers are depths in meters
- Sandy Bottom
-178.4
-211.9
-167.3
-124.9
Start CI00_39
Finish CI00_39
-220
-210
-200
-230
-180
-190
-160
-170
-120
-130
-140
-150
-110
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 Meters
N
NOAA
119°29'48"
119°29'42"
119°29'36"
119°29'30"
119°29'24"
33°58'15"
33°58'12"
33°58'09"
33°58'06"
33°58'03"
33°58'00"
33°57'57"

July 19, 2000 Summary Log

Sarah Fangman, SSE Site Coordinator and DeepWorker Pilot
Channel Islands National Marine Sanctuary

Sarah Fangman

This year, the 2000 Sustainable Seas Expedition spent twenty-five days in the Channel Islands National Marine Sanctuary. During that time, scientists worked around the clock collecting data. Our efforts produced the following:

1) General habitat characterization of an important deep reef area (called the "Footprint"). This area is being considered for Marine Protected Area status.

2) Identification of juvenile habitat for cowcod rockfish, a severely overfished species.

3) Never-before-collected photodocumentation of bank rockfish juveniles *(Sebastes rufus)* and their behavioral associations.

4) Observation and photodocumentation of predation/hunting behavior of the torpedo ray *(Torpedo californica)* at a depth of 120 meters.

5) Observation and photodocumentation of crinoid swimming behavior at 140 meters.

6) Nighttime sidescan sonar surveying of approximately 100 square km of nearshore seafloor (0-100m depths). Mapping activities were concentrated in the southern and eastern area of the Northern Channel Islands.

7) Submersible groundtruthing at three areas that had been

mapped using sidescan sonar.

8) Video and navigation data from submersible dives are being analyzed for qualitative groundtruthing of sidescan sonar data.

9) Nighttime transects across the Santa Barbara Channel conducting towed CTD operations provided information on circulation patterns in the Santa Barbara Basin. University of California at Santa Barbara scientists have processed the data and are synthesizing these observations with radar data of surface current patterns in the area. Of particular interest are propagating, counter-rotating pairs that move down the Channel most strongly in summer. These observations are giving us insights into their sub-surface structure. They also show the vertical and horizontal structure of a strong westward current often found running along the mainland coast.

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Open House

July 14 "Magnificent" Rockfish

Photo Log

June 17 - July 18 Dive Maps

July 19 Summary Log

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Dive 8 Video
South of Anacapa Island
June 22, 2000

Pilot: Donna Schroeder

This rock is alive with motion and color. Look closely. The movement you are watching is actually hundreds of brittle star arms undulating with the surge of water currents. Bright red sponges and orange cup corals dot this colorful seascape.

For More Information

- Read Donna Schroeder's July 14 Log: "Magnificent" Rockfish
- Read Donna Schroeder's biography

LOG

June 5 Welcome to SSE

June 7 SSE Teacher Perspective

June 8 Student & Diver Perspective

June 8 Perspective from Land

June 10 Student-At-Sea Day

June 11 Investigating Circulation

June 18 Mapping the Sanctuary Floor

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June 17 - July 18 Dive Maps

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Biographies

These biographies identify partners in the Sustainable Seas Expeditions' mission to the Channel Islands National Marine Sanctuary. They are listed alphabetically.


Francesca Cava

Francesca M. Cava,
Education Programs Project Manager
Sustainable Seas Expeditions

Francesca M. Cava currently serves as the Education Programs project manager for the National Geographic Society's Sustainable Seas Expeditions. She is responsible for planning, day-to-day operations, overseeing arrangements related to all aspects of the SSE's education program, and encouraging new partnerships with other marine education institutions. During her 21-year tenure with National Oceanic and Atmospheric Administration (NOAA), Ms. Cava became the first woman to be promoted to the rank of Captain in the NOAA Corps, and served in several command positions aboard NOAA research vessels. From 1992 to 1994, Ms. Cava served as the Director of the National Marine Sanctuary and National Estuarine Research Reserve Programs, with overall management responsibility for 12 national marine sanctuaries and 24 estuarine reserves. Prior to this appointment, she served as the first sanctuary manager of the Channel Islands National Marine Sanctuary. Ms. Cava received her bachelor of science in mathematics from the University of Alaska and a master's in public administration from Harvard University.

Guy Cochrane
Research Geophysicist
United States Geological Survey

Dr. Guy R. Cochrane is a research geophysicist for the Coastal and Marine Geology Program of the U.S. Geological Survey. He specializes in sea-floor geologic mapping using sonar methods for environmental and earthquake hazards research.

CULTURAL HISTORY

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1999 MISSION LOG

Guy Cochrane

He has worked in most parts of the Pacific Ocean, from the Arctic Bering Sea to the Ross Sea in Antarctica. He was a member of the team of scientists that explored the waters off the Oregon coast in the Alvin submersible, and first observed cold-vent biologic communities there.

Sylvia Earle

Sylvia Earle, Explorer-in-Residence
National Geographic Society

Marine biologist Sylvia Earle is an Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion --the oceans -- and is the project director of the Sustainable Seas Expeditions. Her research places special emphasis on marine plants and developing technology to access and conduct research in the deep sea. Named one of *Time Magazine's* "Heroes for the Planet" in 1998, Dr. Earle pioneered research on marine ecosystems and has led more than 50 expeditions totaling 6,000 hours underwater. She also holds numerous diving records. In the 1980s, Dr. Earle founded her own company, Deep Ocean Exploration and Research Inc., and cofounded Deep Ocean Engineering Inc. She is also a former chief scientist of the National Oceanic and Atmospheric Administration. She has authored more than 100 scientific and popular publications, including the 1995 book, *Sea Change*, and three 1999 books related to the SSE: *Wild Ocean: America's Parks Under the Sea*, *Dive* and a children's book, *Hello Fish*. As the spokesperson for SeaWeb, a conservation initiative of the Pew Charitable Trusts, she strives to increase public awareness of the pressures facing the world's coastal and oceanic realms. In early 1999, she played a key role in the Clinton administration's decision to double the budget of NOAA's national marine sanctuaries. She holds a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as well as nine honorary doctoral degrees.

Kip F. Evans, Expedition Photographer
Sustainable Seas Expeditions

As the official photographer for the Sustainable Seas Expeditions, Kip Evans captures the visual splendor of scientific discovery, exploration and outreach. For 10 years, he has worked as both a still photographer and an underwater cinematographer. Since 1985, he has logged over 1,000 hours underwater documenting marine life, performing research and

participating in search-and-recovery operations. Mr. Evans has worked on a variety of documentaries, including a recent special on the life of Dr. Sylvia Earle, *Her Deepness*, for CNN, and a Discovery Channel news story on the declining squid fishery off the California coast. His photographs have appeared in Rodale's *Scuba Diving*, *Dive Training*, *Coast & Ocean* and *Aqua* magazines, and on the front covers of such newspapers as *USA Today*, the *San Francisco Examiner*, *San Diego Tribune*, and *Santa Cruz Sentinel*. His clients include NOAA's National Marine Sanctuary Program, the National Geographic Society, Oceanic Diving Equipment, and the UnderWater World Aquarium in San Francisco. He holds a bachelor's degree in environmental studies emphasizing marine biology from the University of California at Santa Barbara.

Kip Evans

Sarah Fangman

Sarah Fangman, SSE Site Coordinator and DeepWorker Pilot
NOAA's Channel Islands National Marine Sanctuary

Sarah Fangman joined the Channel Islands National Marine Sanctuary in February 1998. She coordinates sanctuary research efforts, often in partnership with individuals and organizations interested in the sanctuary and its resources. She is also one of three primary DeepWorker submersible pilots for the research component of the SSE 2000 mission. Before joining the sanctuary, Ms. Fangman worked as a presidential management intern at NOAA's National Marine Fisheries Service. She received a B.A. in environmental studies and biology from Middlebury College, and a master's from the University of Washington School of Marine Affairs.

Laura Francis, NOAA SSE Education Coordinator
NOAA's National Marine Sanctuaries Program

Laura Francis

Laura Francis has been the education coordinator of the Channel Islands National Marine Sanctuary since 1994, and is currently coordinating the educational components of the Sustainable Seas Expeditions. She develops educational materials for teachers and students, produces teacher workshops and student summits, coordinates live SSE Webcasts, and is the principal investigator of two of this year's SSE research projects in the Channel Islands. She holds a B.A. in zoology from Berkeley and a

master's in deep-sea biology from the University of California at Santa Barbara. With more than 10 years' professional experience in marine science education and research, she finds her work most rewarding when she discovers innovative ways to integrate the two disciplines.

Julie Goodson

Julie Goodson, Education Coordinator
NOAA's Channel Islands National Marine Sanctuary

As the education coordinator of the Channel Islands National Marine Sanctuary, Julie Goodson develops educational programs and partnerships to increase awareness about the sanctuary's cultural and living resources. She has more than a decade of experience working in nonprofit educational organizations. Prior to joining the sanctuary staff two years ago,, she was the director of at-sea programs for the Orange County Marine Institute in Dana Point Harbor. She also worked at the Catalina Island Marine Institute as a lab technician and instructor, where she collected and maintained the marine plants and animals used in the fish, invertebrate and algae labs. This year, Ms. Goodson will coordinate educational outreach activities during the SSE 2000 mission to the Channel Islands. She holds a B.S. in aquatic biology from the University of California at Santa Barbara, and is currently completing a master's in biology with a marine emphasis at the California State University at Fullerton.

Kathryn Hintergardt, Webmaster
NOAA's Channel Islands National Marine Sanctuary

Kathryn Hintergardt

Kathryn Hintergardt is the sanctuary Webmaster and developer of the Internet Weather Kiosk. She works closely with the sanctuary staff to maintain the Web site as a vital tool that provides sanctuary constituents with the latest information on cooperative projects. In addition to information about the SSE, the Web site provides continuous updates on many topics, e.g., the sanctuary's research, educational, and cultural resources, revisions to the sanctuary management plan, meetings of the sanctuary advisory council, and news about other marine reserves. Ms. Hintergardt's experience as an educator, administrator, and counselor complements her computer skills and enables her to provide a useful and intuitive product to the

santuary's on-line visitors.

Milton Love, Research Biologist
University of California,Santa Barbara

Dr. Milton Love is an associate research biologist at the University of California at Santa Barbara. For the past 30 years, he has conducted research on reef fishes, and primarily the rockfishes, of the Pacific Coast. Much of his research currently focuses on the fish assemblages living around the oil and gas platforms of California and on offshore natural reefs. He is the author of 40 scientific papers, three books, an educational videotape and more than 80 articles for such publications as *Natural History, New Scientist, Ocean Realm, Diver Travel, Scuba Times* and *Cousteau's Dolphin Log*.

Fred Payne

Fred Payne, Electronic Technician
United States Geological Survey

Fred Payne is a technician with the U.S. Geological Survey (USGS) in Redwood City, CA. He will be operating the sidescan sonar equipment as the NOAA research vessel *McArthur* transects unmapped areas of the Channel Islands National Marine Sanctuary. A U.S. Air Force veteran who has worked for the USGS since 1993, Mr. Payne has 20 years' experience as an electronics technician. During this year's SSE mission, he will operate the Klien 2000 Digital Side Scan Sonar from 7 pm to 7 am each day. He has performed similar operations in the sanctuary aboard the sanctuary vessel *R/V Ballena*. During his career in the U.S. Air Force, he participated in the first Arctic Ocean crossing, from Alaska to Iceland, on the *S/V Polar Sea*.

LCDR Matt Pickett, Manager
NOAA's Channel Islands National Marine Sanctuary

Matt Pickett

Lieutenant Commander Matt Pickett has worked for NOAA in a variety of operational assignments for more than 11 years. He began his career in the NOAA Corps as the operations officer aboard the NOAA ship *Chapman*, where he conducted fisheries and oceanographic research. He also served as the unit dive supervisor for the Miami laboratory of the National Marine Fisheries Service, where he worked on an artificial reef project before joining the NOAA Flight

Program. As a NOAA pilot, his flight experience has ranged from high-altitude photogrammetry work to polar bear research on the Arctic ice pack. LCDR Pickett joined the staff of the Channels Islands National Marine Sanctuary in 1997.

Donna Schroeder

Donna Schroeder, Biologist
Marine Sciences Institute, University of California, Santa Barbara

Donna Schroeder is a biologist at the Marine Science Institute of the University of California at Santa Barbara. She has studied the fishes of the Pacific Coast for more than 10 years. Her research interests include the population dynamics of reef fishes and the influence of changing oceanographic conditions on marine communities. In collaboration with Dr. Milton Love, Ms. Schroeder has been using submersibles to study deep-reef rockfishes in the Southern California Bight for the last 6 years.

Ben Waltenberger, Spatial Data Analyst
NOAA's Channel Island National Marine Sanctuary

Ben Waltenberger

Ben Waltenberger is the spatial data analyst at the Channel Islands National Marine Sanctuary. Using geographic information systems (GIS) and remote sensing, he processes and analyzes spatial data that are used to model and better understand sanctuary phenomena. Some of his current projects include working with other agencies in the region to create a standardized data base of spatial information, improving the Sanctuary Aerial Monitoring and Spatial Analysis Program (SAMSAP), using GIS in emergency response situations, and investigating ways to better model the land-marine interface. His current research involves 3D interface representations and the use of navigational metaphors to visualize ecological data bases.

Dr. Libe Washburn, Professor of Geography
University of California, Santa Barbara

Dr. Libe Washburn is a professor of geography at the University of California atSanta Barbara. His research interests include physical oceanography, ocean turbulence and mixing processes, ocean bio/optics, air-sea interaction and marine pollution. Dr. Washburn is currently involved in a variety of research projects (information

Libe Washburn

about each of these is available on the Web). They include: **Mapping Ocean Surface Currents using High Frequency Radio Radar**, **Kelp Spore Dispersal**, **Storm Runoff in the Santa Monica Basin**, and **Natural Hydrocarbon Seepage in the Santa Barbara Channel**. During the SSE 2000 mission to the Channel Islands, Dr. Washburn will collect ADCP and CTD data to describe the flow and hydrographic character of a coastal eddy that is present in the western half of the Santa Barbara Channel.

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REP. LOIS CAPPS

SHIPWRECKS

CHUMASH ESSAY

EXPEDITION UPDATE

May 24 - June 5, 1999

Barely a moment to catch our breath after the challenges of the Monterey mission, and we were off to the races again! Our expedition into the Channel Islands National Marine Sanctuary included some exciting opportunities to involve the public in our adventure, including a **Great American Fish Count** event on May 27, with a live internet uplink engineered by NASA.

We got to do a lot of exploring in the waters off Anacapa Island and Santa Cruz Island. Tim Friend, a reporter from USA Today, got a couple opportunities to dive to sub, and we tried an improvised method for marking one of our dive sites so we could revisit it later. Kip Evans, the SSE photographer, and I got to do a two-sub dive together on June 1 and saw two giant seabass.

On June 2, we used the ROV to observe and evaluate the effects of sewage outfalls off the Santa Barbara coast. June 3 and 4 we got a few more scientific dives in, but the wind had kicked up, so it was a little touch-and-go for awhile there. On June 5, we had a great public outreach event to cap off a very successful two weeks.

SSE will be on a short hiatus from mission activities while the Olympic Coast National Marine Sanctuary's pilots complete their sub training (with NEW subs!). I'll file a report from Seattle during the training, then we'll see you on the Olympic Coast, starting June 17.

Gale Mead, Expedition Log Editor

LOG

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Interview

Interview with Ed Cassano, Manager
Channel Islands National Marine Sanctuary

What is the most important part of your job as Channel Island National Marine Sanctuary manager?

Click here for audio response. (RealAudio), for help see About this Site

Ed Cassano

I look at the Sanctuary Manager position as very humbling, in that the Sanctuary is such a complex place--between the jurisdictions, the natural ecosystem itself, and the variety of stakeholders that use the resources.

Of course, the primary goal of the Sanctuary program is resource protection. I think the most difficult challenge is to understand the natural variability of the resources as well as the anthropogenic effects on the system.

The Sanctuary a complex place, and our resources to deal with it are limited, so we need to leverage our resources through partnerships. We need to help focus existing institutions both locally and regionally to better address the resource questions that we face in the Sanctuary.

(top)

What are some of the more important partnerships that the Sanctuary is involved in?

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Click here for audio response.

The Sanctuary has a great history in educational partnerships--for example, the Sea Center and the Los Marineros Program (a targeted fifth grade program), both of which were partnerships with the Santa Barbara Museum of Natural History.

Today we are focusing on research partnerships. Our partnership with the University of California, Santa Barbara (UCSB) allows us to work with new satellite tools which give a synoptic overview of how the Sanctuary functions relative to productivity. CINMS also participated in the Bight 98 Project, a Southern California Bight-wide look at benthic habitat, benthic health, and fish assemblages from Baja to Point Conception.

We have partnerships with many local marine educators through a group called MERA, the Marine Educators Regional Alliance, which CINMS facilitates and coordinates. This group has incredible potential to address the marine educational needs of the community.

What are some examples of what is known and unknown about Sanctuary resources?

Click here for audio response.

We know so much, and yet we know very little. There have been many, many years of work by groups like the Channel Islands National Park, the Minerals Management Service, the National Marine Fisheries Service, and UCSB. These groups and CINMS have worked for years, in some cases decades, to develop our basic understanding of the system.

There are some standard sites that monitor indices within CINMS--for example, the Kelp Forest Monitoring sites maintained by Channel Islands National Park. CINMS is now building a two- to three-year database with UCSB on a standard transect looking at oceanography. Other institutions have worked very hard in this area, like Scripps. And we now have the opportunity to use new technology--satellite imagery, sidescan sonar, swath surveys, submersibles like the DeepWorker.

Yet even with our decades of knowledge, resources have still declined. We still know very little about the natural variability in the system and its relationship to how we extract resources. Some very important questions still need to be answered regarding marine reserves, boccacio rockfish, cowcod rockfish, white abalone--Sanctuary resources that are very close to being threatened, in some cases potentially endangered species. For these resources alone, and for the system as a whole, we need to move forward aggressively in understanding the entire system to a level of detail that allows us to manage it effectively.

(top)

How is the use of the DeepWorker going to affect research in the Sanctuary?

Click here for audio response.

The DeepWorker provides a very inexpensive submersible that nonprofessional pilots are capable of driving. It allows us to put the researcher into the environment and conduct their own work, which is unique. The DeepWorker is light, it's versatile, it's got great staying power. It's giving us eyes where we never had eyes before.

By coming to Channel Islands, SSE is giving us a 10-15 day research focus with these submersibles as the core element--but in addition, it's allowing us to use the NOAA ship for other work, such as sidescan sonar. SSE will help us begin to characterize the habitat of the Sanctuary in a methodical way.

There are some other submersible projects out there. Dr. Milton Love has some great submersible projects, but SSE is another one that will really be powerful for us.

Where will the DeepWorker be going in the first year of SSE?

Click here for audio response.

The research focus will be benthic habitat mapping using sidescan sonar images and geological observations from the Deepworker 2000 off Anacapa Island and the Southeast side of Santa Rosa Island, conducted by Dr. Guy Cochrane. We will also further the work of Dr. Milton Love on boccacio rockfish and other rockfish species while we conduct the geological transects.

In cooperation with the UCSB Plumes and Blooms project, we will conduct oceanography associated with these transects. Nighttime operations will include more sidescan sonar mapping. We have a long way to go to map the entire Sanctuary.

SSE highlights understanding the site characterization of CINMS and monitoring deep areas of the Sanctuary on a regular basis--like the Footprint Reef, the deep areas off Anacapa, and others that will really move us forward in our ability to understand the resources.

(top)

What are your objectives for CINMS during the first year of the SSE?

Click here for audio response.

We're testing the concept of DeepWorker use for a variety of science projects. We're also training novice pilots, and we're going to put those pilots into as many different situations as we can--night dives, deep dives, shallow dives--to build up their experience base. And at the same time, we're testing the training program as a whole so future DeepWorker pilots will have the benefit of our experiences.

Another primary objective is to excite. We always talk about exciting a new generation. I'm a product of Cousteau and his ability to instill a sense of need and wonder and desire to protect the world's oceans in a new way. We all need to understand the importance of the marine system. Sylvia said it, and it's a good quote: "Onward and downward."

Are there any obstacles to Sanctuary management that you think SSE will help overcome?

Click here for audio response.

I think so. People will understand the management direction of our programs better when the knowledge base of the resources we're trying to protect is at a higher level. Raising the plight of species like bocaccio or cow cod or white abalone to a higher level will help us in our current management position.

From the Sanctuary perspective, we bring all groups to the table--commercial fishermen, conservationists, environmentalists, regulatory agencies--so by using SSE as a way of building that table, I think ultimately we'll end up with better management.

(top)

Do you think that there's been a shift in ocean management in the last 50 years?

Click here for audio response.

Oh, there's no question about it. There's even a shift that's occurred in the last two years. In the last 50 years we've gone from believing we can just extract and dump into the world's oceans to knowing that both those behaviors have profound effects.

Now what hasn't happened is the system has not improved--which means we have not done enough. There's still pollution going on. We've been able to handle point source pollution, but we really don't have a handle on nonpoint source pollution.

We still have high levels of extraction. We have fisheries being run by economics and not by biology, and that can be a problem because those fisheries are not sustainable. In the last couple of years, we've come to look at marine resources as exhaustible. We recognize that by using them too much we will hurt ourselves.

I think we are at a point of paradigmatic shift. We're at the wall, and I think we're going to go through it. What I hope is that we go through it as a community so when we get to the other side, what results is something that we all want.

Would you talk a little bit more about what "the wall" is?

Click here for audio response.

One of the basic tenets of this country is frontierism. The oceans are the frontier. They are a dangerous place--you can die out there, and many people do. It's exciting, it's wild. There's a sense of freedom. There are no fences, no toll gates. There are rules but few people to enforce them. So the oceans are at the core of what this country was founded on.

Superintendent Ed Cassano and daughter Tara Rose enjoy the DeepWorker.

One-third of all jobs in the U.S. are based in the coastal zone. Fifty percent of the population lives within the coastal zone (0 to 50 miles). So a healthy coastal zone means a healthy system.

I think about my daughter, Tara Rose, and her excitement when she first saw the DeepWorker and wanted to sit in it. I look at Sylvia who has dedicated herself to the Herculean task of changing how this nation looks at the ocean. I see Sylvia and I see my daughter, who's 4 1/2, and I wonder: in 60 years, is Tara going to be looking back at the picture of her in this sub and looking at a better ocean--and a better sense of community and protection for that ocean? I hope so, and I think that's at the core of the mission of SSE.

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Natural Setting

Site Characterization
by Julie Goodson, Education Coordinator
Channel Islands National Marine Sanctuary

In 1980, President Jimmy Carter approved the designation of the Channel Islands National Marine Sanctuary. This 1,252 square-nautical mile portion of the Santa Barbara Channel is an area of national significance because of its exceptional natural beauty and resources. It encompasses the nearshore and offshore waters that surround Anacapa, Santa Cruz, Santa Rosa, San Miguel and Santa Barbara Islands, extending from mean high tide to six nautical miles offshore around each of the five islands. The Channel Islands National Marine Sanctuary is located off the coast of Southern California roughly 100 miles north of Los Angeles.

A satellite image of the sanctuary.

The Santa Barbara Channel is a fertile confluence of warm and cool currents in which diverse communities of marine animals, both

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temperate and tropical species, coexist. Santa Barbara Island is part of the Southern Channel Islands chain; the other islands in the sanctuary, Anacapa, Santa Cruz, Santa Rosa, and San Miguel are known as the Northern Channel Islands. This north-south dichotomy is part of what makes this area so ecologically distinctive: The Santa Barbara Channel straddles a transition zone where two biogeographic regions meet.

(top)

At Point Conception, where the California coastline veers sharply to the east, it is also where the Oregonian zone (water temperatures are in the mid-50's year-round) transitions to the Californian zone (water temperatures range from low 50's to upwards of 72 degrees). Just south of Point Conception, cold temperate waters, that are part of the prevailing California Current, flowing south, converge with the warmer northbound waters of the southern California Countercurrent, creating a gyre effect in the channel. This large, swirling eddy picks up and circulates nutrients.

Sea lions frolick below the surface.

Weather conditions contribute to this abundance of food. During the months of February through March, offshore winds create a phenomenon called upwelling. Deep waters are drawn up to the surface, bringing with them nutrients from below. As the days grow longer and light levels increase, there is a great surge of activity at the bottom of the food chain. More phytoplankton and algae are produced, attracting fish, shellfish, seabirds, and marine mammals. Sharing this fertile habitat are species from as far north as Alaska, such as the northern fur seal, and species from as far south as Panama, such as the bright orange Garibaldi fish.

(top)

Sanctuary waters are frequented by more kinds of marine mammals than any body of water of comparable size. This includes

A Blue Shark

more than 27 species of cetaceans (whales and porpoises), that occur in the Sanctuary at one time of the year or another. Migrating gray whales *(Eschrichtius robustus)* are the most frequently sighted. They may be seen during the months of December through April. The fin whale *(Balaenoptera physalus)*, is also seen in the sanctuary. In recent years, sightings of blue whales *(Balaenoptera musculus)*, minke whales *(Balaenoptera acutorostrata)* and humpback whales *(Megaptera novaengliae)*, have become more numerous.

Five species of pinnipeds -- seals and sealions -- breed and live on the Channel Islands, and forage and play within the sanctuary waters. Harbor Seals, elephant seals, California sea lions, northern fur seals and Steller sea lions are found in the region, although the Steller sea lion has not bred on the channel islands recently and worldwide its numbers are declining for undetermined reasons.

More than twenty-five species of sharks live in the sanctuary, some of them only occasional residents. Basking sharks *(Cetorhinus maximus)* often appear at the ocean's surface, their tall dorsal fins cutting through the rolling swell. The leopard shark *(Triakis semifasciata)* frequents shallow sandy areas. The most feared of the sharks, the great whites *(Carcharodon carcharias)* migrate along the coast, stopping where pinnipeds come ashore and breed. Thresher sharks *(Alopias vulpinus)* use their long caudal fins to hear or stun their prey. The blue shark *(Prionace glauca)* is an offshore resident that sometimes travels inshore at night to feed on squid and anchovies. The horn shark *(Heterodontus francisci)* is usually found in rocky reefs, especially around the islands. The Pacific angel shark *(Squatina californica)* is a bottom-dwelling species, relying on camouflage to ambush fish and other prey.

(top)

This unique association of species, some of them driven off the mainland by expanding development, depends on the secluded waters of the sanctuary for survival. Thus visitors to the sanctuary,

a popular place for fishing, surfing, diving, kayaking and sailing, are asked to comply with a set of regulations designed to preserve the health of the ecosystem. Within sanctuary boundaries, you may not alter the seabed in any way, discharge substances, remove or damage historical or cultural artifacts or disturb marine mammals or birds. The sanctuary program encourages the public to use the area as long as these conservation measures are upheld.

A Kelp Forest

The Channel Islands National Marine Sanctuary is responsible for the protection and preservation of submerged remains of the past found within sanctuary boundaries. Cultural and historic submerged sites include archaeological remains of shipwrecks and prehistoric land sites. Sanctuary stewardship responsibilities include a mandate to inventory sites, encourage research, provide public education and oversee responsible visitor use. The waters that surround Southern California's Channel Islands are filled with our cultural past, from the remains of perhaps the earliest island inhabitants, dating back 10,000 years, to the remnants of over a hundred shipwrecks spanning the history of European presence in the New World.

Historically the four northern Channel Islands were a special place to the Native Americans known as the Chumash. For hundreds of years, these early inhabitants traveled back and forth across the Channel in seaworthy plank canoes called tomols. Today, many archaeological artifacts can be found on the Channel floor. These artifacts, some of which were used in ceremonial rites, provide irreplaceable insight into our cultural past; they are also significant for scientific and religious reasons.

Giant Kelp

(top)

The remnants of over 100 vessels, spanning the European presence in the New World, lie on the floor of the channel. The Crown of England, which dates from 1894, lies off the southeastern corner of Santa Rosa Island. The Comet, a three-masted coastal lumber schooner, beached on San Miguel Island in 1911. These submerged hulls attract marine life creating popular spots for divers. The wreckage of the 19th century steamship known as the Winfield Scott, which sank off Anacapa Island in 1853, is one of the most divable archaeological sites off the coast of California.

Along with the cultural resources that the shipwrecks and archaeological sites represent, the sanctuary waters and the Channel Islands National Park contain invaluable sources of insight into our natural history in the form of fossils. All historical and cultural resources of the marine sanctuary and national park are protected by law. The shipwrecks, Native American sites, and fossils are irreplaceable. Removal or disturbance of these resources destroys their archaeological value and is strictly prohibited. Altering the seabed except for purposes of vessel anchoring and certain types of commercial fishing is also against the law. This protects the scientific and recreational value of these resources.

Zooplankton

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The Sanctuary

The waters that swirl around the five islands within the Channel Islands National Marine Sanctuary combine warm and cool currents to create an exceptional breeding ground for many species of plants and animals. Forests of giant kelp are home to numerous populations of fish and

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invertebrates. Every year over 27 species of whales and dolphins visit or inhabit the sanctuary including the rare blue, humpback and sei whales. On the islands, seabird colonies and pinniped rookeries flourish while overhead brown pelicans and western gulls search the water for food. Major issues that impact the sanctuary include oil and gas development, busy shipping lanes in nearby waters, nonpoint source pollution, and commercial and recreational fishing.

Since its designation in September 1980, sanctuary objectives have focused on balancing the protection of marine animals, habitats and prehistoric tribal artifacts with ever increasing recreational and commercial activities. The Channel Islands National Marine Sanctuary is located 25 miles (22 nautical miles) off the coast of Santa Barbara, California. The sanctuary encompasses the waters surrounding Anacapa, Santa Cruz, Santa Rosa, San Miguel and Santa Barbara islands, extending from mean high tide to seven miles (six nautical miles) offshore.

(top)

The Mission

The islands within the sanctuary are: 1) San Miguel, 2) Santa Rosa, 3) Santa Cruz, 4) Anacapa, and 5) Santa Barbara. Most expeditions will take place adjacent to Anacapa.

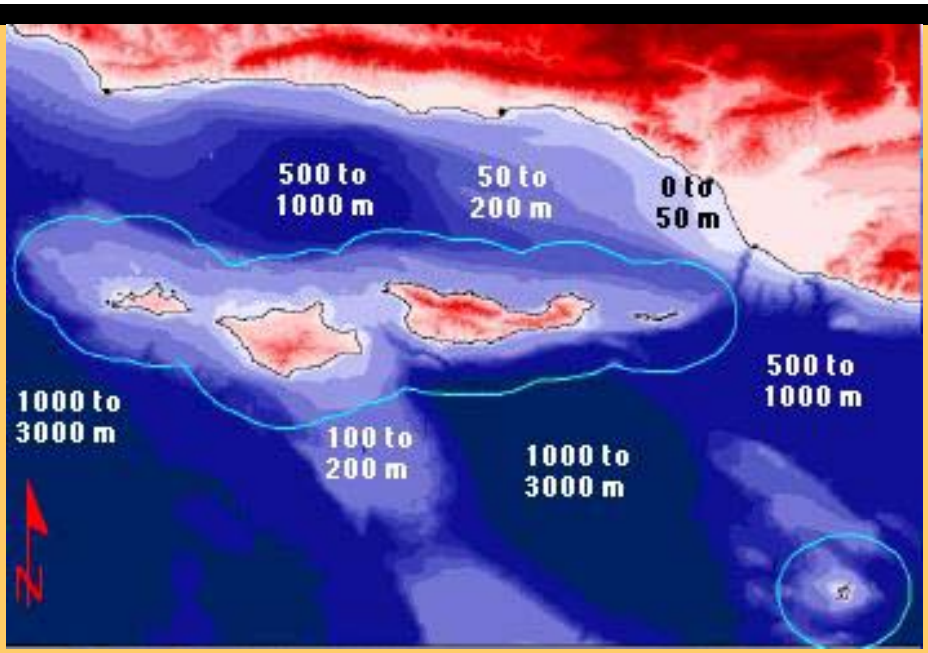
(top)

Aerial Photographs

Western (top) and eastern (bottom) portions of Anacapa Island. Waters off Anacapa Island are the scene of most of the Channel Islands expedition dives. (Source: NOAA's National Geodetic Survey)

(top)

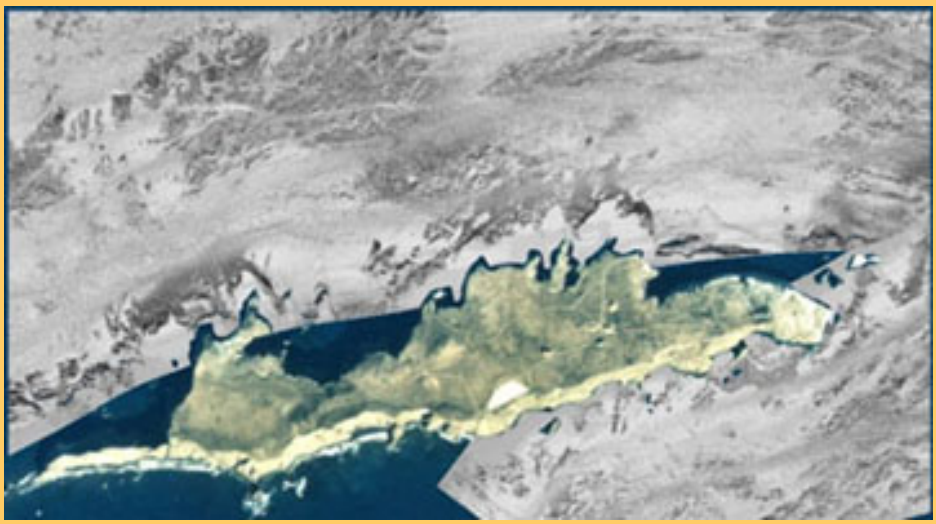
The Sea Floor

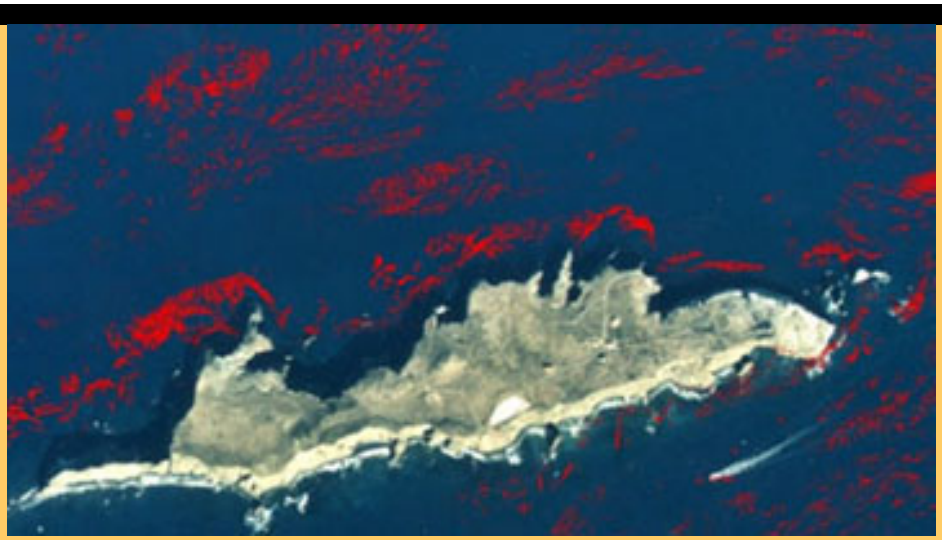


The sea floor around the Channel Islands drops precipitously to the south and west. The expedition will focus dives in waters southwest of Anacapa Island, the small eastern island closest to the coast. (Contributed by Ben Waltenberger, Channel Islands National Marine Sanctuary)

(top)

Side Scan Sonar



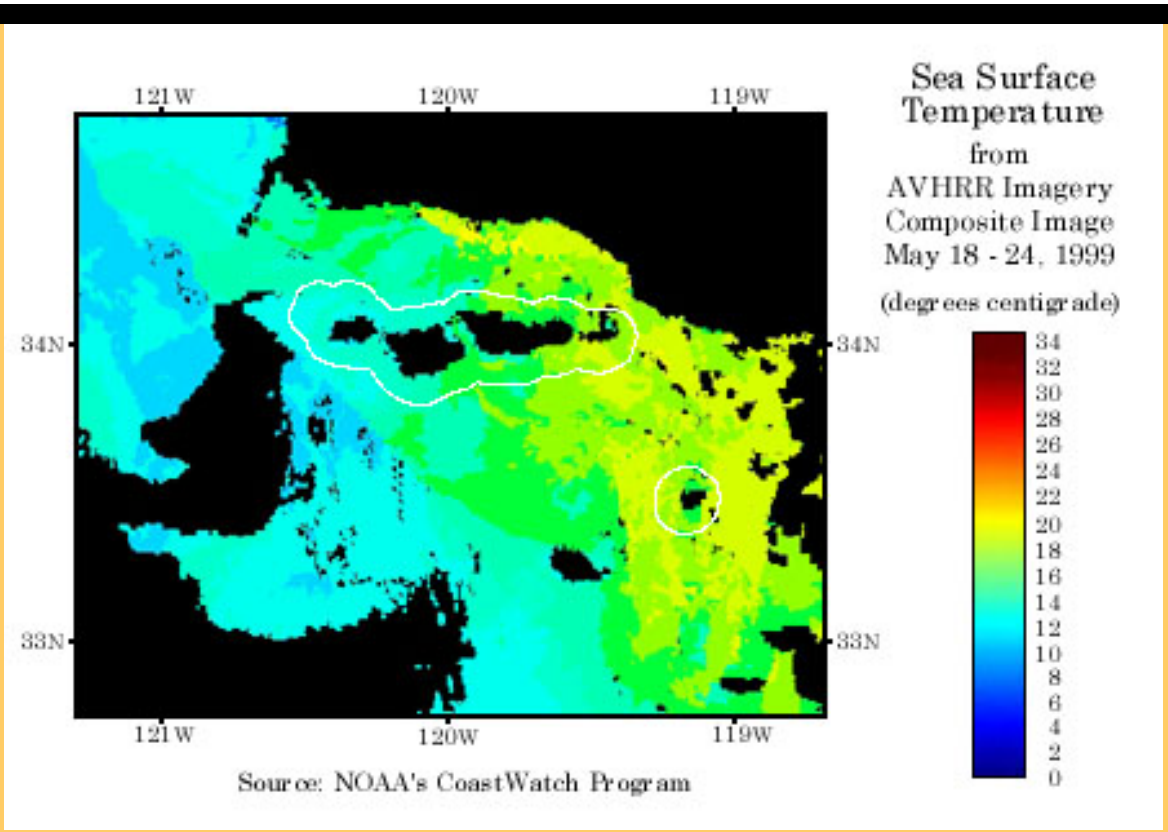


Side Scan Sonar is a mapping methodology that allows us to map the seafloor with acoustic imagery that is analogous to taking airphotos of topside landscapes. The sonar signal gives us an "image" that helps us to determine bottom type. In the above images of East Anacapa Island, the top is a standard processed image, with the multi-grayscale areas representing more topographically variable surfaces like rocky reefs. The larger areas of similar color represent less variable seafloor types, such as sand flats.

By using digital image processing techniques similar to those used on satellite data (bottom image), we can sample for areas of higher brightness ranges to help more easily identify areas that are potentially composed of significant reef structure. This habitat type is a niche environment for many of the species that SSE scientists are interested in studying. Acoustic imagery also plays an essential role in helping us determine survey transects for future missions. (Contributed and processed by SSE GIS Team using original data from PhD. Guy Cochrane, United States Geological Survey)

(top)

Sea Surface Temperature



Relatively warm temperatures (11-18 degrees centigrade) characterize the springtime ocean surface waters of southern California. Produced from the Advanced Very High Resolution Radiometer (AVHRR) on NOAA's polar orbiting spacecraft, the scene shows coolest waters (11-12 degrees cent.) southwest of the sanctuary with warmer waters (17-18 degrees cent.) along the coast near Santa Barbara and Oxnard. Clouds and land are shown in black.

The AVHRR sensor measures radiation reflected from the earth's surface. Data are transmitted from the sensor to ground receiving stations and processed using multi-channel atmospherically corrected algorithms. This particular scene is a seven-day composite image of data collected from May 18-24, 1999. Compositing helps remove clouds that keep radiation from reaching the sensor. Resolution of AVHRR data is approximately one kilometer.

This image represents a series of products being provided by NOAA's CoastWatch Program exclusively for the National Marine Sanctuaries and the Sustainable Seas Expeditions.

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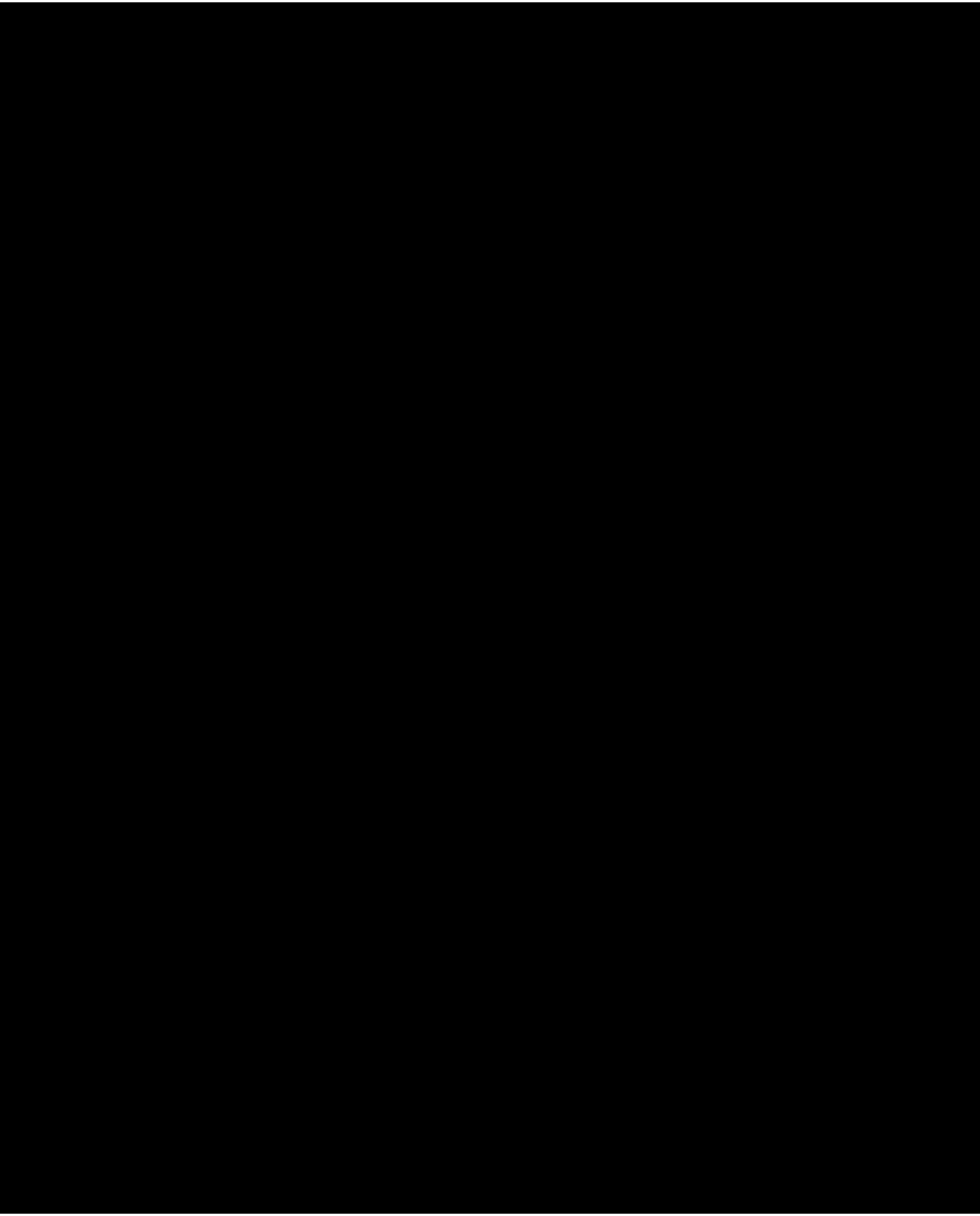

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Sustainable Seas Expeditions

by Lois Capps
U.S. House of Representatives (CA)

U.S. Rep. Lois Capps (D-CA/22)
House of Representatives
Congress of the United States

Oceans are the key to the life support system for all species and play a crucial role in the daily lives of all of us. Yet, we know very little about the Ocean. We know more about the surface of the moon than we know about the floor of the ocean. While the oceans cover most of the Earth, only five percent of the ocean and sea floor has been explored.

However, a new collaborative program by the National Geographic Society, NOAA, and the Goldman Fund, is about to change all of this. The project is the Sustainable Seas Expeditions -- a five-year project of deep water exploration and public education in the twelve national marine sanctuaries.

Last year at the National Oceans Conference, I had the opportunity to meet Dr. Sylvia Earle, the Explorer-in-Residence at the National Geographic Society and Project Director for the Sustainable Seas Expeditions. "Explorer-in-Residence," what a great title! As she told me that day, while the public is very familiar with our National Parks, they are very unaware of the young, but promising counterparts of the National Parks -- our National Marine Sanctuaries.

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Orcas breach off the shores of Santa Rosa Island.

In Congress there is a lot of talk about exploring space as the final frontier. But there is another world out there to be explored, and instead of going up, we must go down. Down to the depths of the vast oceans, to discover the wonders of the sea where we might find new resources, cures for diseases, and answers to scientific questions.

As Dr. Earle states, the Sustainable Seas Expedition will explore our National Marine Sanctuaries in the same spirit that Lewis and Clark explored our Nation over two centuries ago.

(top)

Working in close collaboration with marine sanctuary managers and other scientists, the Sustainable Seas Expeditions expedition team will use innovative submersible technology to undertake the first sustained exploration of sanctuary sites to depths of 2,000 feet to photodocument the natural history of each sanctuary's plants and animals and to establish permanent monitoring field stations within the sanctuary system.

I am proud that the Sustainable Seas Expedition will be at the Channel Islands National Marine Sanctuary from May 24, 1999 to June 5, 1999. The Channel Islands National Marine Sanctuary will be conducting a variety of education and research projects, using DeepWorker submersibles. The Sanctuary's research will be linked to ongoing projects and is designed to generate information relevant to pressing management issues.

U.S. Representative Lois Capps and Ed Cassano, Superintendent of the Sanctuary at Oceans Conference in June 1998.

While visiting the Channel Islands National Marine Sanctuary, The Sustainable Seas Expeditions will also reach out to the local educational community, to increase awareness of the unique marine resources in this region. The sanctuary will serve as a living laboratory and classroom for investigation and discovery by offering teachers and students the opportunity to work alongside sanctuary researchers. Thirty local high school students, representing San Luis Obispo, Santa Barbara, and Ventura Counties, will participate in a Student Summit Conference. The conference will include a half-day interactive session designed to bring high school teachers and students together with ocean experts to discuss the Sustainable Seas Expedition at the Channel Island National Marine Sanctuary. The benefits students will gain, by participating in the Student Summit Conference, are an increased understanding of the underwater cultural and living resources in this region, and how the research process is used in developing management policies to protect natural resources.

The Sustainable Seas program, through its public outreach and education efforts, will go a long way in bringing the well-deserved attention and support of our national treasures -- our national marine sanctuaries. The expedition will be nothing short of revolutionary in our nations understanding and commitment to protect the world's oceans and will lead to better ocean conservation.

Funded in part by the National Geographic Society and a private foundation, the Sustainable Seas Expeditions demonstrates the importance of public/private partnerships in developing a community marine conservation ethic and leading the way for new partnerships in research and education. It is a model to be emulated by Congress.

I remain an active supporter of our national marine sanctuaries in Congress and I am particularly excited about what lies ahead for the Sustainable Seas Expeditions.

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Discovering our Past While Exploring for Our Future

by Bob Schwemmer, Cultural Resources Coordinator
Channel Islands National Marine Sanctuary and Santa Barbara Maritime Museum

As we await the beginning of Sustainable Seas Expeditions' first mission into the Channel Islands National Marine Sanctuary, we find our imaginations run wild sometimes. We can envision, in the early pre-dawn hours, NOAA's 175-foot research vessel *McARTHUR* moving into position for the day's deep water exploration of the Channel Islands National Marine Sanctuary. After a long night of scanning the seafloor with side scan sonar, an instrument that provides a two-dimensional image of seabed features, scientists from the United States Geological Survey discover what they believe to be a large geologic formation. Over the ship's intercom system orders are given "launch the *DeepWorker* submersibles." Within twenty minutes *DeepWorker I* and *DeepWorker II* are deployed and start their descent into the abyss. Reaching 400 feet the ambient light above has now diminished to a faint glow in the upper horizon.

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Although most of the larger "documented" shipwrecks have been located, the 19th-century built 4-masted sailing schooner Watson A. West has remained elusive. Lost off San Miguel Island in 1923, this 192-foot wooden hull vessel is an example of the potential for new discoveries.

"DeepWorker I and DeepWorker II on the bottom, depth 425 feet - heading 240 degrees." "Confirmed, DeepWorker I and II on the bottom, course 240 degrees." The two submersibles start on a parallel transit that will intersect the sidescan target. Water visibility is estimated at over 150-feet horizontal, limited only to the powerful underwater floodlights' ability to penetrate the water column. The seafloor is a flat barren desert of sand, absent of any reef structure except for the occasional encounter with marine life that seem attracted and mesmerized by this alien light source. Thirty minutes into the dive, the concentration of curious fish suddenly multiplies. Could there be a reef nearby?

"DeepWorker I, this is DeepWorker II, are you experiencing a greater assemblage of schooling fish?"

"Affirmative DeepWorker II. Recommend I hold my position - we are close to target"

(top)

The pilot of DeepWorker II starts a circumnavigation of the area

peering into the darkness. *"Wait.... something is moving in the distance, it's very large - maybe a whale? DeepWorker I, turn in my direction and illuminate the target."*

"Roger DeepWorker II, repositioning"

With both underwater camera systems documenting the encounter, *DeepWorker II* cautiously approaches, making sure not to disturb this unknown leviathan of the deep. The image takes on a new dimension. *"This is DeepWorker II my lights seem to penetrate through this life form - this is not a whale but several surging fish nets - they must be snagged to the target." "It's not a geologic formation, I think it's man made - I can see what appears to be a pipe - no it's a cannon - we have discovered the remains of an old shipwreck!"*

This may be only a daydream, but the probability is high of encountering undocumented or even documented cultural and historic sites in the Channel Islands sanctuary. Prehistoric discoveries made at the islands include the remains of perhaps the earliest island inhabitants dating back to over 10,000 years B. P., and the recent discovery of the most complete prehistoric pigmy mammoth recorded to date. There is evidence that submerged remains of prehistoric peoples exist in the sanctuary. Artifacts have been found on the seabed at the islands where land sites have been submerged due to the rise in sea level or through erosion brought on by ocean wave action. Historically the islands were a special place to the Native Americans known as the Chumash, who traveled to the islands in plank canoes called tomols. The Island Chumash composed a single unique culture, sharing in customs, manufacturing similar items such as shellfish hooks and beads.

(top)

A SCUBA diver explores the majestic underwater world of the sanctuary.

These well traveled waters span European exploration from the 1500s to modern times. Due to prevailing currents and weather conditions combined with natural hazards, there are a significant number of shipwrecks. Through the efforts led by Don Morris, CINP Archaeologist and co-author James Lima, an inventory of 140 documented ship and aircraft casualties occurring from 1853 through 1980 have been published. Although most of the larger "documented" shipwrecks have been located, the 19th-century built 4-masted sailing schooner *Watson A. West* has remained elusive. Lost off San Miguel Island in 1923, this 192-foot wooden hull vessel is an example of the potential for new discoveries.

These islands have witnessed the passing of Manila Galleons sailing south along the California coast from Cape Mendoncino en-route to Acapulco; several of these vessels went missing. The islands have been the scene of Russian fur trappers working with Native Alaskans of the Alutiiq tribe to capture sea otters. Small sloops and schooners involved in the early sealing trade have fallen victim to treacherous seas surrounding the islands. The California Gold-Rush brought ships from around the world to the shores of California with passengers seeking their fortunes, many passing near the islands. The Chinese abalone fisherman dating back to the 1860's worked the islands in Chinese built junks with a least two being reported loss in the sanctuary.

(top)

Not unlike the first Apollo flight to the moon or the recent Pathfinder landing on Mars, the DeepWorker submersibles will be introducing, for the first time in history, regions of the sanctuary never seen by man - and the possibility of providing a "port hole view" of our past by discovering new cultural and historic sites. These new discoveries can then be shared with the public and be featured at the Santa Barbara Maritime Museum shipwreck exhibit, a cooperative partnership project of the museum, Channel Islands National Marine Sanctuary.

It bears noting that in the interests of safety, the *DeepWorker* submersible pilots are under the strictest orders not to approach any shipwrecks they encounter. The risk of entanglement is simply too great for an expedition not specifically outfitted to tackle shipwreck exploration. Nonetheless, the potential that previously unknown wrecks might be discovered and marked for future exploration is enticing.

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CHUMASH ESSAY

A Chumash Perspective

by Roberta Cordero, Co-Founder,
Chumash Maritime Association
March 1999

The traditional homeland of the Chumash-the Central Coast's first people-extends over San Luis Obispo, Santa Barbara, and Ventura Counties and parts of Los Angeles and Kern Counties and includes the Santa Barbara Channel Islands. Before European contact, there was much travel and trade between the villages of the mainland and the islands accomplished in tomols, *the Chumash plank canoes. The Channel Islands National Marine Sanctuary funded the building of the Chumash Maritime Association's* tomol, 'Elye'wun *(Swordfish), which was launched in 1997. Roberta Cordero is a co-founder of the Chumash Maritime Association. Her essay reflects a Chumash perspective on resource use and sustainability.*

Imagine moving across warm currents, the taste of salt in the air, in graceful vessels of wooden planks sewn together piece by piece in a skillful design made to cut through the swells and swiftly turn to greet the open sea. Imagine the pride of being honored with the task of bringing the harvest of the sea to the people, of bringing the fruits of the land and the crafts of the people's hands in gift and trade. Imagine the joy of bringing the families together up and down the coastal waters and across the Channel to the islands of *Limuw* and *Xalasat* for visiting and ceremony. Droplets of water sparkle off first one raised end of the paddles and then the other as they are dipped in unison first on one side of the *tomols* and then the other. Our cousins, the dolphins, race with the canoes, gleefully outstripping us with their synchronized leaps and frolics. Or they give "the" people a hurried glance from the frothing center of a school of fish as they feed.

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The cruise of 'Elye'wun and Mo'omat Ahiku and the Channel Islands National Marine Sanctuary R/V Ballena off Catalina Island shortly after dawn in September of 1998. The Chumash tomol and the tongva Ti'at paddle for the first time together in two hundred years.

Imagine the *tomols* landing at the numerous and populous coastal and island villages where Chumash ancestors thrived for thousands of years near the many freshwater creeks and saltwater marshes, abundant sources for food and of materials for houses, baskets, cordage. Hundreds of villages, tens of thousands of people, tens of thousands of years woven together in the life-web. Sustainable earth, sustainable seas. Imagine.

(top)

Until the missionization and holocaust of the Chumash people, our waters were filled with Chumash watercraft, especially the redwood plank canoe, the *tomol.* Until then, the *tomol* wove together Chumash coastal and island communities in a sophisticated, complex system of trade, kinship, and resource stewardship. As with most indigenous nations before European contact, our ancestors' stewardship of bountiful natural resources was sustainable over thousands of years and--we have no doubt--would have sustained us for thousands more. Our ancestors were not perfect, but they did not fancy themselves to be dominators over earth and ocean. They did not dare to live outside respect, generosity, and reciprocity, for these are the values of the properly educated human being; these make up the weave of living balanced and productive lives together and individually. Our ancestors did not imagine there was an end to learning from the life-web of which

the humans are merely a strand. Sadly, that web is now tattered and tangled because we have been severed from the proper stewardship that is both birthright and responsibility.

Among indigenous maritime nations a great resurgence of traditional maritime culture is taking place. The great canoes of Alaska, British Columbia, Washington are once again being carved, crewed and celebrated. The double-hulled voyaging canoes of the Hawai'ians are once again navigating thousands of miles of open ocean. The indigenous peoples of Australia, New Zealand, the South Pacific are joining their efforts to this renewal. No less are the California peoples, both north and south, listening to their ancestors' urging to relearn the canoe knowledge. And always we tell one another about the increasing difficulty of finding large enough trees for the carved canoes, enough fiber plants for the cordage and the baskets needed to build, fish, store. We tell about the perennial battles for sustainable use of the fisheries. We talk about the diligence needed to protect our ancestors' burial sites, about our puzzlement that such simple human respect must be argued over. We decry the increasing scarcity of the food and medicine plants native to our homelands; and we struggle to gain access to the places where our traditional resources still exist. The encroachment of Euroamerican practices and values has left us with only shreds of connection to the land and sea from which we spring and which shaped our ancestors' identity and destiny.

Many Chumash artifacts have been found on the Channel floor within the sanctuary. These artifacts provide insight into the original inhabitants of the Channel Islands and are an irreplaceable insight into the Chumash cultural heritage.

(top)

The Western world views as heroes those who criss-cross the south and north poles, scale Mount Everest, pay to go on Indian-style vision quests, and spend years researching their "power animals." These people often become very interesting and admired, but we seldom hear whether their communities back home gain from these feats. This is the center of our ancient balance: that our communities-human, plant, rock, and animal-benefit from the knowledge and clarity we gain as individuals.

A return to that ancient balance requires that we return to those values - respect, generosity, reciprocity - which are integral to sustainable relationships with one another as much as with earth and sea. With these we may firmly reweave ourselves into the life-web in such a way that communities -- our ecosystems -- can once again thrive. How do we re-learn the intimacy of relationship that makes it possible to understand the workings of an ecosystem? What we are finding is that an explicit task which uses a natural resource for some helpful end engages the mind and spirit in an ever-deepening exchange with that resource.

In building a tomol using modern boatbuilding techniques and materials, Chumash Maritime Association apprentice builders found our curiosity sharpened concerning the tools and skills our ancestors used to build *tomols* in the past. We hope soon to build a tomol in the old way and so we are assessing the availability of the raw materials needed: redwood or pine which we can hand split into planks, dogbane *(Apocynum cannibinum)* from which to extract enough fibers to craft two miles of handmade cordage to tie the planks, asphaltum and pine pitch to mix for *yop*, the adhesive used for *tomols*.

(top)

A Chumash tomol.

To discuss just one element, dogbane was once plentiful and common in local riparian areas. Because of water diversion from many creeks along with environmental degradation in those areas, there are only two known wild dogbane stands in all of Santa Barbara County. We are therefore working not only to sustainably manage and harvest those stands for our use, but also to collaborate with other environmental interests to restore degraded areas by reintroducing native plants, including dogbane. When we involve families and children in every step of planting, managing, harvesting, and processing dogbane, we necessarily gain intimate knowledge of that plant and its needs. We teach and learn respect when we harvest from a plant only what we need and only what will help the plant to thrive. We teach and learn reciprocity with our habitat when we take the time to appropriately prune a plant or to aerate the soil around it. We teach and learn generosity when we volunteer our time to collaborate with others in advocating public and private responsibility in cleaning up what we have polluted.

We do not imagine that our Chumash homeland can ever be restored to what it once was, though we might dream of that. We do work and pray for a swift return to sustainability without which the land and sea will surely die. We believe it is not too much to imagine that the creeks can again flow with pure water, that the sea can again sparkle and dance in robust health, that the *tomols* and other vessels can again enter the weave of the people and all our relations living together in harmony and beauty. It is not too much.

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Conservation in the Channel Islands National Marine Sanctuary

by Peter C. Howorth, Conservationist
Santa Barbara Marine Mammal Center

The Sustainable Seas Expedition is "going where no one has gone before," not to the reaches of outer space, but to the inner space of our own backyard. For the first time, deep regions of Channel Islands National Marine Sanctuary will be systematically explored, studied and charted. The upper hundred feet or so of water has been extensively explored by divers for decades. Beneath that lies a vast unexplored region.

An interested public learns more about the diversity of life in tidepools.

Over 100 shipwrecks have been documented in Channel Islands National Marine Sanctuary, virtually all in shallow water. Yet many

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unsolved mysteries await discovery. Through systematic explorations by submersible and sidescan sonar, a wealth of information of national significance could well be discovered, if the shallow sampling of cultural material from known shipwrecks is any example.

(top)

Geological features deep beneath the sea could harbor remarkable colonies of plants and animals, quite likely some which have never been described. Undersea escarpments favor the upwelling of cold, nutrient-laden water from the depths, providing sustenance for legions of organisms ranging from planktonic forms to blue whales, the largest creatures on the planet. The bathymetry-- undersea topography--of the Santa Barbara Channel, together with its current systems, provide key elements in sustaining a remarkable ecosystem.

A Tube Anemone

This ecosystem has scarcely been touched in terms of understanding the relative importance of deeper water organisms. One of the goals of the Sustainable Seas Expeditions is to examine the habitat of the market squid, a species of growing commercial importance. This squid is also is major importance to myriad organisms, ranging from various pelagic and benthic fish to marine mammals and even sea birds. The effects of increased harvests of these squid on the numerous creatures that prey upon them are unknown. The Sustainable Seas Expeditions could well shed light on this pressing management issue.

(top)

Science is a never-ending voyage of discovery. The Sustainable Seas Expeditions promises to yield valuable data so that informed management decisions can be made to preserve this remarkable region.

A SCUBA diver is dwarfed by the giant kelp forest.

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CHUMASH ESSAY

Marine Reserves, Essential Fish Habitat, and Rockfish Conservation Biology

by Dr. Russ Vetter
NOAA, National Marine Fisheries Service

There has recently been a resurgence of interest in establishing marine ecological reserves, not only as sites for benchmark studies, but also as a tool for fishery management. The rationale for reserves in fisheries management is that they would protect habitat and reproductive adults of non-migratory, structure-associated, rocky-reef fishes. Eggs and larvae would then drift out of the reserve and "reseed" fished areas. What has been woefully lacking is scientific study to guide design and placement of such reserves. The Sustainable Seas Expeditions will enable us to gather information previously unavailable due to depth and other logistical barriers.

Russ Vetter, Geoff Moser, and William Watson have been developing methods that can be used to: 1) evaluate habitat quality and its suitability for inclusion in a reserve; 2) measure reserve specific contributions to egg and larval production; and 3) determine oceanographic dispersal characteristics of potential reserves.

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Santa Cruz Island

(top)

Within the context of the Marine Ecological Reserves Research Project (MERRP), we are examining two sites (Vandenberg and Big Sycamore Canyon) that are state controlled no-take reserves, and two sites (San Miguel and Anacapa) that are within the Channel Islands sanctuary but are fished by commercial and recreational fishers. We are using side-scan sonar, video, and diver transects to develop habitat maps. An acoustic Doppler current profiler will enable us to determine prevailing currents. Egg and larval production is measured by a continuous underway egg pump and by vertical Bongo net tows.

The Sustainable Seas Expeditions cruises will provide valuable new tools and data for studying reserves. The extended bottom time and depth range of the submersible should greatly extend our SCUBA transect capabilities for examining and validating physical habitat maps created by side-scan sonar. Further it should provide a better means of evaluating characteristics of the habitat such as rock spacing, algal cover, crevasse size, and vertical relief, so we can find out what makes one rocky habitat more hospitable than another to attract and retain fishes. It is not

currently possible to make these sorts of observations in waters much greater than 30 m.

Finally, Sustainable Seas Expeditions is expected to extend our night observation capability. One area of particular interest is the study of cow rockfish, sebastes levis, a trophy rockfish that is presently of great management concern. Best estimates indicate that this fish has been reduced to less than 10% of the unfished stock. The area within the sanctuary was historically an area of high abundance. Cow rockfish habitat is centered between 150 and 250m. This depth region is inaccessible by SCUBA but ideal for the Expeditions.

A hiker atop Anacapa Island

We look forward to working with and strengthening the links between National Marine Fisheries Service, South West Fisheries Science Center and Channel Islands National Marine Sanctuary in formulating reserve research and policies that will meet the goals of the sanctuary and the Essential Fish Habitat mandate of the Fisheries Service.

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May 24, 1999

LCDR Matt Pickett, Assistant Manager
Channel Islands National Marine Sanctuary

Throughout the past year, and especially the past few months, CINMS staff have been working in preparation for our SSE mission. Today, on the eve of the launch of our mission, GIS Specialist Ben Waltenberger and I checked the weather and verified good conditions for flying. We decided to fly an aerial survey to map out sanctuary activities prior to the start of SSE.

Using our research aircraft, NOAA 64, the sanctuary has been completing weekly surveys of the sanctuary waters to map vessel use and cetacean distribution for the past two years. Using customized data collection software and a GIS, sanctuary management can obtain near real-time data of activity in the sanctuary. Archives of the survey flights can be comparatively analyzed to detect correlation, variation, and long term trends. We're excited that SSE is providing another data layer for our GIS that will allow us to compare habitat characterization data with historical cetacean abundance and distribution.

Photo 1: View of East Anacapa Island operational area from aircraft NOAA 64.

At 1300, upon completion of the preflight, we taxied for takeoff on runway 15L for the 15 minute flight to start the survey at Anacapa Island. Leveling off at a thousand feet, we noticed the Santa Barbara Channel was a little choppier than we hoped for. The whitecaps make sighting whales and dolphins a little more challenging.

We began the survey by taking some aerial shots of one of the SSE study areas off Anacapa Island (Photo 1). The survey was pretty routine; we spotted a number of commercial fishing vessels, but not many recreational boaters due to the rough weather. We observed a large pod of common dolphins (about 500 animals) off Santa Cruz Island but things really start getting exciting north of San Miquel Island.

Photo 2: Blue whale surfacing off San Miguel Island.

We spotted 11 blue whales (Photo 2), three grey whales, and 15 Risso's dolphin in a very concentrated area of about 5 x 5 nautical miles. We can see krill in the water and spot some blue whales feeding. This area is consistently a hot spot for seeing blues in the summer. Their size is impressive, even from a thousand feet. After a long flight in a small plane, we called it a day and headed back for Santa Barbara airport, touching down smoothly on runway 25 at about 1530. We headed back to the office to plot the data and a few minutes later we had a nice image (Figure 1) of the cetacean activity in the sanctuary for the day, and more data for long term analysis.

Tomorrow, we'll have lots more work to do, loading equipment onto the Mac, and preparing for tomorrow night's student summit event. Everyone is getting antsy, ready to embark on our portion of this expedition.

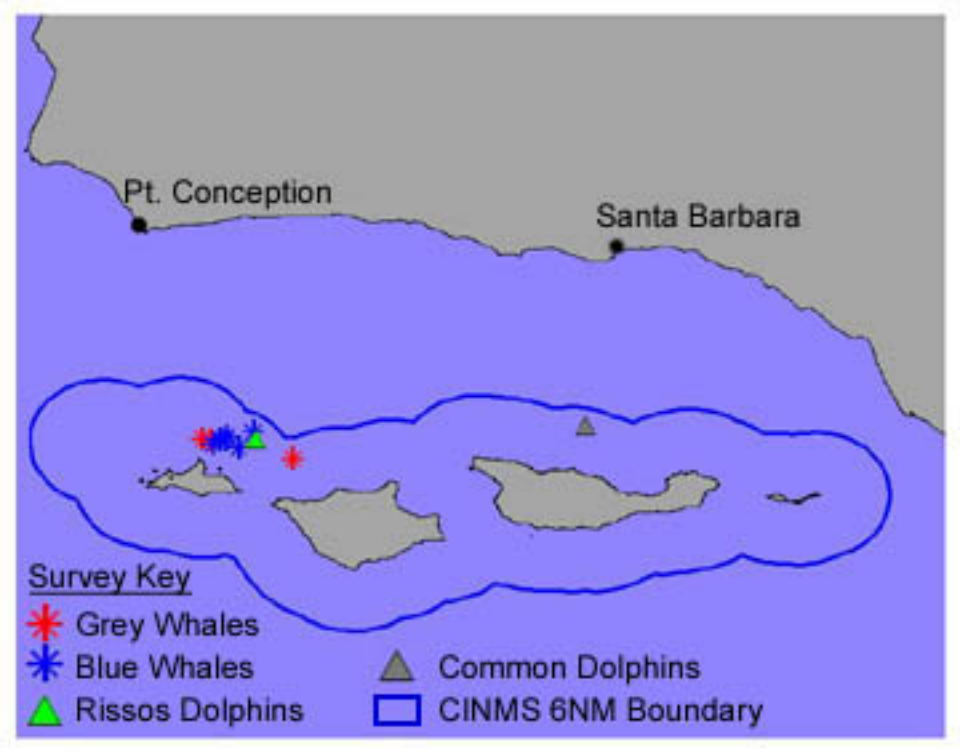

Figure 1: Aerial survey data 24MAY99 2130 GMT.

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May 25, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Laura Francis, Education Coordinator
Sustainable Seas Expeditions

Julie Goodson, Education Coordinator
Channel Islands National Marine Sanctuary

Preparations for the Channel Islands segment of the Sustainable Seas Expeditions have been going on all weekend, and continue today. I arrived at Port Hueneme and the McARTHUR this afternoon to find the oceanographic lab completely transformed. What was once a wet lab full of scuba equipment, nets, and sampling equipment had become a sea of computer equipment, firmly strapped to every available horizontal surface. The name of the game is side scan sonar, which will be run every night after sub ops have been completed. Guy Cochrane will write more about this later.

The Channel Islands National Marine Sanctuary officially kicked off its SSE mission tonight with a Student Summit for 29 high school students from 10 area schools, including Paso Robles, Santa Barabara, and Oxnard. Students proposed research projects for next year's Expedition to a panel of experts that included Dr. Sylvia Earle, CINMS Sanctuary Manager Ed Cassano, commercial fisherman Chris Miller, geophysicist and SSE scientist Dr. Guy Cochrane, and SSE scientist and bioluminescence expert Dr. Edie Widder. The event was orchestrated by the Channel Islands National Marine Sanctuary Education Coordinator, Julie Goodson, who writes:

"My excitement and anticipation for the Channel Islands National Marine Sanctuary Student Summit Conference began when I started receiving the different PowerPoint presentations of the student project proposals for potential research projects. The 29 high school students selected to participate as team members in the Student Summit Conference are truly very talented and committed to getting involved in the Sustainable Seas Expedition. In spite of their hectic school schedules during this time of the year, the students managed to develop interesting project ideas with topics ranging from developing tools to monitor deep-water environments to monitoring the abundance, size and distribution of the California Sheephead in different channel island sites.

"Some members of our student summit team had to travel great distances (students from Paso Robles had a 3 hour journey) to attend the Student Summit Conference in Santa Barbara. We decided to host a reception for the students and panel members before the Student Summit Conference so they could spend more time getting to know each other and relax before the big event. It was wonderful to spend time talking with individual students and teachers and to learn more about their lives and interests for the future. What impressed me most was their raw enthusiasm to learn more about the ocean, and to get involved!

Dr. Sylvia Earle speaks with presenters during the Student Summit.

"The first annual Channel Islands National Marine Sanctuary Student Summit Conference went really well. I was so pleased to see the depth of interaction between individual panel members and students as they presented their project ideas. Everyone in the room seemed to have a really good time sharing stories about the ocean, laughing at awkward moments and carrying on meaningful discussions about science and the scientific process. The raw enthusiasm present in the Student Summit Team spread to members of the Panel. The energy was great!

Cabrillo HS (Lompoc, CA) Research Project

"I think we all benefited from the experience of sharing ideas. This team is excited about participating in the Sustainable Seas Expedition next year. We have already begun planning on our next meeting in the Fall to further define our research project for next year. There was even talk of planning field trips out to the islands to learn more about the resources. I am really proud of the student summit team created for this year's Summit Conference and look forward to working with them next year."

Julie did an incredible job of working with the students, setting up web chats with scientists before the summit, organizing the event, and helping the students put together their presentations. The student teams will accompany Julie on a field trip to Anacapa Island to help with the live broadcast this Thursday.

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May 26, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Weather: Overcast, light breeze
Location: Anacapa Island

Today was a very successful first day of dive ops for the Channel Islands mission. Our goals for the day were to complete Ed Cassano's checkout dive, then have him practice with diving the sub while a group of SCUBA divers did a live audio/video transmission to shore. He ended up spending a full four hours in the sub, with great visibility, lots of critters, and no major mishaps. Hallelujah!

Ed Cassano begins his checkout dive.

I spent the day onshore on Anacapa Island, which was the base the SCUBA divers were using for their work. I had a second through-water communications unit for use as a backup for talking to the sub, and maintained communication with the ship and others involved on the VHF radio as well. Divers joined the sub not only from shore, but from the Channel Islands boat the XANTU, as well. Independent of our project, a group of hikers was on the island, and passed through the landing area while we were doing dive ops, and a crowd of 70 fifth grade students came in to watch a live SCUBA broadcast conducted by Channel Islands National Park staff and volunteers. All these extra people made things a bit confusing at the landing cove, but it was good practice for the students and news media scheduled to join us tomorrow.

At various times, we had SSE Education Coordinator Laura Francis, SSE Photographer Kip Evans, and several other SCUBA divers in the water with and without the sub. Meanwhile, Ed Cassano was having the time of his life in the sub (I've asked him to write something for the log about his experiences, and we'll post it to the site when we get it from him). Lots of fish to see, good visibility, and a sub that was cooperating fully: No ground faults, communication breakdowns, or any of the other 100,000 or so things that could go wrong.

We were able to communicate with the sub, and the divers, and although Ed couldn't

hear the divers' comms, they could hear his transmissions just fine. I was able to hear both Ed and the SCUBA divers on my through-water system, and communications between the shore and the various boats onsite went well. The staff from the National Park were incredibly helpful. Their assistance made a huge difference in how smoothly everything went. By the end of the day, we felt confident that tomorrow's live satellite uplink would be manageable, in spite of all the variables.

When sub and SCUBA ops were done for the day, some of our scientists and ship's crew turned to other important business. All that computer equipment we loaded in Port Hueneme would serve its purpose late into the night, as side-scan sonar operations were conducted. The sonar equipment is used to gather information about the type and topography of the sea floor. It's amazing how much we still don't know about so much of the world that lies beneath the ocean's surface. This expedition affords an important opportunity to get out there to gather more of the data we need to even know what's out there. Guy Cochrane has promised to write up a little something about the side-scan sonar work, which we'll post here as soon as we have it. Meanwhile, most of us are off to bed, to rest up for another very busy day tomorrow.

(top) **RETURN**

May 27, 1999

Robert Schwemmer, Cultural Resources Specialist
Channel Islands National Marine Sanctuary

Channel Islands National Marine Sanctuary (CINMS) And Sustainable Seas Expeditions (SSE) Come to Ventura

Sixty students and their teachers from the fourth and fifth grade class of Blanche Reynolds school in Ventura, took the plunge off Anacapa Island today to witness history in the making, as Channel Islands National Marine Sanctuary Manager Edward Cassano piloted the DeepWorker submersible to meet divers engaged in the Great American Fish Count. Actually the students never got wet, since they were able to view the live video link that was broadcasted to the visitors center of the Channel Islands National Park. Diver and cameraman Dave Stoltz of the National Park provided the underwater video and SSE diver Laura Francis provided the underwater narration for students and visitors.

Students enjoy a model of the DeepWorker at the Channel Islands National Park Visitors Center.

Topside on the island, Julie Goodson of Channel Islands National Marine Sanctuary furnished an overview of the rich marine resources in the sanctuary and passed along questions to Francis on behalf of the students and visitors. The camera panned the abyss for DeepWorker coming up from the depths, and the students gasped with excitement as the submersible came into view. They marveled at the mobility of the DeepWorker as Pilot Cassano demonstrated the tight turning radius by spinning in place.

How can I begin to describe the challenges and achievements associated with today's activities? In addition to all those students on the island, we had numerous television and newspaper reporters on board the McARTHUR during dive operations, then transferred them all to the island to meet with the kids and watch the footage from the dive. We had seven boats in the water in a very small area, including the Mac, the sanctuary's research vessel Ballena, the private dive boats with dozens of scuba divers, and RHIB boats from both the Mac and the Park Service. So much to orchestrate!

The DeepWorker demonstrates its agility beneath the surface.

The dive itself went so well! The two groups of divers (one from the island, one from the dive boat) met up in a kelp bed just outside the landing cove. Moments later, they were joined by Ed Cassano piloting the DeepWorker. One small snafu. Our through-water comms between the sub and the surface that worked so flawlessly yesterday let us down this time. Ed could hear us, but we couldn't hear him. We ended up communicating with him mostly by contacting the scuba divers and getting them to pantomime to him what we wanted to know. What really counts, though, is results, and in spite of the technical difficulties, we were able to pull off this incredibly complicated event in spite of the malfunction.

The students were even more enthusiastic than they were on Monday night. Here are some of their comments:

"The thing that stands out in my mind about this trip is the technology I got to see first-hand working with people. We were able to see what everyone in the water was seeing and we could interact with the people and divers in the water. I really enjoyed the interaction. That was great!" - *Sarah Shutes, Oxnard Unified High School*

"Today was a great day. Seeing the sub in action and meeting the crew was an interesting exerience. Seeing the divers and the sub was a great contrast. Meeting with the press was a definite highlight!" - *Tim Rademaker, Adolfo Camarillo High School*

"I thought this was such a good opportunity for all of the people that participated. I don't know a lot about marine biology, but today I felt like I knew what I was doing, I felt a part of something. I really care about the environment and today I was doing something about it, and on top of that, I was doing something related to the well-being of the ocean, which I can say is a first. I loved going to Anacapa Island and I hope to visit as many of the Channel Islands as possible. I loved every second and I was amazed with the grandness of the project, and the technological aspect was absolutely impressive, but most of all I had a great time and lots o' laughs!" - *Aubrey Duenes, Paso Robles High School, Grade 11*

Upon completion of the live video presentation, I met with the students around a full size model of DeepWorker. I answered their many questions about the capabilities of the submersible and the planned expedition. One student asked, "have any new discoveries been made?" My reply, " already today we've made one exciting discovery: a Giant Sea Bass was spotted on the one of the first dives of the expedition in the CINMS." I also talked with the students about the submersible simulator being built for the maritime museum that will provide a virtual experience of discovery, as they too will have the opportunity to fly through the sanctuary.

On board the McARTHUR, sanctuary and SSE staff gave each other real and virtual high-fives (actually, since our business is exploring the deep ocean, we prefer "low fives."). We pulled off a really difficult and complex operation -- two really successful days of diving in a row, and more to come!

(top) **RETURN**

May 28, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Location: Anacapa Island

Every once in awhile, you can look back on a day, and just go, "YEAAAH!" Today was one of those days. Spirits were high, everyone was in a good mood, we all worked really well together, and we got a heck of a lot done. THIS is the SSE we've all been waiting for!

Sarah Fangman getting ready to dive. Dive supervisor Larry Shumaker will go through a final checklist before the hatch is sealed.

We started work at 0630 (ugh!), and even though most of us were pretty wiped out after getting to bed late last night, we were eager to get out there and get the sub ready for an 8:00 launch. It's a wonder how much you can accomplish when everyone's got a good attitude and a common goal. We whipped through the pre-dive checks in great time, and got the sub in the water with Tim Friend at the helm.

During Tim's dive, the compass fell off, and the suction cup that holds it on had (predictably) fallen down the sub's leg tube, along with one of Tim's eyeglass lenses (you can't drop anything in the sub without it ending up down there). During the post-dive, Guy was showing Tim how the suction cup pops on and off the back of the compass. I glanced up just in time to see a piece of plastic go FWING! and whiz by at head level -- The bracket with the suction cup. Flying at warp speed. 10 feet across the fantail. Past the sub. Past the dive sup. THROUGH the chock. Into the ocean. Never to be seen again.

We were eventually able to breathe again after laughing our butts off (although some of us were still unable to stifle our giggles), and determined that we did, in fact, have a spare. Guy dove next, making good observations of the local aquatic wildlife, and indulging his professional passion for all things geological.

We'd been working straight through meal and break times, taking turns grabbing a quick bite now and then so we wouldn't have to disrupt the flow of our work. By the time Guy was back on deck and we'd turned the sub around for Sarah's dive, we were

actually ahead of schedule! We joked with Ed that he could claim a more important distinction than GFNMS Manager Ed Ueber's. Ed Ueber was very proud of being "the first sanctuary manager to pilot the DeepWorker in his sanctuary on the first dive of the first mission of the first year of SSE." Well, Ed Cassano was shaping up to be the first sanctuary manager to actually have a day of his mission go exactly the way the official Plan of the Day (POD) said it would!

Every night, the project leaders and ship's Ops Officer meet to plan out the next day's schedule, which is then posted throughout the ship. After all the changes and delays and weather problems and sub malfunctions and everything else that drove us crazy during the first three missions, everyone, but everyone, had become thoroughly jaded about the POD ever coming close to matching reality. The only other one we'd had that was accurate at all was the one made up by the ship's Third Mate Greg Hubner a few weeks ago. It consisted of a long row of question marks and said simply, "You'll know when we know." Not much of a plan, but it was honest!

Now we were in the home stretch, with Donna's dive, which went really well. And again, we got to really accomplish some science, even though this was only intended as a checkout dive. The most exciting discovery on Donna's dive was an incredible abundance of juvenile vermilion rockfish. This year's crop is the best she's ever seen, which is very good news for a species that's been under a lot of pressure from various human activities. These little two-inch-long babies will take seven years to grow to maturity, but their presence here now represents a bright ray of hope.

Once Donna was back on deck, we all met in the wardroom to review the day's successes. We were a little pooped after such a long day, but felt so good about how well everything had gone that we hardly noticed. After the meeting, some of us started post-diving the sub while the sanctuary team worked out their plan for tomorrow. Sometimes the post-dive can be a bit of a drag. You're tired after a 12 to 14 hour work day, it's cold as the sun's setting, and you don't have any more dives to look forward to that day. But tonight, it was more fun than work, with a sense of camaraderie running high, The Specials blaring from the CD player in the sub shack and the full moon rising in the still-bright sky. After all the frustrations of earlier missions, the satisfaction of getting so much accomplished is a terrific feeling, and I can't wait to see what tomorrow will bring.

(top) **RETURN**

May 29, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

An early start again today. Bleary-eyed after so many late nights and early mornings, we make our way out to the fantail and start pre-diving the sub. We've selected a site where we can do some fish and geological transects in good rocky-bottom habitat. The first launch is scheduled for 0800, but as the predive progresses, we're all aware of the increasing wind, and experience tells us that it will soon be too windy here to safely dive the sub. Compared to how things were offshore from San Francisco, though, we're lucky. We DO have other options where good scientific dives can be done in the lee of the islands.

The scientific team converged on the wardroom to prowl the charts and decide where to go and what to do. And we got to see again how a potential negative can be quickly turned around in a room full of positive energy and an indefatigable can-do attitude from Ed, Sarah, Donna, Guy, and the rest of the crew. A plan of action was quickly hatched that would enable us to do some science now, and set up a site for follow-up studies later.

Back in Drake's Bay, we'd loaded 300 pounds of concrete from the rickety fishing pier, down a ladder, onto the RHIB boat, hauled it over to the Mac, mixed it on the fantail, and poured to into empty Sodasorb buckets to make weights we could use in ROV operations. Since then, those buckets had been sitting on deck waiting for us to find the right time to make good use of them. The time had arrived.

The plan was a little wacky -- science on the fly -- improvising with materials on hand. But it worked like a charm. We'd identified a 200 yard long strip of rocky-bottom seafloor, around 30 meters deep, that we wanted to explore to get an estimate of the fish population, and to determine the geological character of the place. Chief Bosun Dave Minshall loaned his rope braiding expertise to attach floats on 1 meter

lanyards to each of the three buckets of concrete. Third Mate Greg Hubner, on the bridge with Matt Hovelman, steered us along the exact transect line we wanted to explore with the sub, and with near-perfect timing, we dropped each of the three buckets off the transom to mark the beginning, middle, and end points of the transect. Now, we can not only find the right spots with the sub on this mission, but revisit the exact same points later, with both subs and scuba.

Dive crew prepares to deposit cement buckets for DeepWorker pilots to locate.

The idea with the floats was to make the markers easier to find underwater, but not from the surface. We had the GPS coordinates to find the right spot when we needed to. But finding the markers with the sub proved more difficult than we'd expected. Tim Friend was our pilot, and as he descended to the bottom, most of the team gathered around the through-water comms unit to monitor his progress. He's promised a log entry, and I'll post it here when it comes in.

USA Today reporter Tim Friend prepares for his dive in the Channel Islands Sanctuary.

During Tim's dive, events topside took an unexpected turn. On the bridge of the McARTHUR, the emergency radio channel is constantly monitored. Throughout the day, we'd overheard occasional distress calls from recreational boaters whose Memorial Day weekend outings had gone awry in one way or another. Most calls were far from the Mac, and we could hear the Coast Guard and Vessel Assist responding to the calls that were going out. But one panicked call required our attention.

Greg Hubner and Matt Hovelman were on the bridge when the Casablanca's distress call was broadcast over channel 16. "Greg and I looked at each other when the Casablanca reported their position to the Coast Guard," said Matt. "After consulting the chart we realized that the Mac was close enough to respond with de-watering pumps--so Greg called Captain Sites."

"The humorous thing about the entire scenario was that Greg called the Coast Guard several times regarding what we could do to help the Casablanca, and they never did figure out who we were--Greg's deep voice and Bronx accent had them running for a translator," Matt laughs. "For some reason they thought we were an oil tanker as well, and probably were wondering what we were doing so far south of the traffic lanes because the Casablanca was tucked in a small cove on the south side of Santa Cruz Island, only about 2 miles from our position."

Sites took the Mac's Chief Bosun, Dave Minshall, and two of the ship's engineers, Chris Dvorak and Jake Bennett and set out for the sinking vessel, a 40 foot cabin cruiser, while the sub was still in the water. When they reached the Casablanca, very nearshore off Santa Cruz Island, the main deck was completely covered with water, and the keel was on the bottom. Diesel or gasoline coated the water's surface around the foundering boat. The boat's owner and passengers were on the beach trying to pull the boat closer to shore using only a 1/2 inch line, while the tide tried to pull it further out. Soon, smoke began billowing from the boat's cabin, and the RHIB had to back away until it cleared. Minshall positioned the RHIB behind the boat and pushed it closer to shore until she was firmly aground.

Captain Sites explains what happened next: "Water then began draining out of the vessel. Jake and Chris started the handy billy bilge pump and began dewatering the boat. We climbed aboard the vessel, checked for people, and shut down all equipment and accessories that were still on. We also opened two cabin windows to increase the ventilation and allow the fumes to escape. We ran the portable bilge pump for about 20 minutes but water continued to enter the boat faster than could be pumped out. Water entered the boat each time she rolled. We also found several one hundred dollar bills floating about and gave them to the owner. An anchor was found aboard. It was run ashore and dug into the sand to help keep the Casablanca from drifting offshore."

They stopped trying to pump the water out when it was clear that it would continue to come in faster than they could pump it out. Once they received word that the Coast Guard was enroute and due to arrive shortly, they returned to the Mac so we could recover the sub, which we couldn't do without the Chief Bosun. The Coast Guard and the owner of the Casablanca contacted us later to express their thanks for the Mac's efforts to help them.

Throughout the adventure on the Casablanca, Tim was continuing his dive, making good fish observations and taking video footage of the critters and habitat. Even though the marker concept will have to wait for another day to be proved out, it was a good dive, and a good day. Shortly after he was back on deck, Tim had to catch a ride back to shore, while the rest of us finished the post-dive work on the sub, debriefed, and planned the next day's work.

(top) **RETURN**

May 30, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Guy Cochrane, Scientist
United States Geological Survey

Location: Santa Cruz Island, Channel Islands National Marine Sanctuary

Ed's jazzed. Ian's jazzed. We're all jazzed. The experiment in transect marking was a great success today, and we got four good long dives completed, two dives with each of the two DeepWorkers.

We started pre-diving the subs early, as usual, with myself, Ian, and Ed Hoefing on sub 3. Technically, this is the rescue sub, so it's reserved only for Nuytco staff and selected SSE personnel who can do what's necessary in a rescue situation. Ian's going to dive this sub first today, followed by Lt. Dana Wilkes. While we prep sub #3, the sanctuary scientists are working on sub #4, with Guy as the first pilot, and Sarah to follow later in the day.

Guy's launch goes without a hitch, followed swiftly by Ian's. And now the race is on! Who's going to be the first to find one of the markers? Dive supervisor Larry Shumaker, DOER's Phil Otalora and the sanctuary manager Ed Cassano are glued to the tracking computer, trying to see whether they can accurately follow the location of both subs in relation to the markers, the ship, and each other. Minor confusion leads to major frustration when they realize that the tracking transducers got switched on the two subs. What they thought was sub #3 was really #4, and vice versa. No wonder our two pilots seemed to be having so much trouble following the headings we were giving them!

Here's Guy's take on the dive:

"This was my first non-training dive, the objective of which was to run a geology and benthic fauna transect. We record video constantly during the transect, documenting the change in bottom character, while verbally describing the fish we observe using the sound track on the video. The time annotation on the video can be used to synch the video information to navigation data recorded on the ship telling us where the sub was located when I observed changes in bottom character or fauna.

"The first task of the dive was to locate a buoy. This was to be accomplished using the sub tracking system on the ship, sonar and compass on the sub, and a side scan sonar image of the area recorded last night that shows the location of the buoys relative to large geologic features on the bottom. To heighten the excitement for me, Ian would also search for the buoy, pitting a sonar expert against a submersible expert in a race to the marker.

Predive WardRoom meeting with Dana Wilkes, Guy Cochrane, Ben Waltenberger (CINMS GIS Specialist), Sarah Fangman, Ed Cassano

"Once in the water I immediately did a sonar scan in the direction of the buoy and located a very promising target. With the permission of the dive supervisor I set off at top speed toward what I thought was surely the bucket of cement. It was a rock, a bucket sized rock sitting in the sand. I scanned again using a heading to the buoy location provided by the dive supervisor. Another target, another full speed dash, another rock. Deepworker 3 was launched. I began madly scanning and speeding from one bucket sized rock to another. Deepworker 3 was in the area also searching. Both subs were now winging back and forth in the general area of the buoy. I found another sonar target and went at it. Success!

"Finally, we get the triumphant word from Guy: 'I found buoy #2!' Pandemonium breaks out in the control room, with war whoops, cheers, spontaneous boogie-ing and high fives all around."

Back to Guy's account, and more serious stuff:

"Once Ian joined me in Deepworker 3, we proceeded on a science transect from the buoy to the second marker. I tried to concentrate on identifying the variety of fish species I saw, including aggregations of small vermillion rockfish, a larger Kelp Rockfish, Whitefish, Blacksmiths, Black Eyed Gobies, Sheepshead, several other species I didn't recognize but described for later identification, and my biggest surprise, an Ocean Sunfish slowly flippering away.

"Characterizing the bottom habitat using the submersible was much easier that previous efforts I have made drifting a video camera from a boat. The view area in water with even 20 foot visibility is much greater than the view area of a sled mounted video. The general habitat along the transect consists of fine sand areas populated by brittle stars, sea pens, and small flat fish, low relief massive fractured rocky areas with algae but devoid of organisms such as gorgonia, and rare higher

NOAA's Dana Wilkes and USGS Geophyscist Guy Cochrane in a pre-dive meeting in the WardRoom.

standing rocky areas that do support Gorgonia. It's likely that the low lying rock areas are frequently covered over by migrating sediment. I would like to see the transect revisited frequently to test this hypothesis."

Back on the surface over two hours later, the good-natured competitiveness between the two men is still in full swing. Both subs emerge together some distance from the ship, and have to transit back on the surface. But the sub Ian is piloting is a lot heavier than the one we usually use, because it has the manipulator arm mounted on it. The extra weight puts more of a strain on the thrusters, and slows the sub down considerably, so there is really no way he can transit as fast as Guy. On the fantail, we can't resist ribbing Ian for being one step behind Guy again.

Next in the water are Sarah Fangman and Dana Wilkes. Sarah's objective is to locate the buoys again, and continue observations of the wildlife and habitat. She very quickly finds the first buoy, and is joined there by Dana on the bottom. The problem with sub #3, though, is still the weight from that dratted manipulator arm. In spite of the large number of floats on the port side of the sub, it still has a distinct list, and with a 200 pound pilot, it is incapable of becoming neutrally buoyant (never mind positive). We have a lot of laughs topside listening to Dana and Sarah describe his attitude in the water, picturing some lopsided Igor-like figure gimping its way through the water, kicking up huge clouds of silt, and trying unsuccessfully to stay off-bottom using the vertical thrusters. Amusing as it may have been, though, we quickly learned that the second sub is a bit too disruptive when trying to conduct observations of the fish and other wildlife.

After we'd put the subs to bed for the night, we gathered in the Plot Room and reviewed the video images we'd managed to collect, including some great shots of fish and the subs, and some pretty amusing shots of sub #3's awkward floundering.

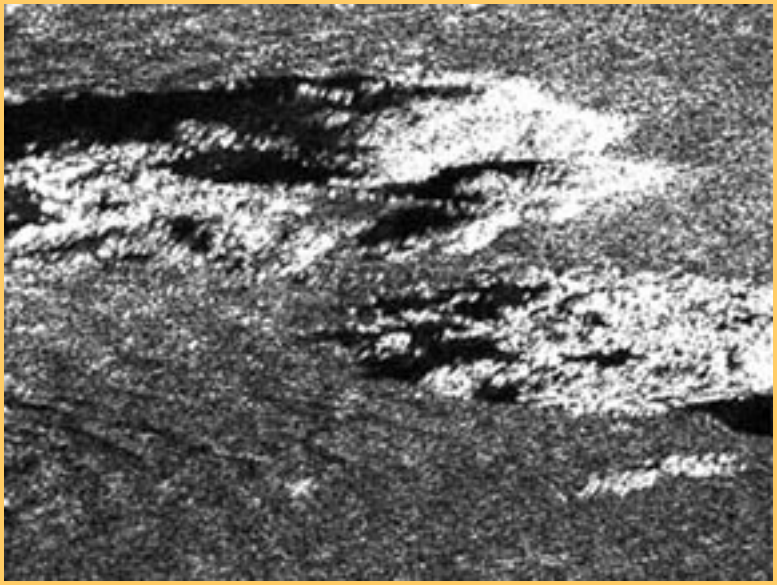
When the rest of the ship's crew and scientists have retired for the evening, all that's left is the three-man watch crew (Greg Hubner on the bridge, Matt Hovelman assisting with sonar work in the O-lab, and Brett Puckett in engineering), and Mike Boyle, the side scan sonar specialist, who will work through the night gathering valuable benthic data for USGS. The rest of the ship is peaceful, silent except for the hum of the engines and the tick-tick-tick of the sonar unit.

The moon is full, brilliant, its bright blue-white light glittering on the black water,

illuminating the clouds with a soft backlit glow, and subtly revealing Santa Cruz island, dark-on-dark-on-darker. We sit in the Oceanographic lab, lit only by monitors and moonlight, Mike and Matt and I, and watch as the side scan images of the sea floor below us scroll across the computer screen and onto a seemingly endless roll of paper. We drink coffee. We eat chocolate. We listen to Paul Simon and Ella Fitzgerald. We talk, a little. Mike and I take turns checking on our respective laundry. Finally, I cave in to my fatigue and retire at 3:00 a.m. Tomorrow it begins again.

(top)

RETURN



This graphic is a side scan image showing a 100m by 100m portion of the transect area. Light areas are hard rock surfaces and black areas adjacent to the light areas are the sound shadows of high standing rocks. Gray areas are fine sand habitat.

May 31, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Lisa Cooper, Intern
Sustainable Seas Expeditions

Gale writes:

We got off to a later start this morning, because we knew that weather conditions in the location we wanted to dive would prevent our being able to put the sub into the water until late morning. Ah, the pleasure of being able to sleep later after so many early mornings and late nights!

Lisa Cooper, a Sustainable Seas intern with the sanctuary, helped with public outreach work all weekend, and provided the following report of her activities:

This past weekend a mock-up of the DeepWorker 2000 submersible was on exhibit at the Channel Islands Harbor Maritime Museum in Oxnard, California. There was a great turnout each day, and people came with their cameras loaded and questions ready for answering. The most interested people seemed to be senior citizens, as they have been lucky enough to witness first hand the progress of deep ocean exploration.

After hearing of the technical aspects of how to operate the DeepWorker, people spoke of two reasons they would not go down: claustrophobia, and giant squid. It seems they were familiar with Captain Nemo and the Nautilus! Throughout the whole weekend people were interested in the Sustainable Seas Expedition and were extremely supportive of the expedition's efforts to help the public know more about how to manage ocean resources and thus create long term use of its resources.

Special thanks go to the media of Southern California. Through their efforts, a lot more people knew of the Sustainable Seas Expedition and were able to see the DeepWorker mock-up last weekend. Personally, I felt it was an engaging weekend that was enjoyable and enlightening. I was grateful to be there.

Gale continues:

Today is Memorial Day, and the ship's flag is at half mast in recognition of the holiday. Late in the morning, it's a beautiful sunny day, with some wind, but not too much to keep us out of the water.

We completed several additional science dives, gathering important data about the fish, the habitat, and the geological structure of the place. This is what we had in mind for SSE all along! Weather troubles and technical difficulties will always be a part of science at sea, but days like today are the payoff. The Channel Islands scientists are able to get plenty of dives in the subs, and the information they're gathering will go a long way towards enhancing our understanding of what makes these waters so special, and what we need to do in order to preserve their wild nature and biological productivity.

This time, we didn't put the two subs in the water together as we did previously. While doing so has its value, it also complicates the dives considerably, and can make it harder to unobtrusively observe the fish. We again end the day tired but satisfied, and plan for tomorrow's activities.

(top) **RETURN**

June 1, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Francesca Cava, Project Manager
Sustainable Seas Expeditions

Gale writes:

Today was yet another terrific, successful, wonderful day at sea. During earlier missions, my challenge was to find new and interesting ways to say we'd been blown out by bad weather. Now, I'm finding my vocabulary pushed to the limit, trying not to be redundant when I enthuse yet again about successful days and successful dives. This is great!

One of the most exciting things today was seeing our various data collection methods complement and enhance each other. Almost every night, I've gone to sleep to the sound of the side-scan sonar ticking away at three pings per second. This is extremely valuable data that will be compiled, analyzed, and made available to anyone who needs to know what's where, in terms of the Channel Islands benthic habitat. But we were able to make immediate use of the data. Looking at the previous night's side-scan sonar data enabled us to identify a prime dive location for the sub. Instead of taking a stab in the dark trying to find a spot in the lee of the islands that had good stuff to explore, we used the sonar data to pinpoint just the right location to drop anchor for the day.

Sylvia was the first to dive. She took the sub into some sandy bottom habitat we'd identified, gathering video images and making observations of the local critters. Her enthusiasm is infectious, as she's thoroughly delighted to see sand dabs and rays, and was even graced with a visit from a curious sea lion. Her colorful descriptions make me long to join her down there, such as when she reports the numerous sea hares "galloping" along the bottom. Later, when I made my own dive, I saw sea hares, too, but to my mind they seemed to mosey rather than gallop. Maybe they'd tired themselves out after putting on a show for Sylvia.

Next to dive was SSE Project Manager Francesca Cava. While Francesca was diving the sub, our photographer, Kip Evans, Sanctuary Manager Ed Cassano, and biologist Donna Schroeder SCUBA dove with her. Judging from the smile on Ed Cassano's face, it was a great dive for all concerned.

Ed Cassano shows his satisifaction after a successful scuba dive.

Here's Francesca's dive report:

This was a very special dive for me. After several training dives, in Seattle, San Francisco and Monterey, I was finally able to transcend beyond training into an actual exploration dive, and right here off my own home town of Santa Barbara. When I was manager of the Channel Islands National Marine Sanctuary, I scuba dived this area before over ten years ago. But with scuba there had never been enough time to just float through the water with the primary mission of just finding out what was there.

My mission included locating and finding rocky outcroppings, likely habitats for a wide abundance of species. Visual and compass headings, and the sidescan sonar, quickly brought me to a series of rocky habitats.

What a difference from previous dives! Today, visibility was about 10 to 15 feet, far less than the 65 feet of a few days ago, but the best I'd had to date. These rocky areas were teeming with dozens of Blacksmith fish, small blue-black fish about 4 or so inches in length, several Sheephead, an occasional orange Garibaldi, a juvenile Kelp Bass, several unidentified nudibranchs and even a Bat Ray. I was also lucky enough to have a just finished fish guide along with me in the sub. I found it extremely handy and just plain fun to sit in the sub, take a quick look around and compare my live companions to their sketches.

At one point I thought I saw a couple of Yellowtail, although the scientists topside assured me I must be mistaken. However, there was no doubt when a young California sea lion decided I must be a new toy. We played hide and seek for several minutes until the scuba divers arrived.

Gale continues:

After Francesca's dive, I jumped in to try to break the record for the fastest pre-dive ever (but without sacrificing one iota of thoroughness). I was highly motivated, you see, because I was scheduled as the next and final pilot of the day, and I knew that if we didn't get the sub in the water soon, the wind might pick up, or it might get too late to start dive ops, and the last thing I wanted was to see my dive scrubbed! I needn't have worried, as everything went quickly and smoothly.

After I was in the water, Ian radioed me to let me know what I was going to be asked to do. The plan this time was to have Kip Evans join me in the second sub, and the two of us would head in the opposite direction from the one Francesca had taken, into

rocky habitat in somewhat deeper water. I was elated! My greatest hope during the Channel Islands mission was to get the chance to dive below 85 feet, because at that depth, in rocky habitat, there's a chance to survey for white abalone.

Gale Mead prepares for her dive.

White abalone *(Haliotis sorenseni)* are on the brink of extinction due to overfishing that occurred almost 30 years ago. During the 1970's, so many were taken that the ones that were left were too few and far between to breed, and they're coming close now to the end of their natural life span. It's believed that only about 1,600 individual white abalone are still alive throughout their entire range (Point Conception, California to Bahia Tortugas, Baja California).

I've been working for over a year with **Marine Conservation Biology Institute** to help get white abalone listed on the endangered species list, and to work with the researchers involved in trying to study and save them from extinction. Everyone who's been diving on this mission has been provided with a detailed description of what to look for, but so far, most of our dives haven't been in suitable habitat.

Once Kip joined me in the water, we set out on our heading over sandy bottom, where we saw little but algae, sea hares, and sand dabs. Soon, however, a rock face about six feet high loomed ahead of us. We came up over the top of the face and moved along a large flat rock area covered with silt and carpeted with countless thousands of brittle stars. At 65 feet or so, we were still too shallow for white abalone, but continued on. We came to the end of that rocky rise, and down the other side, counting fish as we went along. Up and over and across and around more rock formations, with sand in between, and lots of fish, gradually working our way deeper.

Just as I came down the other side of another rocky outcropping, we were asked to stop and give life support readings. I appreciated the value of sitting still for a few minutes, as the fish started to come closer to the sub and give me a much better look at them. A ray gracefully overflew the edge of the rock face I was next to, seemingly oblivious to my presence, then vanished into the gloom. I looked at my depth and noticed that we'd finally gotten to the 85 foot point, deep enough for white abalone. Then came the words I least wanted to hear: "OK, guys, I need you to take a reverse heading and start making your way back towards the ship." BOO! HISS! Not yet! We just got here!

But one of the golden rules of sub piloting is to never disobey the dive supervisor, if you ever want to be allowed to dive again. So I was glad I was diving with Kip, who

pushes it to the limit: "Topside, this is DeepWorker One. We're on our way. I just need to stay here for a few more minutes to get a couple more images." Heh heh. I'm more than happy to squeeze those few extra minutes into our dive. Unlike with SCUBA, there's no need to worry about running out of air anytime soon. We have all the time in the world, to the extent that we want to push our luck with Ian.

We slowly made our way back towards the ship, stopping every once in awhile to get more fish images and give life support readings to topside. Then, as I was coming over a rock ledge, I saw him, out of the corner of my eye: a giant sea bass, who looked to be a good four feet long! This is tremendously exciting news, because this is a species that's suffered so much from the effects of overfishing. Kip was following me, and I hurriedly radioed him, "KIP! Coming towards you on my starboard side! Giant seabass!" He was quick to reply, "I see him, and there's another one behind him!"

We settled to the bottom and tried to be as inconspicuous as possible (not very). The two magnificent fish swam around for a moment or two, and then took off. We waited for a few breathless moments, but they did not return. A few precious seconds of video Kip was able to shoot can at least prove that we weren't hallucinating!

I was given the order to surface first, and the first thing I heard from Ian when we switched to VHF from through-water comms was that Kip had seen another giant sea bass right after I left the bottom. Darn the luck, I wish I'd seem him too! But the important thing is that those fish are there. It's very encouraging news indeed.

Tired, happy, and eager to dive again (as soon as possible, please!) we close another day of the expedition. Tomorrow will be a different animal entirely, as we leave sanctuary waters and try to take a look at the effects of sewage dumping in the waters off Santa Barbara's coast.

(top) **RETURN**

June 2, 1999

Francesca Cava, DeepWorker pilot aboard the NOAA R/V McARTHUR
Sustainable Seas Expeditions

Sylvia Earle onboard the McARTHUR with Heal the Ocean director, Hillary Hauser, and board member Jean-Michel Cousteau.

Over the past several years we have seen dramatic deterioration in the quality of our ocean waters along the coast of Santa Barbara, my home. Many of our beaches are closed or placed under health advisories for much of the year because of high bacterial counts. To help shed some light on potential causes of these problems, a local environmental organization, Heal the Ocean, approached SSE several months ago to request that one day of our expedition be devoted to exploring our near coastal waters -- waters that are so important to public health and our tourist economy. We were pleased to help this emerging environmental grassroots effort and to work with its director, Hillary Hauser, and board member Jean-Michel Cousteau. I also looked forward to the opportunity to pilot the sub in a highly impacted area so close to our beaches and marine sanctuary.

Santa Barbara, like many coastal communities, suffers from many sources of pollution that contribute to the overall degradation of water quality, including the disposal of sewage as close as a few hundred yards offshore. The exploration of sewage outfalls seemed well suited to DeepWorker's capabilities -- the environment surrounding these outfalls is largely unexplored and considered off-limits for SCUBA operations. Heal the Ocean hoped DeepWorker could get a close look at the environment adjacent to the outfalls that could help enlighten our citizens and civic leaders as to the possible problems that we might have as a result of our relatively rudimentary methods of dealing with sewage disposal.

After many months of study and planning dives with an ROV, Heal the Ocean and SSE drew up a plan to explore the area surrounding a sewer outfall near a popular beach between Santa Barbara and nearby Montecito. While EPA and State sewage treatment standards are technically being met at this location, many believe that much more could be done to lessen the nutrients and pathogens that this and other outfalls contribute to the nearshore ocean.

Francesca Cava prepares for a dive as Sarah Fangman looks on.

With great anticipation the day for our dive came, however we ran into problems almost immediately. Prior to my dive, the McARTHUR deployed an ROV to take a look at the bottom for possible obstructions that might give us difficulties. The ROV encountered what appeared to be the remains of fishing nets that had snagged on the outfall diffuser pipes. One of the biggest dangers to any submersible operation is entanglement, and as much as we all wanted to complete this dive, for safety's sake, it had to be scrubbed at the last minute.

Fortunately, all was not lost. While disappointed I was not able to see first hand the conditions on the bottom, we did get a good look from our ROV both on the day of the dive and during the planning missions that had been undertaken before the arrival of the sub.

The visual distinction between the waters of Anacapa Island, that I had experienced the day before, and the waters near the mainland, as revealed by the ROV was dramatic. Degradation of the marine habitat off the mainland coast was very evident -- sea urchins were deformed, many with only a few spines, and the one crab we did see was utterly listless and encrusted with debris. The water near the coast was clouded with particulates, severely limiting visibility. While due to many factors aside from sewage, these findings were disturbing and largely unknown before our expedition. I would guess this situation is also unknown to the many beach visitors and swimmers who frequent the popular Butterfly Beach, less than a quarter mile away from the area of our ROV operations.

The expedition allowed Heal the Ocean to bring a much needed public focus to these problems that affect the quality of our ocean waters. At a dinner that night following the aborted dive, Heal the Ocean raised a great deal of support to undertake complex analyses of the virus load the outfalls are contributing to ocean. And through newspaper and television coverage of the expedition, we were able to add many new volunteers to the growing army of people who want to help us rid the ocean of contamination.

(top) **RETURN**

June 4, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Francesca Cava, Project Manager
Sustainable Seas Expeditions

Gale writes:

The last two days of science dives for the Channel Islands mission, and while we're still excited about the work we're accomplishing and the opportunities we've had to dive, it's clear we're getting a little tired, too. Ed Cassano, whose eyes are always (even now) bright with enthusiasm, looks up from his laptop computer while sitting at the table in the wardroom, and the eyes I see are red from lack of sleep and glazed from staring at computer screens and papers and charts.

We're still doing everything that needs to get done, still eager as ever to dive, to explore, to check out the fish and the rocks. But everyone, ship's crew and scientists and sub technicians and photographers and writers and managers are all fighting exhaustion. It'll be good to have a few days break before the Olympic Coast mission starts.

During our science dives, a major component of our work has been in taking inventory of the fish and invertebrate species living in the sanctuary water.

Francesca Cava shares her thoughts about the importance of cataloging the sanctuary's living resources:

My dive a few days ago made me realize how important it would be to understand and be able to list all the species that live in the sanctuary.

Its amazing to realize that even today, there is no "official" checklist of plants and animals that allows explorers like myself to record our findings for future reference and comparison. At depth, it was even more evident just how important such a tool would be not only for my present dive, but for future explorers to use as a reference to compare what we were seeing during this mission to what was yet to be seen. Finding ways to advance exploration of the marine sanctuary into long lasting monitoring protocols is an important goal of SSE. This seemingly easy task could be

one of the first steps. Much of the data on species is in the literature, but making a "checklist" for each sanctuary is still needed. Today's dive made me realize its completion is more important than ever.

However, despite its usefulness, completing a sanctuary checklist could be a formidable job. I'd recently leafed through a fish guide for North America that took decades to compile! And, one of the reasons the Channel Islands were chosen as a sanctuary is because both northern and southern species live here -- it is incredibly diverse. The challenge would be to figure out how to review the staggering amount of data in the literature and winnow it down to a manageable number of species, along with their descriptions, for use with video identifications and archive. Is there anyone out there who would like to help?

Gale continues:

Tomorrow is officially the last day of the Channel Islands mission. It seems to have gone by so very quickly! We have big events planned for our grand finale. Tune in to tomorrow's log entry for all the details!

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June 5, 1999

Claire Johnson, Project Team Member
Sustainable Seas Expeditions

Dave Lott, GIS Specialist
NOAA/NOS Special Projects Office

Weather: Sunny

The Santa Barbara Maritime Museum was buzzing early this morning as staff from the Channel Islands National Marine Sanctuary (CINMS) set up booths for the Sustainable Seas Expeditions Ocean Fair and Press Conference. Several staff members stood in the parking lot pondering what to do with the 500 pound mammoth crate containing the new SSE exhibit, hot off the press and straight from the east coast. An extremely tall ladder, many volunteers and some swift thinking popped up the eight 8' x 4' display panels depicting descriptions of SSE, the DeepWorker 2000 submersibles and information about the Sanctuary in no time at all. Another duty done until the afternoon when the mock-up of the DeepWorker would join the exhibit after "The Parade."

The Channel Islands parade contingent.

Speaking of "The Parade," two miles away, the mock-up was being towed by children, animals, and an assortment of oddly dressed folks through downtown Santa Barbara, down State Street and along the palm-lined Cabrillo Avenue as a special part of the Big Dog Parade. This popular annual event had the potential to overshadow the Ocean Fair, so the decision had been made to incorporate SSE into the parade for the public to enjoy.

Here is Dave Lott from the National Ocean Service's Special Projects Office with his impressions on being part of the Big Dog Parade:

"We need 'Dawgs' to pull the Deepworker Model in the parade on Saturday

Dave Lott doubles as a sea anemone.

morning..." I had seen the writing on the board outside CINMS manager Ed Cassano's office all week. Big Dog Parade- what the heck? "The biggest thing in Santa Barbara," I was told. Not to be missed.

"The annual event put together by a local clothing retailer draws hundreds of participants and spectators. All the entries in the parade are pretty much centered around a 'dog' theme, of course.

"I should have known better, as there was still some debate on Friday night regarding who was going to be our 'big dog' and wear the fuzzy, very hot looking big dog outfit...

"Saturday morning at 7:30am -- with about 4 hours sleep under my belt -- I arrived at the office to lend a hand to the parade crew and the team setting up our own big media day and Ocean Fair. "OK, I'll wear a fish costume." Did I say that? "I really shouldn't you know...they need a hand down here scrubbing barnacles off the fuel dock." I tried every excuse.

"Actually the staging area for the parade did foreshadow the events that would unfold. A few yapping dogs, some volunteers with radios and clipboards, some simple costumes, the sidewalks rather empty. No big deal. By 8:30 the fish costumes started coming out of the boxes -- compliments of the Gulf of the Farallones staff who made the six-hour trek south. It was either push a two hundred pound submersible model adorned with kelp, with a dog and small children riding in it (on shopping cart wheels) for two miles or wear a costume. I chose the green and purple anemone.

"I'm not sure exactly when the scene started to turn surreal, most likely when several bagpipes positioned 25 feet away started tuning up. Not to be outdone, the rather large Goleta Middle School marching band began their warm ups 50 feet the other direction. Did I mention the dogs? Oh yes, a sled dog team 10 feet away began howling over the noise of the bands. Not to mention our own courageous crew decked in marine life costumes milling around a submersible. I didn't know whether to laugh or cry. And then the Tin Man showed up with his silver dog...

"At 9:30 sharp the nearby sled dogs were quickly whisked away and attached to a wheeled cart and with the pop of a cap gun took off with a Big Dog mascot in tow. We were entry 120 out of 400. "You're up next, Submersible!... Walk nice and slow," barked the parade organizer. A rather strange thing to be heard in context of a parade, I thought. Little did I know that literally thousands of people had filled the sidewalks of Santa Barbara in the time we had been getting ready.

"Panic struck immediately as we cleared the start area. There were thousands of screaming kids, barking dogs, and clapping people. I was carrying the right side of

the large NOAA/SSE banner. I said to the jellyfish and the sea cucumber carrying the rest of the banner to my left, 'get ready to pick up the slack... I may run away at any moment...' I stuck it out, though. Only one mishap, the submersible cart wheels got stuck in a rail road crossing for a moment. It really wasn't that bad, all in all. I think next year we should bring our own musical instruments."

Spreading the word about the marine sanctuary program at the Big Dog Parade.

Claire again:

Dave was right, the situation did have a surreal flavor. On my walk with LCDR Matt Pickett, Assistant Manager of the Channel Islands National Marine Sanctuary, to the Chase Palm Park to help load the mock-up on the trailer for transport, we were swamped by over 1,000 dogs, most in costumes ranging from chihuahuas with ponchos and sombreros to St. Bernards with aprons and chef's hats. Unfortunately we did not have the pleasure of seeing our co-workers dressed as sea anemones and jellyfish.

Armed with t-shirts, Matt and I approached groups of children to ask trivia questions about the marine environment. "What is the largest animal to have ever lived on earth?" I have to say that I am fairly impressed with the youth of Santa Barbara. Most every child readily and accurately responded, "the blue whale." Furthermore, these children are honest, admitting that they had recently participated in Los Marineros, the fifth grade science curriculum for Santa Barbara public schools. Despite this advantage, each child with the correct answer to our spontaneous questions not only received a smile but a CINMS/SSE t-shirt with a picture of the DeepWorker sub on the sleeve courtesy of the sanctuary.

We continued along our path and made our way to the local swimming pool, Los Baños, which was loaded with young children participating in a regional swim meet. The man on the microphone was quickly won over by our enthusiasm, agreeing to periodically announce our Ocean Fair and Open House over a loudspeaker.

Now for the event I had been waiting for. How often does one get a chance to see the latest technology rise from the ocean depths into their local harbor? Rounding the bicycle path we watched from a distance as members of the Chumash Indian tribe rehearsed their chants for later in the day. The Chumash people are few in number, representing a culture that once inhabitated the Channel Islands off the coast of California. Some of you may have heard of them since they are the subject of the well known book, *Island of the Blue Dolphins*. The Chumash have always believed in sustainable use of our oceans and this presented a great opportunity to link to the cultural and historical significance of the Channel Islands National Marine Sanctuary with their traditional beliefs. Legend has it that when the Chumash people were ready to make their way to the mainland, a rainbow bridge was provided to them by their god. She stated that if they looked down they would fall from this bridge into the

The DeepWorker float thrilled the crowd.

depths of blue Pacific Ocean. Their god could not bear to see her people falling into the lapping waves, so she transformed them into dolphins, known in Chumash as Alo'lkoy. Perhaps this is the reason the Santa Barbara Channel is brimming with 27 different types of cetaceans (whales, porpoises and dolphins)...

While I had been meandering around town -- accosted by costumed dogs and terrorizing children with spontaneous questions -- those aboard the ship were busily pre-diving the subs, deploying them from the ship to a temporary place-holding station at the boat ramp near Sea Landing. The main attraction, you might say, was about to begin. Two of the CINMS pilots, Donna Schroeder and Sarah Fangman flew the subs in from the ship to this location where they were swapped out for LCDR Ed Cassano and Dr. Sylvia Earle to make their grand entrance escorted by the Chumash tomol or canoe, Elye'wun for its first public debut.

The crowd outside began to hush as a member of the Chumash tribe began quite a traditional ritual and a poignant chant. Hundreds of people were silenced by the sound of the conch shell and rattling of sticks as the DeepWorker subs piloted by Earle and Cassano came into view through the harbor led by the traditional tomol. The next few minutes held people captivated, including myself, while the importance of ocean health to human health was pieced together with customs of those who have always cared. Following this dramatic entrance into the Santa Barbara harbor, the DeepWorkers were raised out of the murky water and lifted for all to see. Curious spectators leaned out of restaurant windows and peered over Brophy Brother's railings to see the intriguing site. The crowd had now moved away from the Chumash ceremony and gathered around The Chandlery and the Naval pier to see a glimpse of not only the eye-catching DeepWorkers, but of Sylvia Earle, the famed ocean explorer.

The pressure hulls were equalized and both hatches popped open to bring Sylvia and Ed back to civilization on land. Ed's daughter, Tara Rose, ducked under the ropes and ran into her daddy's arms thrilled to see him again. Her dad is not only the Channel Islands NMS Manager, but also was heavily involved with Sustainable Seas Expeditions as the Mission Coordinator for his site as well as a pilot of the DeepWorker. I don't need to tell anyone how much time and energy was spent planning for events such as this, I'm sure it is very apparent. Sylvia hopped out of the sub and greeted children and allowed for photo opportunities until it was about time to join others for the press conference.

Laura Francis writes:

"The press conference included remarks by Chumash elders, Dr. Sylvia Earle, LCDR Ed Cassano and Congresswoman Lois Capps. All speakers were eloquent in their

discussions about the need to learn from our past and the importance of caring for the ocean systems that support us. The CINMS Open House and Ocean Fair was a perfect ending to a successful mission and the staff and volunteers of NOAA's CINMS deserve special recognition for the incredible amount of work and care that it took to coordinate such a special event."

Back at the Santa Barbara Maritime Museum, the public was mingling inside the Naval Reserve building learning how to tie nautical knots and watching a video of the May 27th NASA uplink with the Great American Fish Count divers and the DeepWorker sub. Others were observing Cabrillo High School Aquarium's exhibit which featured Conqfish 1, a pressurized underwater habitat for two tiny white mice. Hands-on, interactive exhibit booths for more than 20 environmental organizations were present. There were stations where children could view bioluminescence under a dark hood, a place for them to draw pictures for the "kids gallery", make clay sea creatures and build their own DeepWorker models with "Art from Scrap" and learn about the many different and exciting aspects of the marine environment and all it offers everyone. I believe that SSE will captivate and open the eyes of many and eventually lead these new believers to make change. This change is essential to our continuing growth as a species.

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Summary of Investigations

Overview

The Channel Islands National Marine Sanctuary set out to accomplish several research objectives during a ten day Sustainable Seas Expedition. The first objective was to test the DeepWorker submersible as a research platform and to modify research protocols designed for use with the DeepWorker. To this end, 18 dives were completed around Santa Cruz and Anacapa Islands and data were gathered on fish assemblages and habitat. Other research activities conducted during the mission included mapping over 80 square nautical miles of bottom habitat using a U.S. Geological Survey high-resolution digital sidescan sonar. University California-Santa Barbara scientists conducted 20 full oceanographic and optic stations describing the physical oceanography of dive sites and sidescan areas.

The Channel Islands National Marine Sanctuary research vessel BALLENA (shown in front of Arch Rock off Anacapa Island) acted as a support vessel during the missions.

Sidescan Sonar

During the 1999 Expedition in the Channel Islands National Marine Sanctuary approximately 150 square kilometers of sidescan sonar data were collected. Sidescan sonar data processing is presently one third complete. Submersible dives were also made in the sidescan areas. Observations and video collected on the dives will complement the sidescan sonar data to provide benthic habitat maps.

Mike Boyle and crew work on the sidescan sonar fish before beginning a night of sidescan operations.

Michael Neumann deploys one of the optics instruments used to collect data for a study on the relationship of satellite-sensed ocean color to chemical and biological parameters.

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SUSTAINABLE SEAS EXPEDITIONS
SANCTUARY LOG

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Dive 9 Video
South of Anacapa Island
June 22, 2000

Pilot: Sarah Fangman

Here is a common site divers encounter in the shallow waters of the Channel Islands National Marine Sanctuary. Although it looks like a plant it actually is an animal - well, a colony of animals - called a Gorgonian sea fan. Notice too the red urchin at the base of the sea fan. Red urchins are commercially harvested in the Channel Islands and shipped oversees to the Asian markets.

For More Information

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- Read Sarah Fangman's July 19 Summary Log
- Read Sarah Fangman's biography

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Dive 10 Video
South of Santa Rosa Island
June 23, 2000

Objective: to groundtruth sidescan sonar images along fixed transects
Pilot/Scientist: Guy Cochrane, USGS

During much of this dive, pilot Guy Cochrane encountered sandy bottom habitat. This clip shows a boulder he found along the transect. Fish like the Kelp Rockfish and Painted Greenling make rocks like these their home. Notice the encrusting pink sponges, golden bryozoans and colonial red anemones growing all over every inch of this rock!

For More Information
• Read Guy Cochrane's June 18 Log: *Mapping the Sanctuary Floor*

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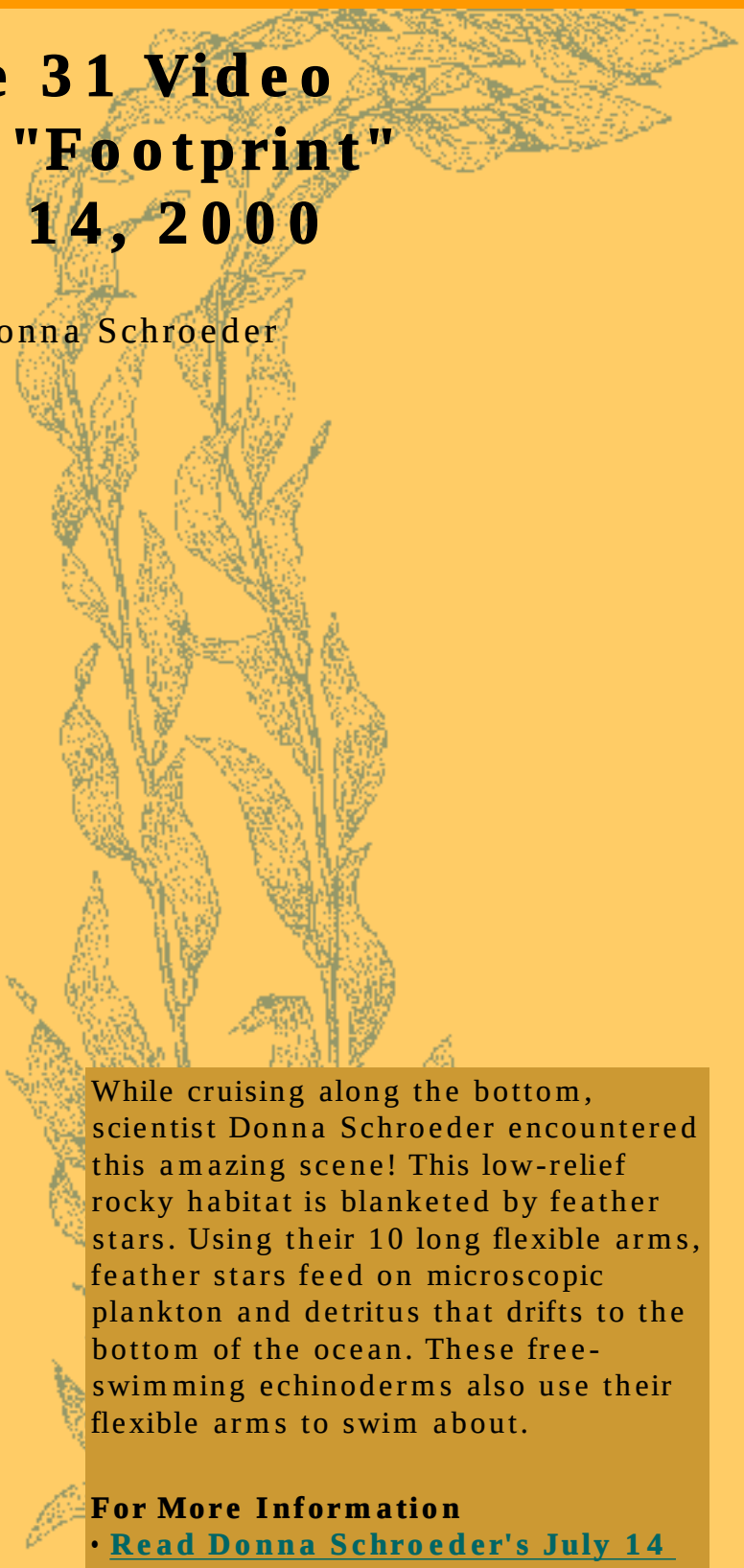
Dive 31 Video
The "Footprint"
July 14, 2000

Pilot: Donna Schroeder



While cruising along the bottom, scientist Donna Schroeder encountered this amazing scene! This low-relief rocky habitat is blanketed by feather stars. Using their 10 long flexible arms, feather stars feed on microscopic plankton and detritus that drifts to the bottom of the ocean. These free-swimming echinoderms also use their flexible arms to swim about.

For More Information

- Read Donna Schroeder's July 14

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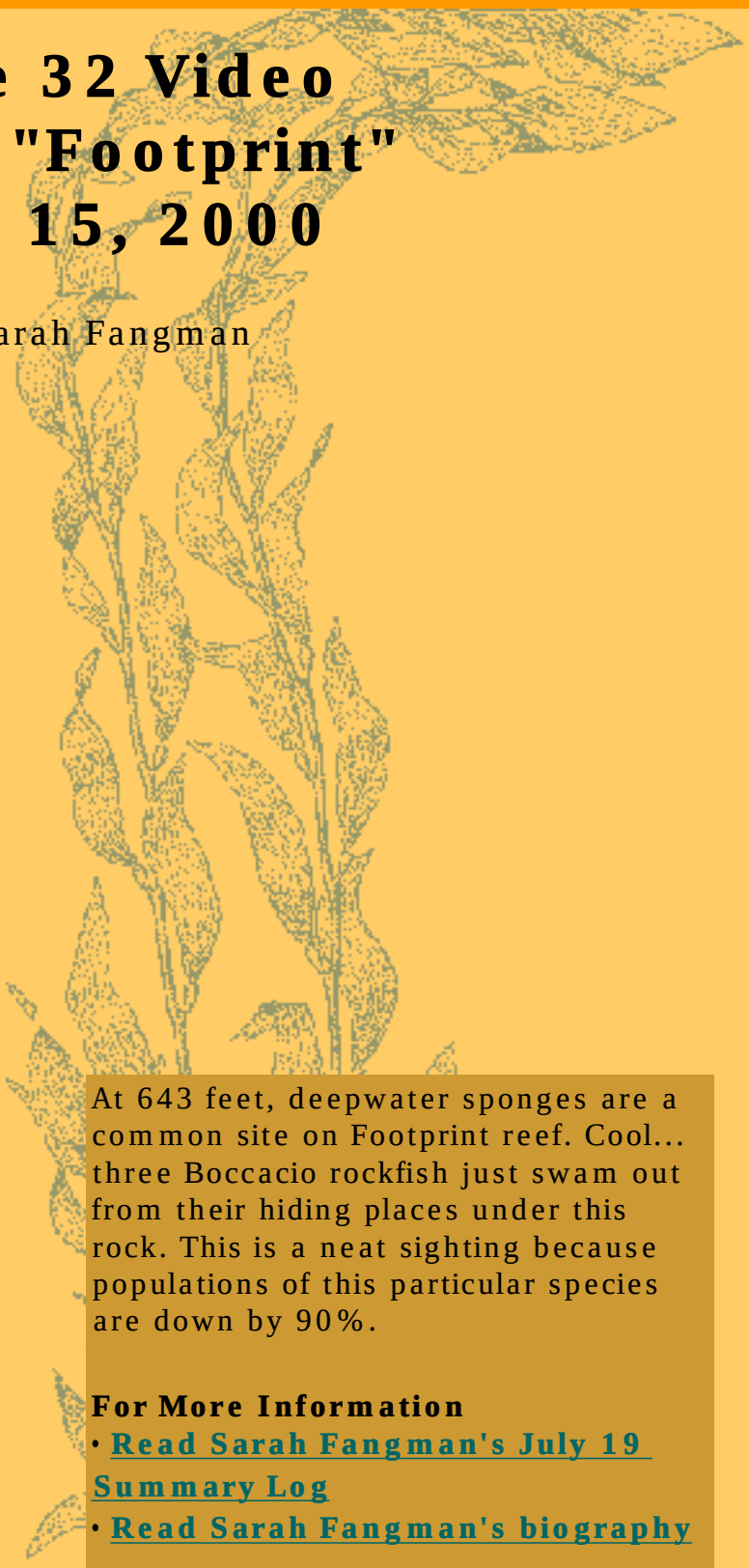
Dive 32 Video
The "Footprint"
July 15, 2000

Pilot: Sarah Fangman



At 643 feet, deepwater sponges are a common site on Footprint reef. Cool... three Boccacio rockfish just swam out from their hiding places under this rock. This is a neat sighting because populations of this particular species are down by 90%.

For More Information

- Read Sarah Fangman's July 19 Summary Log
- Read Sarah Fangman's biography

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Dive 38 Video
South of Santa Cruz Island
July 18, 2000

Pilot: Guy Cochrane

What looks like a field of grass is actually a field of brittlestars... thousands of brittle stars! Scenes like these were common during *DeepWorker* dives indicating that millions of these fragile ophiuroids live in the sanctuary. Brittle stars get their name from the fact that their flexible arms can break easily but are readily regenerated.

For More Information

• Read Guy Cochrane's June 18

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Dive 39 Video
The "Footprint"
July 18, 2000

Pilot: Sarah Fangman

This small benthic octopus lures tasty morsels like worms, crabs and fishes with it's sucker-lined tentacles. In this clip the elusive octopus tries to evade *DeepWorker* pilot Sarah Fangman's lights. Oh look, there is another benthic dweller in this shot... can you see it? Look up in the right-hand corner of the frame for a flatfish.

For More Information

• Read Sarah Fangman's July 19 Summary Log

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• Read Sarah Fangman's biography

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Photo Log: Education

CINMS Education Coordinator Julie Goodson greets local HS students onboard the NPS vessel *Ocean Ranger* as they prepare to venture to Anacapa Island for the CINMS SSE underwater uplink.

On Anacapa Island Dr. Sylvia Earle speaks about her love of the ocean and the importance of protecting this irreplacable resource

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Carpinteria HS Student Christina interviews diver Shauna Bingham as she prepares to participate in the uplink.

Everyone onshore can watch the divers below and participate in a fish count.

Students and teachers crowd to Anacapa landing to see and hear the underwater divers via the uplink. (James Forte)

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Carpinteria HS student Christins and her teacher Juanita surround CINMS divers at Anacapa Landing. (James Forte)

An elementary school student asks Dr.Earle what she likes best about being in the ocean.

At the National Park Service Visitor Center in Ventura, Carol Peterson helps the students understand where the sanctuary is located.

A *DeepWorker* model gives students an upclose experience of this amazing one-person submersible.

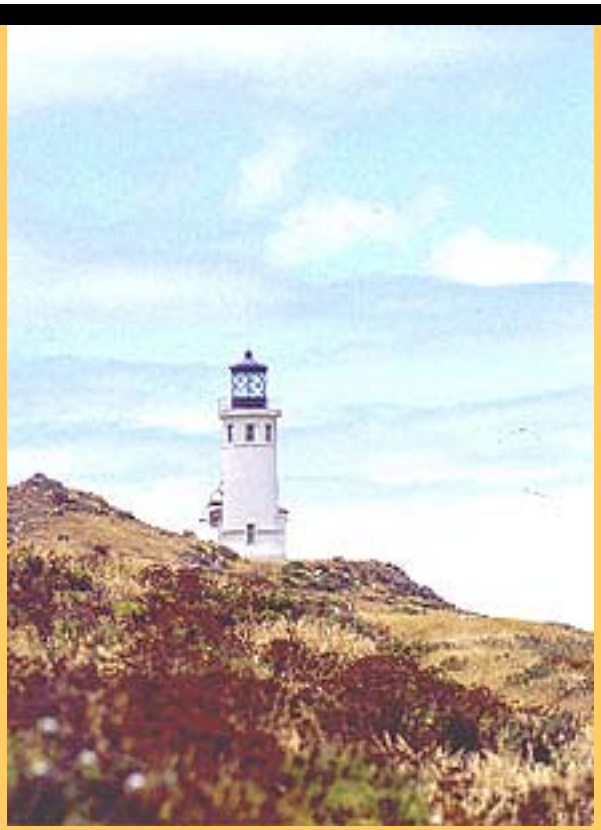
Via the satellite uplink by NASA, students at the NPS Visitor Center were able to watch the divers off Anacapa Island and ask them questions.

Carpinteria High School teacher Juanita Lorenzana and her students on Anacapa Island.

The gull chicks had just hatched and were running about during our visit to Anacapa Island.

NPS ranger leads the students on a hike around Anacapa Island after the uplink. (James Forte)

Anacapa Lighthouse (James Forte)



The Chumash tomol 'Ely'wun paddles out to meet the McArthur for the second year in a row.

SSE Education Coordinator Laura Francis answers questions from vistors to the *McArthur* during the CINMS SSE Open House.

Executive Officer Stacy Burke and Captain Michelle Bullock are models for young women who aspire to leadership at sea.

LCDR Wade Blake sharing some insights with young visitors during the ship's tour. (Becky Swift)

Roberta Cordero of the Chumash Maritime Association, was at the Open House on Santa Barbara's Historic Stearn's Wharf.

Students from Cabrillo High School built an underwater mouse habitat called CONQFISH1!

Sanctuary Manager LCDR Matt Pickett congratulates Kayla and Allison, this year's CINMS recipients of the NOAA Environmental Hero Award.

Vermont residents, Kayla Gennrich and Allison Barkyoumb, raised money in support of protecting the resources in the sanctuary.

Dr. Sylvia Earle speaks to our Environmental Heroes and the assembled audience.

CINMS Staff, LCDR Wade Blake of the *McArthur*, Dr. Earle and the CINMS Environmental Heroes (Becky Swift)

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Photo Log: Operations and Personnel

CINMS SSE divers and crew after Sylvia's record-breaking 2000 ft dive.

Guy Cochrane (left) and Lacey O'Neill in the lab.

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Mike Boyle, is the USGS side scan technician and all around great guy.

Evening planning for the next day's events.

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Mike and Joe answer the question, "Exactly where is the Footprint?"

Donna Shroeder relaxing at the end of her second expedition to the CINMS.

CINMS Webmaster Kathryn Hintergardt (left) jumps from the Web into the sub. She is joined by Sarah Fangman, CINMS Research Coordinator.

Airborne! (Common Dolphin, *Delphinus delphis)*(Lacey O'Neill)

Dave Lott plots the sub's location and depth during the dive.

Sylvia is all smiles after visiting the CINMS 2000 feet down.

The *McArthur* framed by the arches of Anacapa Island (Lacey O'Neill)

Guy, Donna, and Sarah strike a pose. (left to right)

Saddle up that sub and I'll be gettin' on my way...

The *McArthur* pointing to Santa Cruz Island (Wade Blake)

On the bridge of the *McArthur* with its dedicated and patient crew. Click on image for a wide-angle view.

Lacey O'Neill (left) and Ed Cassano share a cup of java in the support vessel during a *DeepWorker* dive.

Sarah Fangman, Shauna Bingham, and Laura Francis discuss the finer points of the video uplink at Anacapa Island.

Claire Johnson, from the National Ocean Service, enjoyed staffing the SSE table at the CINMS Open House. (Becky Swift)

LCDR Wade Blake and LCDR Michelle Bullock participate in the CINMS Open House. (Becky Swift)

Dave Hermanson hands a plate of muffins to the support crew during a *DeepWorker* dive.

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Photo Log: Launch and Recovery

The NOAA ship *McArthur* off of Anacapa Island in the Channel Islands National Marine Sanctuary. (Kip Evans)

Prior to launching the submersibles, the *McArthur's* rigging had to be strength tested using a bag filled with 5 tons of water.

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Before each dive, all equipment on the sub is checked and rechecked. (Kip Evans)

Launch time

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Lifting the sub... Anacapa Lighthouse in the background

Kip Evans hits the water

Diver Dana Wilkes releases lines that attach the sub to the ship during launch and recovery.

The support boat stands by as the dive begins.

Recovery

CINMS's *Xantu* stands by...

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Photo Log: Underwater Life

Anemone (Kip Evans)

Feeding Brittlestar (Kip Evans)

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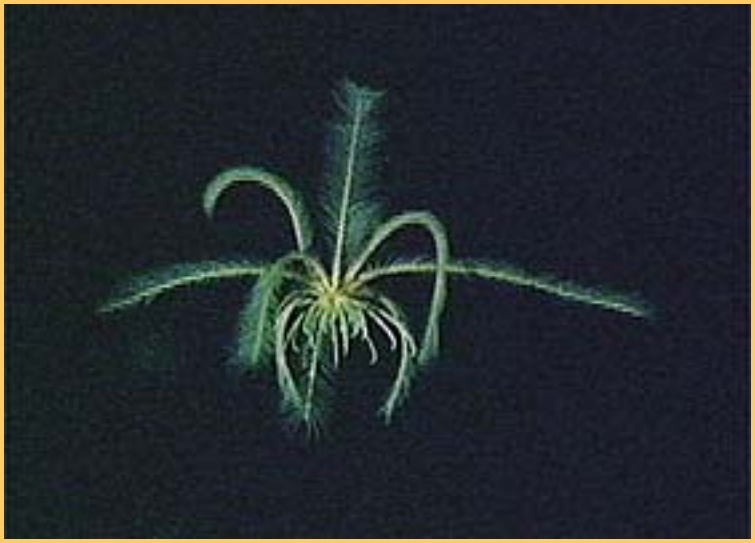
Greenspotted Rockfish (Donna Schroeder)



Swimming Crinoid (Donna Schroeder)

Rockfish at the 'Footprint' (Donna Schroeder)

Open House

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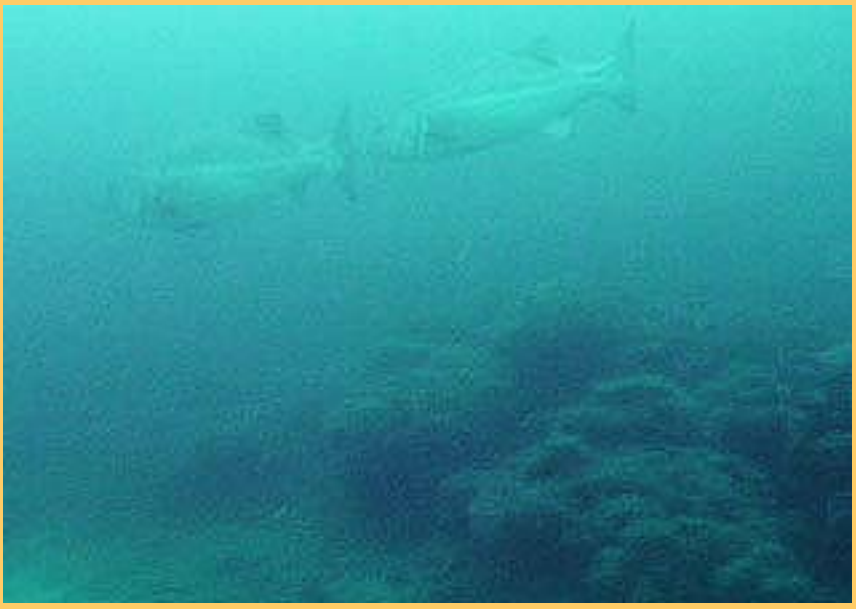
Cow Cod (Donna Schroeder)

Topedo Ray (Donna Schroeder)



Black Sea Bass (Sarah Fangman)

Siphonophore
(Kip Evans)

Blacksmiths
and Gorgonian
(Kip Evans)

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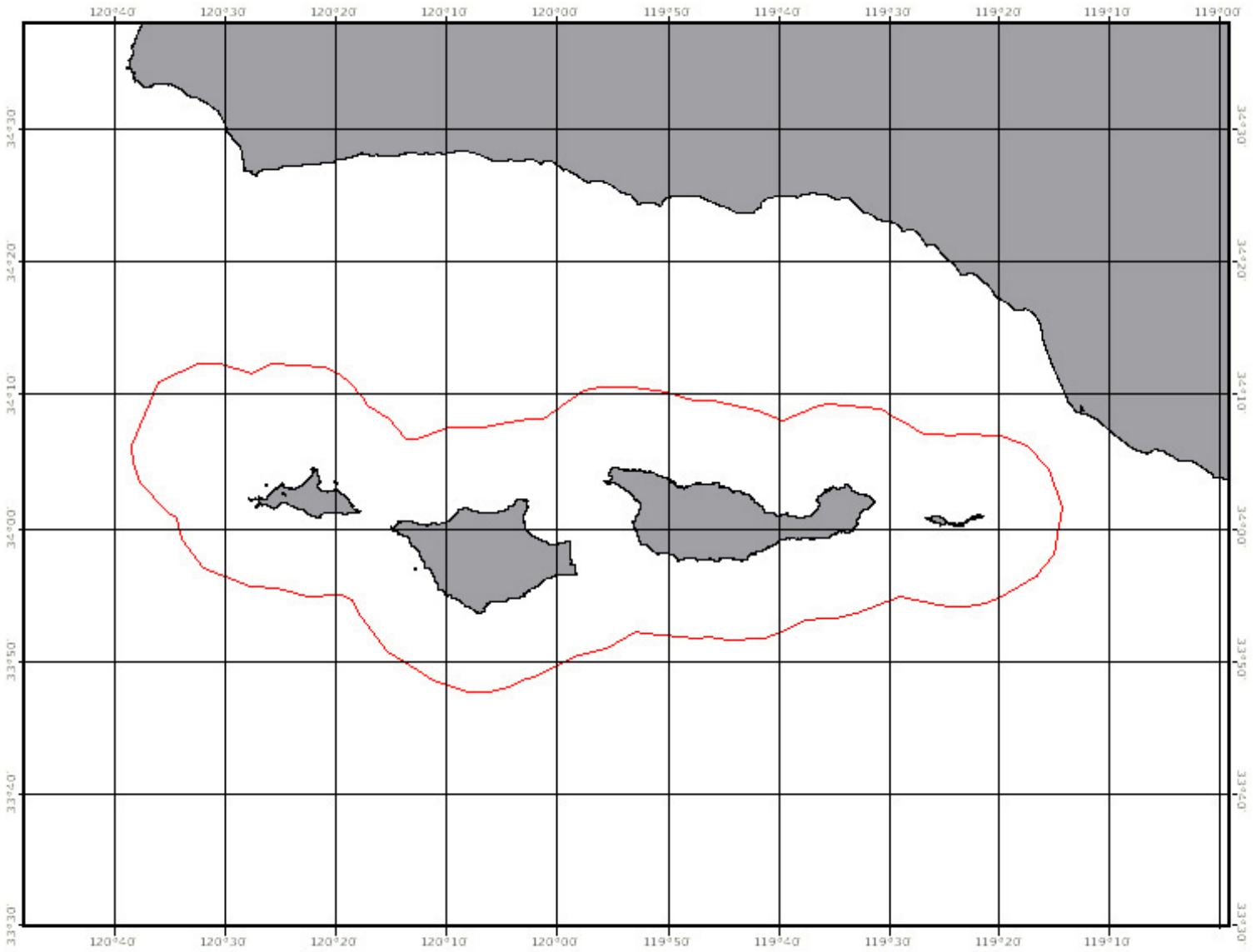
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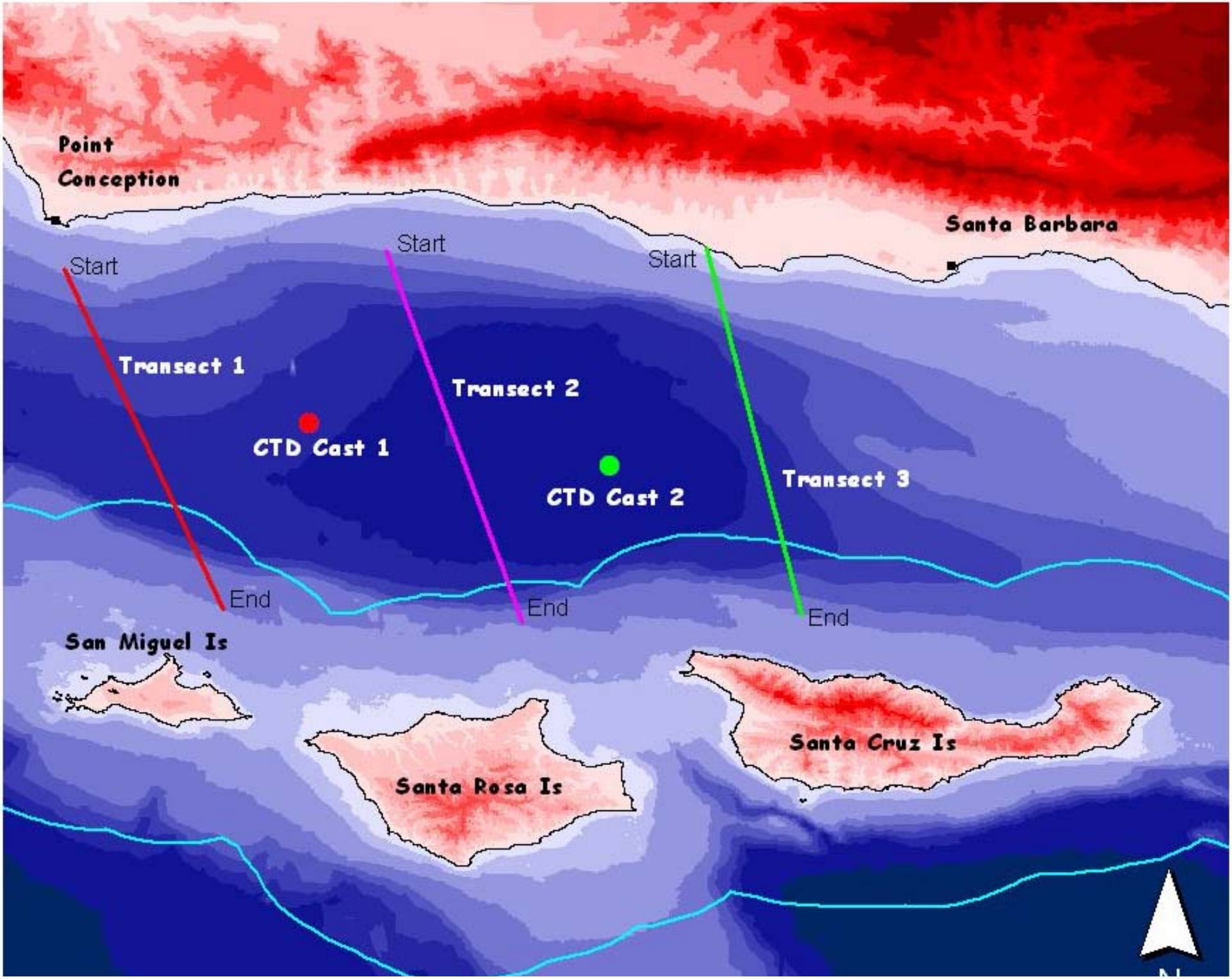
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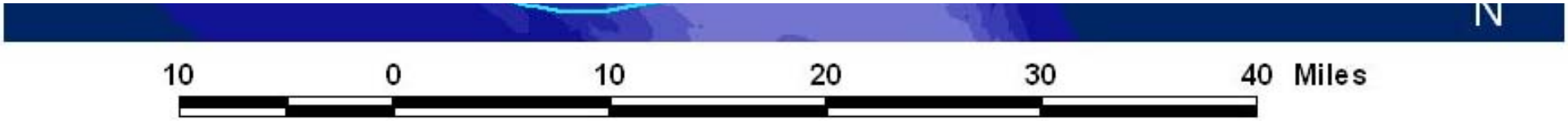
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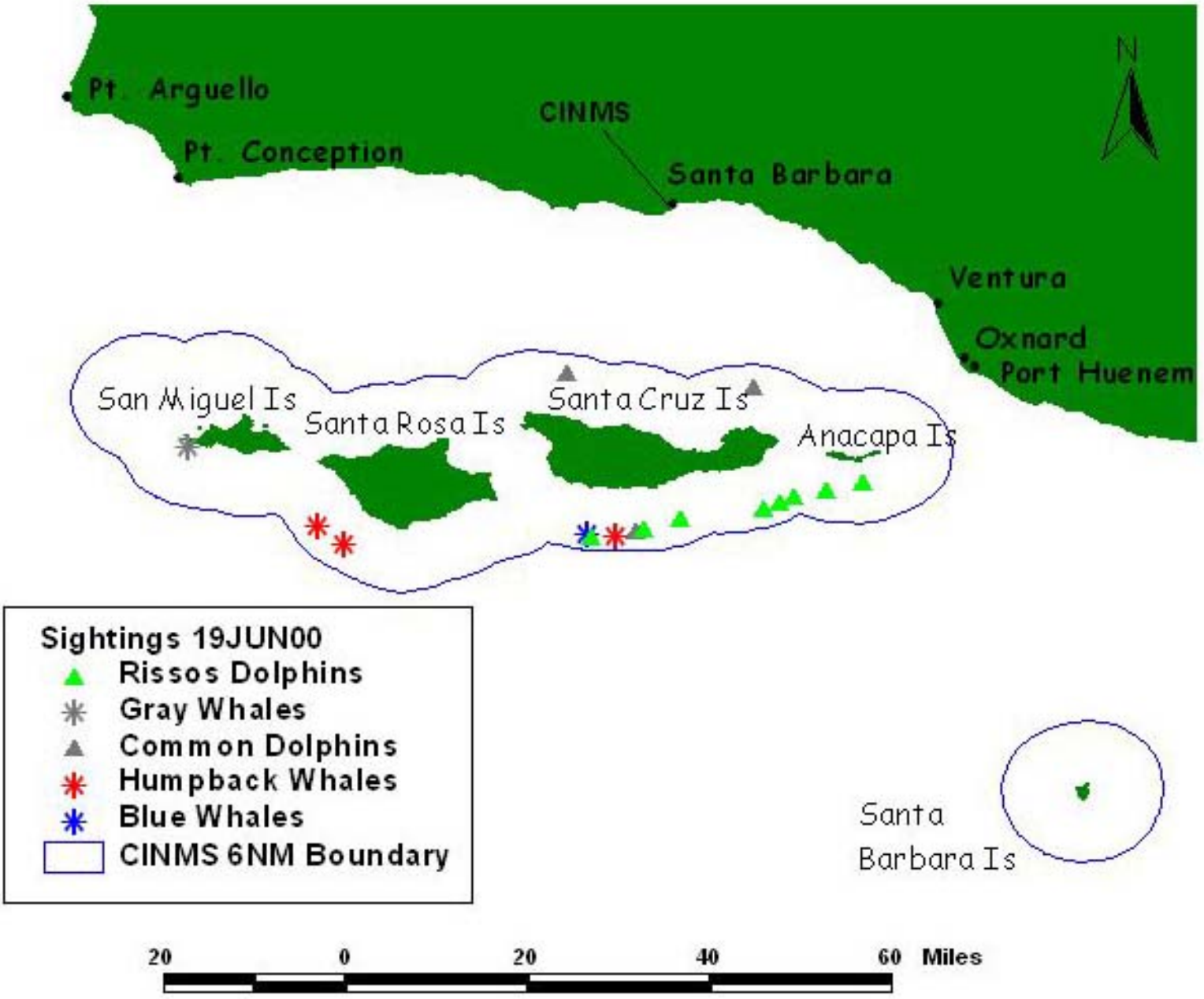
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SUSTAINABLE SEAS EXPEDITIONS

SANCTUARY LOG

MONTEREY BAY

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EXPEDITION UPDATE

June 26 to July 12, 2000

Track the Monterey Bay expedition on this page. To learn about planned education and research activities, plus other interesting facts, select a background essay of your choice. You can also follow expedition logs and updates.

Welcome Log Congressional Representative Sam Farr welcomes the Sustainable Seas Expeditions to the Monterey Bay National Marine Sanctuary.

Congressman Sam Farr with SSE Director Dr. Sylvia Earle.

June 26 The Monterey Bay National Marine Sanctuary welcomed the Sustainable Seas Expeditions (SSE) in an evening celebration at the National Geographic Theatre, located in the Hearst Castle State Park Visitor Center. More than 100 local residents were treated to a presentation by Dr. Sylvia Earle and a special showing of "The Living Sea."

June 28 Seven students, ranging from 6th graders to college sophomores, boarded the NOAA vessel *McArthur* today to witness the Sustainable Seas Expeditions first-hand. They received a full tour of the

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Welcome SSE

June 26 Hearst Castle Celebration

June 28 Students-at-Sea

June 29 Student Scientists

June 26-29 Personal Log: Webster

June 29 - July 2 Personal Log: Guardino

July 4 Underwater Fireworks

July 6 Another Success

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ship, learned about DeepWorker submersible operations as well as tracking and organization, and visited the video and photography editing studio. The research team reports that Dr. Steve Webster is getting some ribbing from the crew for being "Cleanup Man." He used the manipulator arm on the DeepWorker to bring up an old space heater (not a water heater) from 100 ft deep. Though visibility was only 10 ft because of plankton blooms in the water, Dr. Webster saw many squid eggs, and also brittle stars, along the sandy bottom. **Read Dr. Webster's personal account.**

Students involved in the expedition with their teacher.

June 29 Teacher-in-the-Sea Mike Guardino is diving at Pt. Lobos today. Dr. Sylvia Earle reports that dive conditions are "picture perfect." The only communications problem with the DeepWorker is Mike having trouble wiping the smile off his face long enough to talk. His dive today is supporting research that he and his students have been conducting over the past two years, which involves studying the marine protected area at Pt. Lobos at scuba depths. Meanwhile, a group of 4th through 6th grade students are observing the mission from close proximity aboard the charter boat *Sanctuary*,as well as conducting hands-on science and monitoring activities. **Read their log.**

A student from the Boys & Girls Clubs checks out the plankton.

June 30 The wonders of live uplink technology allowed Internet participants from around the nation to interview Dr. Sylvia Earle, and to chat with Teacher-in-the-Sea Mike Guardino about his student-assisted research to determine the effectiveness of "no-take" marine reserves. Mike explained the project and their preliminary findings of the presence of larger fish in the Pt. Lobos marine reserve, versus in the surrounding unprotected areas. Meanwhile, research operations on the *McArthur*are temporarily "on

July 6 Personal Log: Guardino

July 8 Personal Log: Makowka

June 28 - July 12 Dive Maps

July 12 Summary Log

hold" for maintenance on the subs and the remotely operated vehicle.

Mike Guardino descends in the DeepWorker submersible.

July 2 Our Teacher-in-the-Sea, Mike Guardino, dove to 150 ft for 3 hrs today. At times, thousands of squid surrounded him in the midwater column. Yesterday, the expedition located large patches of squid eggs on the bottom. Squid have become one of the most important fisheries off the coast of California, but little is known about the conditions necessary for spawning, or the migration patterns of adults. **Read his account of the last few days.**

The crew launches the Phantom ROV.

July 3 Dr. Baldo Marinovic of the University of California, Santa Cruz, spent the night gathering **data on krill**, using standard net-tow techniques. He found the krill to be very abundant, and was planning to use the *DeepWorker* to view and describe their behavior. The wind picked up in the early morning, however, creating conditions unsafe for sub deployment. Instead, the crew launched a remotely operated vehicle (ROV), attached by cable, that filmed some krill behavior and jellyfish in the midwater. The Phantom ROV descended to a depth of 350 ft.

July 4 DeepWorker pilot and underwater photographer **Kip Evans was greeted to 4th of July underwater fireworks** as he turned off the submersible lights at 1,000 ft. The krill used their own bioluminescence to create dazzling sparks of light. The plan was to locate krill with the ship's echosounder, sample them with nets, then observe their behavior with the DeepWorker. Kip accomplished all of these objectives, first making a 300-ft dive, followed by the 1,000-ft dive.

July 5 The DeepWorker explored the head of Monterey Bay Canyon today. Diving between 300

and 550 ft, the sub documented the vertical distribution pattern of krill. Monterey Bay Canyon, one of the largest underwater canyons on the West Coast of North America, is a dominant feature of the Monterey Bay National Marine Sanctuary. **View a "fly-through" of the canyon**.

A common species of krill found in the sanctuary: *Euphausia pacifica* (max. size 25 mm).

Dr. Baldo Marinovic conducts krill research.

July 6 After completing the krill project early, the ship returned to Pt. Lobos to finish fish and invertebrate surveys for the marine protected area education project. **Read the log.** Both Mike Guardino, our Teacher-in-the Sea, and Dr. Steve Webster, Senior Marine Advisor of the Monterey Bay Aquarium, completed their DeepWorker dives. **Read Steve's log.**

July 7 Today is a maintenance day for the submersible. Crew members are taking advantage of this break to spend some time onshore. While many are receiving special tours of the Monterey Bay Aquarium, others are shopping for the galley, getting haircuts, and taking care of other personal business.

July 8 Dr. Sylvia Earle took some good footage of krill in Monterey Canyon today, diving to a maximum depth of 1,013 feet. Meanwhile, the crew has been busy with maintenance on the sub. **Read an account of the last few days from Jennifer Makowka**, a research intern at the sanctuary.

Dr. Sylvia Earle prepares to pilot the DeepWorker submersible.

July 9 Rick Starr, marine advisor for the University of California Sea Grant Extension Program, made his DeepWorker checkout dives to 175 ft at Sur Canyon today. He

filmed an assortment of rockfish, including blue, black, yellowtail, olive, and gopher rockfish. We believe this is the first time that the Sur Canyon has been explored by a submersible.

July 10 Rick Starr piloted the DeepWorker to 625 ft in Monterey Canyon today. He conducted a rockfish survey to determine the range of this species.

Rick Starr in the DeepWorker.

July 11 Kim Reisenbichler, a scientist at the Monterey Bay Aquarium Research Institute, made a dive to 625 ft in the DeepWorker today. Kim continued the rockfish survey in Monterey Canyon and conducted some midwater exploration.

July 12 The Monterey mission came to a close today, but not before Rick Starr made one last dive, to 750 ft, to conduct a rockfish survey at Big Creek Reserve along the Big Sur coast. He estimated 20 different rockfish species in the area. **Read the Summary Log.**

The sun takes its nightly plunge as the Monterey mission comes to a close.

The NOAA ship *McArthur*is now heading south, to the Channel Islands National Marine Sanctuary, to continue the Sustainable Seas Expeditions. **Follow along . . .**

View a series of dive maps from the Monterey Bay expedition.

View the expedition dive maps.

Interview

Interview with William J. Douros, Superintendent
Monterey Bay National Marine sanctuary
June 2000

Click on a picture to view a short video clip of each response (Quicktime video).

What's unique about the Monterey Bay National Marine sanctuary?

The Monterey Bay National Marine sanctuary is the largest marine protected area in the United States and the third largest in the world. The sanctuary protects an incredible diversity of marine life and marine habitats, from rocky shores and kelp forests and sandy beaches, to deep canyon systems and the largest habitat on earth, the open ocean. The productivity in this region is spectacular. Small, single-celled organisms lead to a food chain that expands to crustaceans, krill, and all the way up to blue whales and fin whales, the largest mammals on earth.

Perhaps most significantly is that this incredible productivity and diversity of marine life happens along an urbanized coastline with about 8 million people that live within about 20 miles of this region. It's an incredible place, and it's close by for many people to see.

What do you think have been the most important achievements of the Monterey Bay National Marine sanctuary since its designation in 1992?

To many people the most important achievement is that no oil or gas development has happened off the central California coast, because of the sanctuary designation. But the sanctuary has created some extensive and important partnerships with educators to help expand education and outreach to school kids as well as with the lay public; also partnerships with

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researchers to conduct and coordinate research on this incredibly diverse marine ecosystem. We have a Water Quality Protection Program that has extensive efforts with cities and local governments to reduce urban runoff, with harbors and marinas, and with farmers to reduce the effects from agricultural runoff. And the sanctuary, I think, has really helped to accomplish an important thing: to help make the connection for the public between where they live on land and the marine ecosystems offshore.

What have been the major challenges in managing the sanctuary?

Well perhaps the most important challenge that we face in managing the sanctuary is frankly a lack of budget and a lack of staffing. The sanctuary protects over 5,300 square miles; it's larger than three states in the United States. We've got a small budget that we use to help protect these areas and conduct research, and to do education and outreach. But also the many people that live near and along the coastline create challenges for us in terms of how to allow their activities and allow their appreciation and use of the ocean without damaging its environment for the species that live here in the ocean.

How do you think Sustainable Seas Expeditions will benefit the sanctuary?

The Sustainable Seas Expeditions is going to really help the sanctuary expand its education and outreach, and public awareness of the ocean, and of the deep sea especially. We've found that it's a great tool here locally to get people inspired about ocean conservation, but it also has national appeal.

The other way the Sustainable Seas Expeditions is going to help the sanctuary is by expanding our exploration of some of the deep water systems, by getting people, observers down into some of the deep canyons--along the Big Sur coast and out into Monterey Canyon--and also in the habitat that's the largest on earth, the open ocean system.

What lessons have you learned from last year's expeditions?

Last year here in Monterey we learned that you need good weather, perhaps ideal weather, in order to carry out this mission. Central California can be a windy place, with big seas in the spring and early summer time,

and we're going to need good weather to make this project work. We've also learned that the Sustainable Seas Expeditions has tremendous public relations value and we intend to capitalize on that strength of the project. The last thing that we learned is that you need a good team to pull this project off. It's a very complicated project; there are some risks to it, and it's important to have a good team with everyone on the same page as to what the mission should be about and what it should be trying to accomplish. And with a good team we think we can accomplish some incredible things with this project.

What are the Monterey Bay sanctuary's goals and objectives for the Sustainable Seas Expeditions this year?

In Monterey we intend to continue some of our projects from last year. The first is a study in the evaluation of the effectiveness of marine protected areas using our Teacher-in-the-Sea, Mike Guardino, as well as the National Marine Fisheries Service biologist, Mary Yoklavich, who's studied these no-take areas for years. We also want to expand our exploration of and characterization of the open ocean, an important large habitat here in the sanctuary full of tiny invertebrates and large invertebrates that make for a very interesting system.

We've got a couple of new projects this year. We want to do some exploration in the canyon system, ideally the Big Sur canyon system which has had very little exploration by other scientists. And also we want to try to characterize what krill do--small crustaceans that are the primary food for a number of different animals, including big whales, and shearwaters that migrate up from New Zealand. We want to observe their behavior down on the ocean floor. We know a lot about what they do from the surface, but we've never spent any time--no scientist has to our knowledge--studying krill and how they behave along the canyon shelves, especially when predators like whales come near by.

Tell us about some of the important management issues for the sanctuary currently.

The sanctuary is involved in a number of really important, significant management issues right now. And you'll notice when I describe them that many of them all happen close to shore.

Kelp harvesting, and the amount of kelp harvesting, has been a major issue in the sanctuary for the last couple of years. Divers,

kayak shop owners are concerned about the amount of kelp that's harvested to feed abalone in aquaculture facilities. So we're working to try to improve the state of California's overall management of kelp harvesting.

Also along Highway One down along the Big Sur coast, occasional storms in the winter time will wash out the road, and the state agency CalTrans that rebuilds the road often likes to use the ocean as a source to remove excess material from their repair activities. We're working with the State to try to find better management practices for their repair work.

Also tide pools, like the one I'm standing in right now, are an issue that's really gotten a lot of attention in the last year, especially in Pacific Grove. There's a concern by many in the community that there are just too many people using tide pools--trampling, maybe even removing some of the plants and animals that live here--and we're working with the community to try to find the right management approaches to protecting tide pools.

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Planned Education Activities

Jen Jolly, Public Outreach Specialist
Monterey Bay National Marine Sanctuary

About SSE Education

Students enjoy a sanctuary outreach event. Here they check out marine creatures.

The naturalist Loren Eiseley wrote, "If there is magic on this planet, it is contained in the water." Unlike the Great Houdini's card tricks and sleight of hand, the magic of the underwater world does not fade away upon scientific investigation and greater understanding. More thorough knowledge of marine ecosystems, which research will provide, may diminish the mystery surrounding the "unknown realm" of the oceans, but this new knowledge can only add to the thrill of excitement we feel when we contemplate the lives of undersea creatures so different from ourselves. The Sustainable Seas Expeditions (SSE) provide both the tools for exciting new ocean exploration as well as a mechanism for publicizing the beauty and wonder of our nation's marine sanctuaries. The education team of the Monterey Bay National Marine Sanctuary looks forward to the Sustainable Seas Expeditions' second visit as a way to spread the feeling of magic about the sanctuary's underwater environment.

As one of the strengths of the SSE program is its integration of marine research and education, some SSE activities are aimed at enhancing science education in the classroom. For the last two years, marine educators have used the SSE as a focal point to stimulate hands-on marine research and monitoring by local high school science classes. In the 1999-2000 school year, 40 students from six local high schools designed and conducted team research projects in the Monterey Bay National Marine Sanctuary. The majority of these were hands-on monitoring projects involving field data collection, such as characterizing rocky intertidal communities and using scuba to compare fish assemblages between a no-fishing

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Students get their hands wet at sanctuary education events.

marine reserve and an adjacent fishing area. These hands-on projects cultivated, in the best possible way, an active interest in scientific research and the marine sanctuary. The students will continue their education during the SSE mission, with a first-hand look at the research activities and *DeepWorker* technology aboard the NOAA research vessel *McArthur*. Middle school students will also be offered a boat cruise to learn onboard research techniques and observe the *McArthur* and *DeepWorker* submersible from close proximity.

'Teacher in the Sea' Mike Guardino discusses a plan with his student research team. (Photo courtesy of Kip Evans.)

Mike Guardino, a science teacher from Carmel High School, was trained as a *DeepWorker* pilot and was the project's first Teacher-in-the-Sea. This year Mr. Guardino, assisted by Dr. Steve Webster, will conduct a series of submersible dives over a five-day period to extend the student investigation of fish communities within and outside of a no-fishing marine reserve to deep waters beyond the reach of scuba. Mr. Guardino has integrated his SSE experiences with his teaching by creating a class in subtidal ecology at Carmel High. He has trained 18 of his students in scuba, research diving techniques, and marine fish and invertebrate identification so that they can participate in the SSE project. Their combined scuba/submersible research will further investigate the effectiveness of no-take marine reserves as a fishery management tool.

The SSE 2000 mission also provides a number of exciting opportunities for the public to learn about high-tech underwater exploration in the Monterey Bay National Marine Sanctuary. Those who attend the kick-off reception and fundraising benefit in San Simeon on June 26 will have the opportunity to meet Dr. Sylvia

Students are frequently exposed to Monterey Bay marine life during sanctuary-sponsored educational events.

Reception with Dr. Sylvia Earle -- Monday, June 26, 2000

This special evening with National Geographic Society Explorer-in-Residence Dr. Sylvia Earle will kick off the SSE 2000 mission and benefit the Monterey Bay Sanctuary Foundation. It will be held at the Hearst Castle Visitor Center in San Simeon from 6:30 to 9:30 p.m. Dr. Earle and other dignitaries will provide remarks, and "The Living Sea," a new National Geographic Society film will be shown following a food and wine reception.

***DeepWorker* Model Display -- Late June through Labor Day**

This exhibit will be on display at

Earle, the SSE project director. The event will also feature a new film, "The Living Sea." An SSE exhibit, including a life-size model of the *DeepWorker* submersible, will be on display at the Monterey Bay Aquarium. A live, interactive Web cast is planned for June 30, which will bring SSE directly into your home. On July 12, the public is invited to an open house aboard the *McArthur*that will be hosted by the ship's crew, and SSE pilots and researchers.

SSE Education Activity Calendar

Students participating in the 2000 Sustainable Seas Expeditions Student Summit. Students from regional high schools conducted team-based research or education projects aimed to promote understanding, stewardship and protection of the Monterey Bay Sanctuary. The students presented results of their projects at the conference, and had the opportunity to interact with scientific experts on marine research and conservation issues.

the Monterey Bay Aquarium from late June through Labor Day. The exhibit includes a life-size model of the *DeepWorker* submersible and interpretive information.

Teacher-in-the-Sea Educational Research Dives -- June 27 to July 1, 2000

SSE Teacher-in-the-Sea Mike Guardino will conduct a series of *DeepWorker* dives to continue the student-assisted research investigation he began last year. His research focuses on no-take marine reserves and whether they are an effective tool for fisheries management. Mr. Guardino, assisted by *DeepWorker* pilot Dr. Steve Webster of the Monterey Bay Aquarium, will conduct an invertebrate census and fish surveys to quantify the assemblage of organisms as a function of their protection (or lack thereof) in and outside of Point Lobos Reserve, a no-fishing marine reserve. Submersible tasks will include roving fish surveys, fish species counts, and benthic transects to measure the density of select invertebrate species down to a depth of 110 meters.

Students and Teachers-at-Sea -- June 28 and 29, 2000

Selected high school students and their teachers will spend a day on the NOAA ship *McArthur* to experience and document the research expeditions first-hand. Students will rotate through a series of science activity stations focusing on *DeepWorker* technology. Additionally, a group of 20 fourth through sixth grade students from the Monterey County Boys and Girls Club will observe the *McArthur* and *DeepWorker* submersible from a nearby charter boat. They will learn shipboard sampling techniques and conduct hands-on marine science monitoring activities.

Live Interactive Web Cast -- Friday, June 30, 2000

Participate in a virtual SSE education activity without leaving your computer. Click the link for more information.

***McArthur* Open House in Santa Cruz -- Wednesday, July 12, 2000**

The public is invited to tour the NOAA ship *McArthur*, view the *DeepWorker* submersible, and meet with sanctuary and SSE staff, scientists, students and teachers to learn about SSE goals and activities. Free boat shuttles will provide transportation from the Santa Cruz Harbor to the ship, tentatively scheduled for 3-7 p.m.

To read more about the **Education Program of the Sustainable Seas Expeditions**, click the link.

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Planned Research Activities

Dr. Andrew De Vogelaere,
Research Coordinator
Monterey Bay National Marine Sanctuary

The NOAA ship *McArthur* launches the *DeepWorker* for explorations in the Monterey Bay Sanctuary. (Photo courtesy of Kip Evans.)

There are many ways to study the ocean, all with certain advantages and disadvantages. For many years, most biological sampling was conducted with nets. More recently, remote sensing with satellites and aircraft have enabled sampling over large areas at a relatively low cost. Tethered cameras have provided a safe way to observe animals' behavior in their natural habitat; nets make mush out of jellyfish! However, there is no substitute for placing a person directly in the ocean environment, especially in a vehicle like the *DeepWorker* submersible which provides the pilot with excellent visibility. The Monterey Bay National Marine Sanctuary hopes to contribute to the development of deep-water exploration tools by using the *DeepWorker* to study jellyfish, krill and marine protected areas.

A submersible like the *DeepWorker* is a versatile tool that is relatively small and simple to operate. In the future, ocean exploration in submersibles may well be common; however, we are still treading relatively new ground, or, more appropriately "new water" with this technology. The sanctuary staff has spent a lot of time with its SSE partners to train pilots, work out operational procedures, and modify ship equipment. In comparison to space exploration, we are lacking in our ability to observe the ocean environment. Advances we make to enhance the accessibility of

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Deep-sea benthic invertebrates. (Photo courtesy of MBARI.)

submersible studies will be a significant contribution.

In the Monterey Bay, we have extensive information on how seasonal winds create an ocean environment rich with nutrients, creating blooms of plankton and small animals that attract birds and whales from throughout the Pacific Ocean.

The *DeepWorker* in its element. (Photo courtesy of Kip Evans.)

When Monterey Bay offers up a feast of **krill** (small, shrimp-like animals), seabirds called shearwaters come from New Zealand and humpback whales travel from Hawaii to partake of the bounty. We do not, however possess a good understanding of krill behavior, nor do we have photographs of the tiny creatures as they interact with their predators and migrate from the depths to the surface on a day/night cycle. Another important creature in the food web here is the jellyfish, a favorite food of the large leatherback turtles who visit Monterey Bay. Much of what we know about the "jellies" has been learned by regional marine scientists who are monitoring their abundance through time with cameras operated from the surface. We plan to use the *DeepWorker* to provide unique observations of krill and jellies to enhance these studies that have been using more traditional ocean research tools.

Marine refuge areas, where the harvest of marine resources is limited or excluded, can occur naturally by virtue of geographical or marine habitat features that bar human access, or can be imposed as part of our resource management measures. In the Monterey Bay National Marine Sanctuary, reserves that prohibit harvest exist at Big Creek along the Big Sur coastline, at the Point Lobos Reserve, and at Hopkins Marine Life Refuge.

In addition, the sanctuary has numerous deep canyons and steep rock walls that are difficult to lower nets into. SSE research and

Deep-sea benthic invertebrates. (Photo courtesy of MBARI.)

education projects will focus on the Big Creek and Point Lobos **marine reserves** to study the effectiveness of marine harvest refuges and strengthen the long-term monitoring of these sites.

Marine research is exciting and challenging, especially when scientists are sent directly into the deep ocean. Through this Web site, we hope to share our experiences with you.

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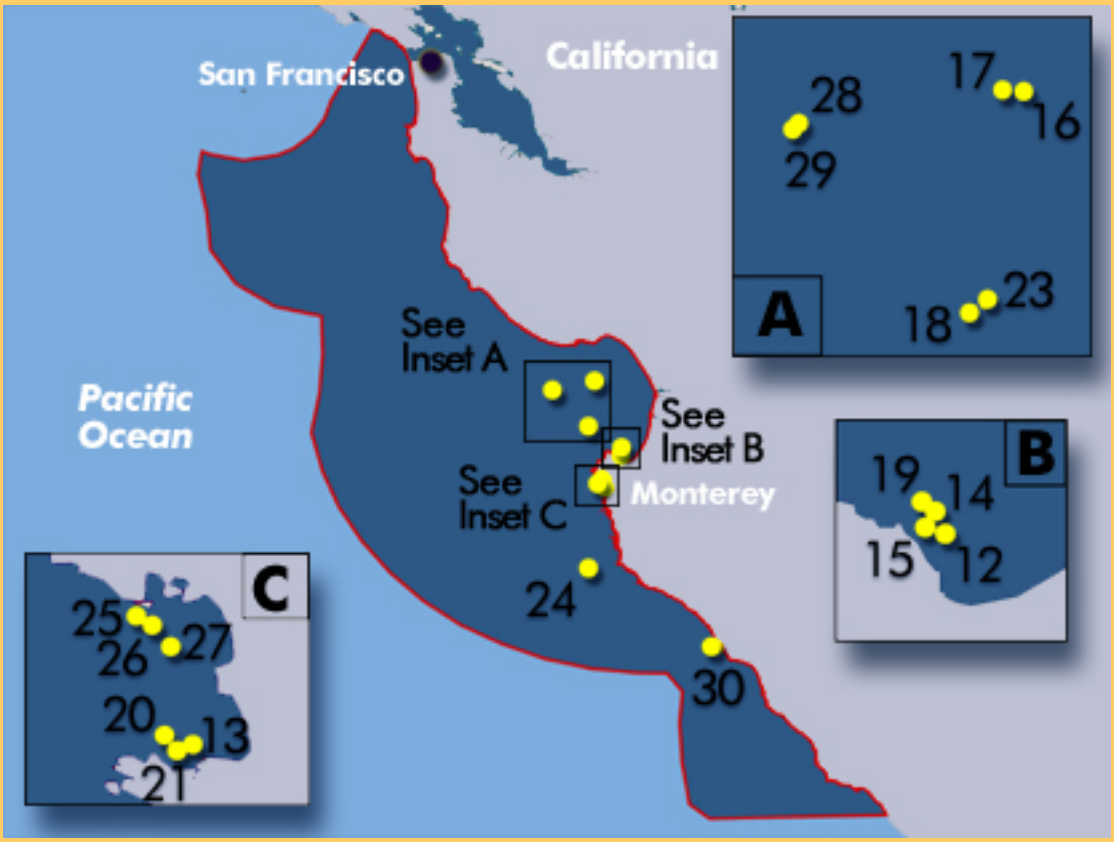
Maps

Dive Maps



View a series of dive maps produced during this expedition. Click on the reference map above to **link to the Dive Maps page**.

Three-Dimensional Fly-through

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The fly-through movie is automatically downloading in the background. To view, click the play buton.

In this fly-through you will be taken deeper, farther and faster than the *DeepWorker* submersible could possibly go. For 40 seconds, you will be propelled through a dark underwater canyon lying off the coast of Central California within the Monterey Bay National Marine

Sanctuary, whose full extent has been hidden until mapped by modern scientific surveying. The fly-through begins approximately 15 miles offshore, and carries you due East (follow the arrow) toward the shores of Monterey Bay, beginning with a slow descent to nearly 2000 meters below the surface, allowing you to see the vast entrance to the submerged canyon. The virtual submarine then races up the winding canyon, surveying the cliff walls along the way. The fly-through ends safely in the shallow nearshore part of the canyon at about 100 meters below sea level, at a point just West of Moss Landing.

Panorama of the Monterey Bay Canyon

To view a QuickTime Virtual Reality Panorama of the Monterey Bay Canyon, follow the directions below. This movie requires the lates version of QuickTime and the QuickTime Browser Plug-ins.
Download QuickTime

Virtual Reality Panorama of the Monterey Bay Canyon

- To Zoom In, hold the SHIFT KEY down.
- To Zoom Out, hold the CONTROL KEY down.
- To Pan around the image, hold the mouse button down while dragging the mouse in the direction you would like to pan.

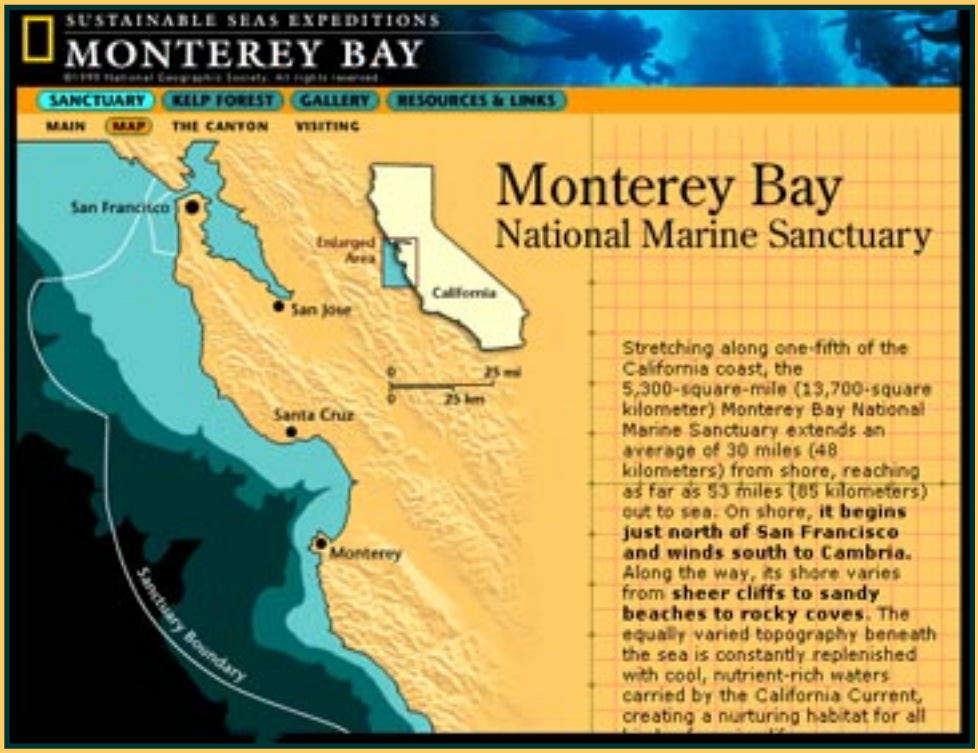
About the image: This image was generated from a uniform 3"x3" latitude/longitude grid of elevation and bathymetry data . The data for land areas came from the United States Geological Survey; ocean data are primarily from NOAA multibeam sonar surveys. Arbitrary vertical exaggeration was applied to make the geomorphic features stand out strongly. The land coloration was chosen to suggest the lush vegetation and reddish soils of the region. The view is from the South at about 75 ° elevation angle. (Credits: 3D plot by Peter W. Sloss, NOAA-NESDIS National Geophysical Data Center)

New Map of the Monterey Bay Sanctuary

This image shows clearly the great expanse of the sanctuary, and gives a satellite view of the land and canyon features that make this area so unique. The map was produced in partnership with the **Monterey Bay Sanctuary Foundation**.

National Geographic's Tour of the Monterey Bay Sanctuary

To view National Geographic's Tour of the Monterey Bay Canyon, click on the image below.



Monterey Bay Sanctuary Boundary Map

The waters of Monterey Bay and the adjacent Pacific Ocean off the central California coast were designated and protected in 1992 as the Monterey Bay National Marine Sanctuary. This vast area stretches 400 miles (348 nautical miles) north to south, extends an average of 35 miles (30 nautical miles) offshore, and covers over 5300 square miles (4,024 square nautical miles). The sanctuary is managed to balance recreational and commercial uses with protection of natural resources, water quality, habitats, and its bountiful resident and migratory marine life. Major resource management issues in the sanctuary are vessel traffic and its potential impact on living resources and water quality; assessing the design and effectiveness of marine management zones; assessing impacts of increasing human populations; causes of change in threatened species populations, such as the sea otter; coastal erosion; non-point source pollution; and impacts of non-native, invasive species. Visitors will find a mostly undeveloped coast of spectacular steep cliffs in the southern half of the sanctuary. The Monterey Bay region includes the moderately sized cities of Monterey and Santa Cruz separated by vast sandy beaches. This area is home to over 20 marine research institutes, making it a world renowned center for marine research. To the north, the shoreline is rocky with intersperse pocket beaches and cliffs. Up until the city of San Francisco, this coast is dotted with small towns and moderately-sized cities.

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Close Encounters with Krill

Baldo Marinovic,
Assistant Research Biologist
Institute of Marine Sciences, University of California, Santa Cruz

Two common species of krill found within the sanctuary waters are: *Euphausia pacifica* (top), max. size 25 mm; and *Thysanoessa spinifera* (botom), max size 34 mm.

Euphausiids, or krill, are small shrimp-like crustaceans that inhabit the cooler waters of the earth's oceans. Within the coastal waters of California, krill are preyed upon by a variety of marine organisms including commercially important species (such as squid, sardines, rockfish, salmon), seabirds, and several species of endangered whales (humpback, fin, blue).

Krill have a number of unique and important characteristics that make them a key species in the open water food webs of California's marine sanctuaries. Krill can feed directly on phytoplankton, the unicellular salad of the sea. This allows them to directly exploit energy from the very base of the food web, and contributes to another characteristic of krill: they are extremely abundant.

In addition, krill undergo daily migrations, rising to the surface waters at night to feast on phytoplankton, and returning to the deep during the day where they form dense aggregations. These aggregations are typically found 100-200 meters (300-600 feet) below the surface where there is very little light, making detection by predators more difficult. Swarming may also make it more difficult for most predators to target individual krill; however, it is this very behavior that makes krill attractive to whales. The blue whale is the largest animal to have ever lived, yet it feeds almost exclusively on krill. Blue whales do not consume individual krill;

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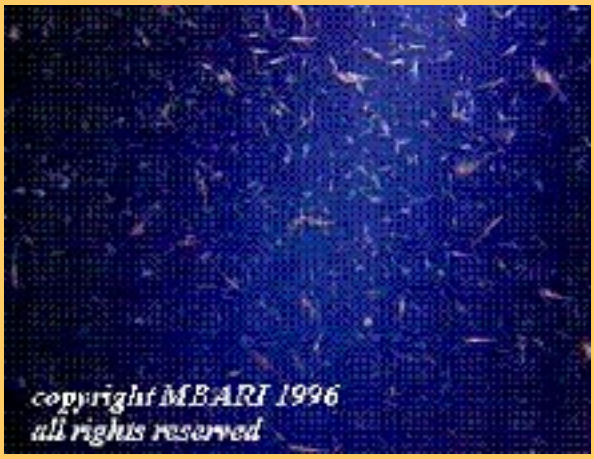
Aerial photograph of a Blue whale surfacing from a feeding dive. Note the extended throat filled with krill laden seawater.

they consume schools of krill. They do this by gulping large quantities of water containing krill and then filtering out the krill through the use of specialized hair-like plates in their mouth called "baleen." Ironically, the very behavior that krill use to avoid most of their predators is the very thing that makes them attractive as food for whales!

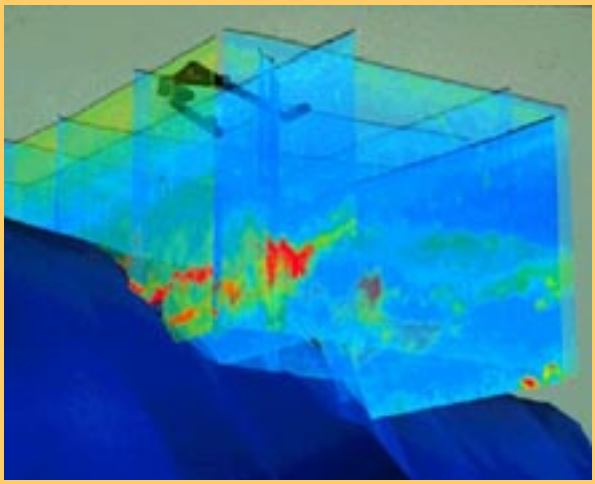
Many basic questions remain unanswered with regards to the biology of krill and the interactions between krill and krill predators. We know that krill abundance and reproduction is tightly linked to patterns of phytoplankton productivity. Similarly, we know that phytoplankton productivity in the coastal waters of California is largely dependent on the process of wind-driven upwelling, whereby cold, nutrient-rich waters are brought to the sunlit surface waters where phytoplankton can utilize them. What is not clear is how krill, which can live more than a year, have evolved to take advantage of this seasonal phenomenon so as to maximize their survival, growth, and reproduction. We also lack a full understanding of how whales locate and exploit these rich but ephemeral krill patches, as well as what types of signals whales utilize to locate krill schools when foraging in the dimly lit waters of the Monterey Submarine Canyon.



Euphausiid (Krill) Swarm

We hope to answer some of these questions through our research in this year's Sustainable Seas Expeditions.

Using the *DeepWorker* submersible, we hope to gain direct observation and a photographic record of krill behavior, including interactions between krill and their predators.



Composite echogram of hydroacoustic data showing a distinct krill scattering layer in association with the edge of the Monterey Submarine Canyon. The black line on the surface represents the surface track of a blue whale feeding on the pictured layer.

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Marine Reserves

The following abstract describes a research project conducted in the Monterey Bay National Marine Sanctuary. The study compared deep-water benthic (bottom-dwelling) fish and habitats in "no-take" marine reserves with those outside the reserves, to help determine the value of reserves in maintaining populations of marine fishes which are harvested outside of the protected zones. SSE scientists will attempt to build on this existing research.

Deepwater Benthic Fish and Habitats Associated with a Marine Reserve off Central California

Mary Yoklavich (1), Jean deMarignac (2), Jeffrey M. Field (2), Robert N. Lea (3), Gregor M. Cailliet (2), Richard M. Starr (4)

Big Creek Ecological Reserve

Big Creek Ecological Research Reserve (BCER), located off the Big Sur coast, has been closed to fishing since January 1994. We combined the use of side-scan sonar, bottom profiling, and manned submersible operations to identify and characterize large- (i.e., hundreds of meters to kilometers) and small-scale (i.e., 1 meter to tens of meters) habitats and associated benthic fish resources in deep water inside and adjacent to the BCER. Our overall objective was to estimate abundance, species-habitat relationships, and species and size composition of fish assemblages, and to compare these variables inside and outside the reserve and between two years of increased protection.

Forty-nine research dives were made in water depths from 30-270 m inside and outside of the BCER, during which 145 10-minute video transect surveys of fishes and associated habitats were

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completed over various bottom types and water depths. A total of 70,144 individual fishes from 83 taxa were identified, including 36 species of rockfishes.

Several distinct fish assemblages have been described in general. Large schools of young-of-the-year rockfishes dominate rock areas of 40-120 m depth; low relief fields of coarse sand and sea pens in about 70 m of water appear to be a nursery ground for stipetail rockfishes in particular. Adult fishes of small species were associated with sand, fine sediments, and shell-hash substrata of low relief, while large species, especially rockfishes, were closely associated with rock crevices, small caves, and boulder/pinnacles.

Mary Yoklavich

Higher habitat-specific densities of fishes occurred inside the BCER than outside the reserve to the south, and there were significantly larger individuals of harvested species inside the reserve. After only a few years of closure, it appears that the Big Creek Ecological Reserve offers some protection for local rockfish populations.

These data will serve as a valuable baseline for future monitoring of this reserve. By integrating geophysical data collected over a relatively broad area with observations made from the submersible, we are able to describe and quantify the use of deep-water habitats by fishes throughout the BCER area, hopefully contributing to our understanding of the role that deep-water habitats within a reserve may play in maintaining populations of marine fishes that are being harvested in unprotected areas.

---

1. National Marine Fisheries Service
2. Moss Landing Marine Laboratory
3. California Department of Fish and Game
4. Sea Grant Extension Program, University of California

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Partnerships Pay Off In Ocean Protection

Rachel Saunders, Director
S.E.A. Lab Monterey Bay

Elephant seal pup finds a comfortable spot at a protected haul-out area along the Monterey Bay Sanctuary. (Photo courtesy of Kip Evans.)

"Unprecedented Partnership Protects California Sanctuaries from Catastrophic Oil Spills," read the headline on a May 31, 2000 press release from the U.S. Department of Commerce. A two-year collaborative effort to reduce the risk of vessel-related spills impacting sanctuary resources had finally paid off. A long sought after "ounce of prevention" in the form of new vessel routing measures had finally been approved by the United Nations' International Maritime Organization (IMO).

For those of us who have worked as marine sanctuary advocates, and who have had visions of alternative shipping lane proposals dancing in our heads for more than a decade, the IMO's recent action is a huge accomplishment. It also represents a significant piece of hard work. The partnership approach taken by the Monterey Bay National Marine Sanctuary and the U.S. Coast Guard deserves commendation, as does the active and crucial participation of the other "partners", including state and local agencies, elected officials, industry, and environmental groups.

This recent sanctuary protection initiative is just one example of how partnerships have emerged in recent years as an increasingly desirable

and effective approach to addressing some of our most complex

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marine resource issues. Some additional examples in which partnerships have played, or are currently playing, a pivotal role in the sanctuary include:

Farmers learn about both urban and agricultural runoff issues in a workshop led jointly by the sanctuary and Monterey County Resource Conservation District.

• A joint effort in the mid-1990s by the Resources Agency of the State of California, the sanctuary, the National Marine Fisheries Service, the state highway department, private landholders, the Center for Marine Conservation and other groups to protect a newly established elephant seal haul-out area near San Simeon, California;

• A joint effort initiated this spring by the sanctuary and the National Marine Fisheries Service, along with local partners (the Monterey Bay Sanctuary Foundation, the Coastal Watershed Council, the Santa Cruz County Resource Conservation District, and Save Our Shores) to enhance the conservation of threatened salmon and steelhead in central California;

• A recently announced collaboration between the sanctuary and the cities of Monterey and Pacific Grove, along with the Coastal Watershed Council, to engage citizens as partners in helping address urban nonpoint source pollution;

• A recent joint effort involving 30 different institutions to initiate the development of a Monterey Bay Sanctuary Ecosystem Monitoring Program; and

• A multi-level, multi-partner collaboration to launch "S.E.A. Lab Monterey Bay"--a new residential ocean science education camp located along the shores of the Monterey Bay Sanctuary where

Volunteers learn how to use water quality monitoring test kits as part of Urban Watch, a program which involves local citizens in monitoring their city storm drains for runoff contaminants, a collaborative effort between the sanctuary, two local municipalities, and a local non-profit organization.

young students and teachers will improve their understanding of ocean science and stewardship. Partners include community leaders such as Congressman Sam Farr, representatives from educational institutions (e.g., California Sea Grant College program, the California State University at Monterey Bay, the University of California at Santa Cruz, the U.C. Davis Sea Grant Extension Program, and the Santa Cruz and Monterey County Offices of Education), federal and state agencies (NOAA, the sanctuary, the California Coastal Commission, the Naval Postgraduate School), and local businesses.

All of these partnerships combine capabilities, resources, and expertise to address issues such as marine mammal management, nonpoint source pollution, habitat and fisheries management, ecosystem management, and stewardship education. Marine sanctuaries are a perfect platform for building partnerships and for addressing problem-solving within a broader framework. Indeed, NOAA's National Marine Sanctuary Program is authorized to "develop and implement coordinated plans for protection and management" and is charged with "ensur(ing) coordinated and comprehensive conservation and management" of the areas designated as sanctuaries. To carry out this mandate, sanctuaries need to work "horizontally"--across, through, and with communities, agencies, and individuals.

The next generation learns how water flows through a watershed, picking up whatever pollutants may lie in its path. Educational programs such as S.E.A. Lab Monterey Bay educate young students about environmental science and stewardship.

As we enter the new millennium and demands upon our rich marine environment continue to mount, agencies and organizations will become increasingly challenged to meet their mandates and missions. Partnerships offer an approach in which we can work together to find creative solutions, to share resources, ownership and responsibility, and to build bridges where none have existed. Partnerships do not replace the more traditional "top-down" management approaches; oftentimes, this sort of management is

needed to encourage collaboration and coordination. But partnerships are certainly the wave of the future. If we are to have sustainable seas, and sustainable lives, we need to work together.

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Water Quality Protection Program

Susan Pufahl, Water Quality Specialist
Monterey Bay National Marine Sanctuary

Growers and resource managers discuss conservation management practices to reduce erosion and excessive sedimentation, and limit the amount of nutrients and pesticides which may migrate to irrigation ditches and nearby rivers, and eventually into the sanctuary.

Until recently, water pollution was believed to be caused almost entirely by large factories and sewage discharge pipes. But today, there is growing recognition that water pollution comes from many different, scattered sources. Urban and rural residents are now called upon to join industry in efforts to protect water quality.

In such regions as the Chesapeake Bay, the Great Lakes and the Florida Keys, water quality has reached crisis conditions, and very expensive clean-up efforts are under way. In contrast, the generally good water quality of the Monterey Bay National Marine Sanctuary is giving managers the opportunity to protect and enhance the sanctuary's marine environment instead of cleaning up a mess down the road. According to Dr. Holly Price, director of the sanctuary's Water Quality Protection Program (WQPP), "We're trying to develop a long-term, proactive program that will address the hot spots we do have and prevent the crisis situations that have developed elsewhere in the country."

To protect water quality, managers need to adopt strategies that reach beyond the waters of the sanctuary. The quality of the water in the sanctuary is linked to the quality of the water that drains into it from its adjacent coastline, which spans nearly 300 miles of

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California's Central Coast. Pollutants are transported into the sanctuary by 11 major watersheds--more than 7,000 square miles of land area--that carry rainfall and irrigation water from mountains, valleys, rivers, streams and wetlands.

Agricultural fields along the northern coast of the Monterey Bay National Marine Sanctuary. (Photo courtesy of Kip Evans.)

Recognizing that water quality is a key to ensuring the protection of all sanctuary resources, 27 federal, state, and local agencies, as well as public and private groups, are working together to develop a comprehensive water quality management plan to enhance and protect the physical, chemical, and biological conditions in the sanctuary and its watersheds. According to Dr. Price, "One of the main things we want to avoid is creating another layer of bureaucracy on top of what we already have. This area has over 150 existing federal, state, and local programs that deal with some component of water quality in the sanctuary and its watersheds. We're trying to find ways to better coordinate those agencies and programs, to direct them to sanctuary problems, to address gaps and redundancies, and to get them working together more effectively."

Volunteer water quality monitors test for dissolved oxygen in the Salinas River, which drains one of the major watersheds of the Monterey Bay Sanctuary.

Working with the region's water quality experts, the WQPP has identified existing problems in the sanctuary and its watersheds, along with their five main sources. Key problems include sedimentation, toxic pollutants in sediments, fish and shellfish, high nitrate and fecal coliform levels, fish population declines, low flows in rivers and streams, wetlands alteration, and habitat degradation. The sources of these problems are very diverse, and include urban runoff, marina and boating activities, agricultural runoff, water management, and point sources of

pollution. The planning team is tackling these sources one by one.

In urban areas, rainfall collects on hard surfaces and flushes out many kinds of materials that accumulate on the ground during dry weather, including oil, grease, coolants, metals, garden fertilizers, pesticides, pet droppings and litter. Storm drains carry this polluted stormwater directly to local rivers or coastal waters without stopping at treatment facilities. To address these threats, the WQPP has worked with the region's cities, public and private groups to develop seven top strategies: a regional stormwater management program, regional education/outreach program, technical training program, storm drain inspections and mapping, structural/nonstructural controls, sedimentation and erosion control, and California Environmental Quality Act revisions. A key role for the sanctuary is educating homeowners and businesses about the simple steps they can take to reduce pollution, such as properly disposing of oil and other chemicals.

The unique soils and year-round mild climate along the Central Coast sustain a $3 billion agricultural industry that produces more than 200 crops. Monterey County alone produces more than 80% of the nation's leaf lettuce, 70% of its artichokes, 55% of its broccoli and cauliflower, and more than one-third of its celery, strawberries and mushrooms. But agricultural activities too can contribute pollutants to the region's surface waters. Impacts from agriculture include erosion and sedimentation, offsite transport of chemical fertilizers and pesticides, and microbial contamination.

One of the strategies in the Water Quality Protection Program's urban runoff plan is to help citizens make the connection between their activities on land and their potential impacts on the Monterey Bay National Marine Sanctuary: what goes into the stormdrain comes out into the Bay!

The WQPP has worked with the agricultural community, environmental groups, and public and private groups for the past three years to develop strategies to address these issues, which culminated in an action plan in October 1999. The strategies focus on improving technical assistance and education, funding and economic incentives for conservation measures, coordination and streamlining of the existing regulatory system to reduce barriers to implementing erosion-control practices, and improving maintenance

practices for rural roadways and public lands. Implementation is now underway, with the local Farm Bureaus taking a unique leadership role in developing networks of landowners and operators to address water quality issues. These projects will represent an innovative effort on the part of agricultural organizations to establish improved soil and nitrate management practices, document their implementation, and develop water quality data to monitor their success.

Boats berthed at Moss Landing Harbor in the Monterey Bay. (Photo courtesy of Kip Evans.)

Harbors around the sanctuary receive pollutants not only from land-based activities such as urban and agricultural runoff, but also from marina and boating activities. Pollutants from harbor activities fall under four general categories: toxics from anti-fouling paints, oil and gasoline from motor operation and maintenance, solid waste and debris, and bacteria and nutrients from boat sewage. Working with the boating community, local government, and environmental groups, the WQPP has developed priority strategies to address these sources. These include regional public education programs, regional technical training, waste oil/bilge waste recovery and disposal, hazardous and toxic materials management, vessel maintenance and underwater hull cleaning practices, and a pollution reduction progress review for harbors. Bilge pumpout systems have recently been installed in two harbors, and educational programs are now in place.

The WQPP has also been involved in an effort to establish the Monterey Bay Sanctuary Citizen Watershed Monitoring Network, a sanctuary-wide network of volunteer water quality monitoring groups. More than 20 citizen monitoring groups currently collect water quality data in coastal waters or the watersheds that drain into the sanctuary. The Network was established to offer technical and educational support to these groups, as well as to coordinate data sharing, create common monitoring protocols and a quality control plan, encourage communication among the groups, and facilitate agency use of volunteer data.

Thus far, the Network has held several trainings, produced a "How-to Guide" for regional groups, and organized a sanctuary-wide "Snapshot Day" on Earth Day this year. During this event, 130 volunteers collected data from more than 80 rivers and creeks that

drain into the sanctuary, to provide a "snapshot" of the health of sanctuary watersheds. With the hiring of a permanent coordinator this summer, the Network promises to grow as an important resource for Central Coast citizen monitoring groups.

A volunteer grabs a sample of water to test for several water quality parameters, as part of a sanctuary-wide 'Snapshot Day' monitoring event. Over 130 volunteers participated in the event, fanning out into the sanctuary's 11 major watersheds on Earth Day 2000 to test the water quality of over 80 rivers and creeks which drain to the sanctuary.

While continuing to implement these plans, the WQPP is now looking ahead to address water quality issues related to wetland and riparian habitat, as well as point sources of pollution. Since water pollution is caused mostly by nonpoint sources, everyone who lives and works in a watershed--and that's all of us--can play an important role in protecting local rivers and creeks, and ultimately coastal waters, through one's day-to-day activities.

To learn more about the WQPP, call the Monterey Bay Sanctuary office, (831) 647-4256.

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Biographies

These biographies identify partners in the Sustainable Seas Expeditions' mission to the Monterey Bay National Marine Sanctuary. They are listed alphabetically.


William J. Douros

William J. Douros, Superintendent
Monterey Bay National Marine Sanctuary

William J. Douros is the superintendent of the Monterey Bay National Marine Sanctuary. His past work and educational experience combine coastal policy, marine science and operational management. After graduating with a master's in marine ecology from the University of California at Santa Barbara in 1985, Mr. Douros worked at the Santa Barbara County Energy Division, which regulates offshore oil and gas development in that county. His graduate work, conducted at Santa Cruz Island, examined intra-specific competition within extremely high-density populations of black abalone (Haliotis cracherodii). He also evaluated archaeological remains to determine how prehistoric predation on abalone may have affected their population sizes. He has performed more than 500 research dives for his own work and as a field assistant for others.

Sylvia Earle, Explorer-in-Residence
National Geographic Society


Sylvia Earle

Marine biologist Sylvia Earle is an Explorer-in-Residence at the National Geographic Society, a position she has held since 1998. She is working with a variety of Society divisions on projects involving her passion--the oceans--and is the project director of the Sustainable Seas Expeditions. Her research places special emphasis on marine plants and developing technology to access and conduct research in the deep sea. Named one of *Time Magazine's* "Heroes for the Planet" in 1998, Dr. Earle pioneered research on marine ecosystems and has

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led more than 50 expeditions totaling 6,000 hours underwater. She also holds numerous diving records. In the 1980s, Dr. Earle founded her own company, Deep Ocean Exploration and Research Inc., and cofounded Deep Ocean Engineering Inc. She is also a former chief scientist of the National Oceanic and Atmospheric Administration. She has authored more than 100 scientific and popular publications, including the 1995 book, *Sea Change*, and three 1999 books related to the SSE: *Wild Ocean: America's Parks Under the Sea*, *Dive*, and a children's book, *Hello Fish*. As the spokesperson for SeaWeb, a conservation initiative of the Pew Charitable Trusts, she strives to increase public awareness of the pressures facing the world's coastal and oceanic realms. In early 1999, she played a key role in the Clinton administration's decision to double the budget of NOAA's national marine sanctuaries. She holds a bachelor's degree from Florida State University and a master's and doctorate from Duke University, as well as nine honorary doctoral degrees.

Kip Evans

Kip F. Evans, Expedition Photographer
Sustainable Seas Expeditions

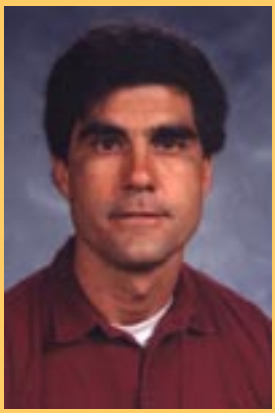
As the official photographer for the Sustainable Seas Expeditions, Kip Evans captures the visual splendor of scientific discovery, exploration and outreach. For 10 years, he has worked as both a still photographer and an underwater cinematographer. Since 1985, he has logged over 1,000 hours underwater documenting marine life, performing research and participating in search-and-recovery operations. Mr. Evans has worked on a variety of documentaries, including a recent special on the life of Dr. Sylvia Earle, *Her Deepness*, for CNN, and a Discovery Channel news story on the declining squid fishery off the California coast. His photographs have appeared in Rodale's *Scuba Diving*, *Dive Training*, *Coast & Ocean* and *Aqua* magazines, and on the front covers of such newspapers as *USA Today*, the *San Francisco Examiner*, *San Diego Tribune*, and *Santa Cruz Sentinel*. His clients include NOAA's National Marine Sanctuary Program, the National Geographic Society, Oceanic Diving Equipment, and the UnderWater World Aquarium in San Francisco. He holds a bachelor's degree in environmental studies emphasizing marine biology from the University of California at Santa Barbara.

Laura Francis, NOAA SSE Education Coordinator
NOAA's National Marine Sanctuaries Program

Laura Francis has been the education coordinator of the Channel

Laura Francis

Islands National Marine Sanctuary since 1994, and is currently coordinating the educational components of the Sustainable Seas Expeditions. She develops educational materials for teachers and students, produces teacher workshops and student summits, coordinates live SSE Webcasts, and is the principal investigator of two of this year's SSE research projects in the Channel Islands. She holds a B.A. in zoology from Berkeley and a master's in deep-sea biology from the University of California at Santa Barbara. With more than 10 years of professional experience in marine science education and research, she finds her work most rewarding when she discovers innovative ways to integrate the two disciplines.



Michael Guardino

Michael Guardino, Science Teacher
Carmel High School

Michael Guardino teaches advanced placement chemistry and honors physics at Carmel High School and works for the Education Department at the Monterey Bay Aquarium. He also volunteers his time to certify his high school students as scuba divers and involve them in marine research techniques. Mr. Guardino was selected to be the first SSE "Teacher in the Sea," and he trained as a *DeepWorker* pilot for the 1999 SSE mission in the Monterey Bay National Marine Sanctuary. This year he will conduct *DeepWorker* dives in and around the Point Lobos Reserve in Carmel Bay, continuing the student-assisted research investigation he began last year to measure the benefits of a no-take marine reserve within the sanctuary.

Baldo Marinovic

Baldo Marinovic, Assistant Research Biologist
Institute of Marine Sciences at the University of California, Santa Cruz

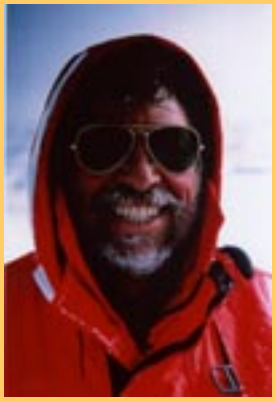
Baldo Marinovic is an assistant research biologist with the Institute of Marine Sciences at the University of California, Santa Cruz. His research interests focus on euphausiid (krill) population biology, zooplankton ecology, pelagic food-web dynamics, and the potential impacts of climate change on zooplankton and fisheries interactions. During this year's SSE mission in Monterey Bay, he will observe krill behavior as they interact with

their predators and migrate on a day/night cycle from the depths to the surface.

George I. Matsumoto, Education / Research Specialist
Monterey Bay Aquarium Research Institute

George I. Matsumoto

George I. Matsumoto is the education and research specialist at the Monterey Bay Aquarium Research Institute. He directs the seminar and internship programs, coordinates joint projects with the Monterey Bay Aquarium, and focuses on the natural history and systematics of gelatinous zooplankton in his research. His SSE project has two objectives: to examine the vertical distribution of zooplankton using both day and night transects, and to compare and contrast the results obtained from the *DeepWorker*. Dr. Matsumoto's Ph.D. dissertation included deep-sea work using remotely operated vehicles (ROVs) and submersibles. He has been active in education and research for the past 15 years, and spent three years teaching and researching in South Australia before returning to the Monterey area in 1996.



Bruce H. Robison

Bruce H. Robison, Deep-sea Biologist / Senior Scientist
Monterey Bay Aquarium Research Institute

Bruce H. Robison is a deep-sea biologist and senior scientist at the Monterey Bay Aquarium Research Institute. His current research focuses on the deep-living pelagic animals of the Monterey Submarine Canyon. Dr. Robison led the first team of scientists trained as submersible pilots for research in mid-water, and he pioneered the use of undersea vehicles for deep pelagic research. His research with the Sustainable Seas Expeditions will investigate the vertical migrations of fish, squid, and zooplankton, from their daytime depths to the near-surface waters at night.

Rick Starr, Marine Advisor
University of California Sea Grant Extension Program

Rick Starr is a marine advisor for the University of California Sea Grant Extension Program. For 20 years he has published articles about the biology and ecology of marine species that are harvested as fishery resources, and developed educational materials to

provide people with an appreciation for the intricacies of the marine environment. He is currently conducting research on species-habitat associations and the movements of fishes associated with marine reserves. Mr. Starr has contributed to four nature films for public TV and has helped design exhibits for the Montery Bay Aquarium, Oregon Coast Aquarium, and the Hatfield Marine Science Center Aquarium. He will use the *DeepWorker* submersible to survey rockfishes inside and out of marine reserves. He is also leading a team of scientists studying the movements of sharks associated with the heads of submarine canyons.

Rick Starr

Steven K. Webster, Senior Marine Biologist
Monterey Bay Aquarium

Steven K. Webster

Steven K. Webster, the senior marine biologist at the Monterey Bay Aquarium, has been involved with the institution since its inception in 1976. His prior positions at the aquarium were project coordinator and director of education. Dr. Webster's SSE dives will focus on the identification, distribution and size comparisons of fishes inside and outside of the Point Lobos Reserve at the head of the Carmel Submarine Canyon. He will also work with the team involved in accomplishing the educational objectives. Dr. Webster taught marine biology and invertebrate zoology at San Jose State University from 1971 to 1978, and has led summer marine biology courses for high school students in the Caribbean for 30 years. He has been a diving instructor and underwater photographer for 36 years.

Mary Yoklavich, Fishery Biologist
NOAA National Marine Fisheries Service

Mary Yoklavich

Mary Yoklavich works as a research fishery biologist at the Santa Cruz Laboratory of NOAA's, National Marine Fisheries Service, and is a research associate at Moss Landing Marine Labs and the University of California at Santa Cruz. She has co-authored over 45 scientific publications, and is well known for her research on the reproduction, age, growth, and habitat assessments of West Coast rockfishes. She recently received NOAA's Bronze Medal Award for her innovative

research to characterize the essential habitats of deepwater fishes using geophysical remote sensing and in situ observations from occupied submersibles. During the Sustainable Seas Expeditions, she hopes to apply underwater observational techniques to study the use of habitats by fishes in the Monterey Bay National Marine Sanctuary.

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Welcome to the Sustainable Seas Expedition

Sam Farr
Member of Congress

Rep. Sam Farr

It is with great pleasure and pride that I welcome the Sustainable Seas Expedition 2000 to Monterey Bay, the largest sanctuary of our twelve site National Marine Sanctuary system. Congratulations to the National Geographic and Dr. Sylvia Earle, the Richard and Rhoda Goldman Fund, and the National Oceanic and Atmospheric Administration, on the Sustainable Seas mission to explore "in depth" the life, geology, and history within our national marine sanctuaries.

This is the second visit to our sanctuary by the Sustainable Seas Expeditions, led by my personal friend and inspiration Dr. Sylvia Earle. During the Expeditions' first visit in April of 1999, the submersible *DeepWorker* made quite a few training dives at "shallow" depths to give the novice pilots a chance at becoming more familiar with the submarine's capabilities, such as how to launch the vessel from a moving ship.

Unfortunately, weather conditions prohibited some of DeepWorker's planned research dives. It is humbling to be reminded of the combined powers and forces of wind, waves, and tides. Although the dives were shallow in terms of a submarine's potential, they still by far surpassed the depth limits imposed on a scuba diver. Highlights included a "shallow" dive to

Sam Farr and students

285 feet where we all enjoyed the green light produced by bioluminescent invertebrates, and the participation of high school teacher Mike Guardino on a *DeepWorker* dive to the deep.

Our sanctuary was established in 1992 by the will and efforts of people who live along the central California coast. It is wonderful and empowering to realize that this part of the coastline and ocean will be protected and enjoyed by many future generations because of the concerns of conservation-minded citizens over the living resources in the Monterey Bay. The National Marine Sanctuary Program in many ways is the ocean equivalent to our land-based National Forest Service. Both programs are mandated to protect the resources while promoting public and private use of the resources, as long as those uses are compatible with the main mandate of resource protection. Another very important mandate of the sanctuary program is to conduct public outreach and education to improve public awareness of ocean and sanctuary resources. The paradigm of an immutable ocean with infinite bounties has shifted to one of a dynamic ocean with resource limits, deserving of our respect and protection. The Sustainable Seas Expeditions holds special significance for our sanctuary because of its ability to illuminate the possibilities--and boundaries--the ocean has to offer through the unique research and educational experiences made available to us with a submersible.

The Monterey Bay National Marine Sanctuary encompasses over 5,300 square miles and stretches from Marin County southward to Cambria in San Luis Obispo County. Within this expansive area we can find a large variety of ocean and coastal habitats, ranging from majestic kelp forests and wind-swept sandy beaches to one of the largest submarine canyons of the world. The entire area is

Guardino

July 8 Personal Log: Makowka

June 28 - July 12 Dive Maps

July 12 Summary Log

nourished by nutrient-rich upwelling, supporting an exceptionally rich and abundant marine ecosystem, including endangered and threatened species such as the California sea otters and stellar sea lions.

Black rockfish are large, powerful swimmers. They, like other rockfish, suspend themselves in the Kelp's stipes so that smaller fish (prey species) can't see them.

I am a fifth-generation Californian and have lived a large majority of my life within the spray of Pacific Ocean waves. I have a deep passion for the oceans and ocean issues, and have worked tirelessly to bolster the nation's land and ocean resource initiatives designed to save essential fish habitat, and to provide the nation's marine sanctuaries with additional opportunities to sustain themselves financially.

In the State Assembly, I authored the Californian Ocean Resources Management Act (CORMA). I was also chair of the Council of State Governments' "Ocean's Task Force," comprised of the Western states and Pacific Islands. In addition, I authored the Coastal Clean-Up law that has grown into a world-wide event.

The National Ocean Conference of 1998, the first of its kind, took place on the shores of the Monterey Sanctuary. Participants included President Bill Clinton, Vice President Al Gore, First Lady Hillary Rodham Clinton, several heads of government departments and agencies, eight members of Congress, and numerous representatives of fisheries, industry, academia, non-governmental organizations and military.

The National Ocean Conference was an historic event which brought together for the first time stakeholders in ocean resources to begin the critical dialogue on how best to manage, conserve, explore and sustainably use our oceans and their resources for the future.

As a nation, we are becoming increasingly aware of how the quality

Rep. Sam Farr speaks at a local sanctuary gathering.

of our lives is integrally linked to the health of the oceans. If the United States is to meet the challenges of the 21st Century, we must continue to invest our efforts towards a better understanding and protection of the oceans' processes and resources. Towards this end I have formed the House Oceans Caucus with three other Members of Congress: Tom Allen (ME), Jim Greenwood (PA), and Curt Weldon (PA). Our intent is to create a bipartisan voice within Congress on ocean issues. As co-chairs of the Oceans Caucus we aim to build awareness, to exchange information and ideas, to explore important issues, and to develop and implement policy pertaining to oceans.

On July 17-19 of 2000, we will be succeeding the National Oceans Conference of 1998 with an International Oceans Conference entitled, Oceans for the New Millennium - Developing and Implementing Ocean Policy in the House of Representatives. This year's conference in Washington, D.C. has been organized by the American Association for the Advancement of Science with the American Geophysical Union in honor of the House Oceans Caucus. The conference will result in a practical agenda and a succinct time-line to accomplish critical legislative actions affecting ocean policy. Each piece of legislation will be produced from one of four issue areas of great concern to the ocean community: biology, pollution, governance, and security. The Caucus has hosted, in preparation for the Conference, a series of briefings to educate Members and staff on the aforementioned topics. The briefings were presented by various departments and agencies of the government in March through June 2000. For more information about activities of the House Oceans Caucus such as the briefing topics, the Oceans Conference 2000, or Members, visit our **House Oceans Caucus website**.

The governance issue for this year's conference is focused on the importance of establishing a unified national oceans policy. Towards this end I have introduced the Oceans Act of 1999 and 2000. These bills, patterned after legislation which created the Stratton Commission over 30 years ago, addresses the need for a thorough assessment of the current state of our nation's coastal and marine resources, programs, and policies, including federal funding priorities, infrastructure requirements, conflicts among marine

users and technological opportunities. An independent review by an Oceans Commission of existing ocean activities is essential to respond to changes that have occurred over the past three decades. It is paramount we develop an effective new policy for 21st Century to conserve, and use in a sustainable manner, ocean and coastal resources, protect the marine environment, explore ocean frontiers, protect human safety, and create marine technologies and economic opportunities.

This purple striped jellyfish is just one example of the many types of jellies that mysteriously appear and vanish throughout the year in the Sanctuary.

There is much work and research to be done by Congress, scientists and citizens before we can understand the depths and secrets of our oceans to adequately and wisely protect their resources and treasures. It is interesting to note that nearly half of the pharmaceuticals under development to treat cancer are derived from marine species, and more than one-third of our gross national product is derived from ocean-related activities. The oceans clearly provide our economy and potential medicines with much raw material. It would therefore logically follow that we would protect and sustain the source of these materials. However, in 1998 there were over 7000 beach closures due to pollution or high levels of bacteria, and fisheries are collapsing on both coasts, throwing whole communities into economic despair. The partnership program of the Sustainable Seas Expeditions offers unique and exciting possibilities towards finding solutions to these problems. More importantly, the discoveries made by the team of scientists associated with the *DeepWorker* submersible will be shared with children in classrooms around the world. Exposure to new discoveries and oceanic processes by these young minds will create a new generation of informed stewards for the oceans. I look forward to the continued participation of the Monterey Bay National Marine Sanctuary in this unique project over the next few years.

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June 26, 2000
Hearst Castle State Park Celebration

Brady Phillips
Monterey bay National Marine Sanctuary

The Monterey Bay National Marine Sanctuary launched this year's Sustainable Seas Expeditions on June 26 with a special evening featuring Dr. Sylvia Earle, hosted by the Hearst Castle State Park Visitor Center and National Geographic Theatre in San Simeon. The Visitor Center's hillside location offered spectacular vistas of the sanctuary's southern-most boundary and the Hearst Castle. Over 100 people participated in the evening's celebration of ocean conservation and exploration in the Monterey Bay Sanctuary. Proceeds from the evening benefited the non-profit Monterey Bay Sanctuary Foundation and their work to increase awareness, understanding and protection of the Monterey Bay National Marine Sanctuary.

Sanctuary Superintendent Bill Douros and Sylvia Earle give the *DeepWorker* their blessing at the reception to kick off this year's Sustainable Seas Expeditions in the Monterey Bay National Marine Sanctuary.

Participants were welcomed with a warm reception in the Theatre's lobby. Sanctuary, Foundation, and SSE staff circulated among the

excited participants and fielded questions about the sanctuary and the SSE mission. But the most popular attraction was the *DeepWorker* model. Curious onlookers marveled at the tiny sub and its ability to plummet to depths of 2,000 feet. Although some people expressed concern about being too claustrophobic in such a small space, others confessed their lifelong dream of someday getting to explore the sanctuary in such a sub.

Participants at the reception check out the *DeepWorker* model.

After the reception, the crowd moved into the National Geographic Theatre, which houses a huge IMAX-style screen. William Douros, Superintendent of the Monterey Bay sanctuary, introduced the speakers. Kirk Sturm, Superintendent for the Hearst Castle State Park, provided a very warm welcome to the sanctuary and expressed a desire to continue to expand their relationship with the sanctuary in educating the public about ocean conservation issues. Dennis Long, Executive Director of the National Marine Sanctuary Foundation, thanked everyone for their support and talked about how the Foundation works with the sanctuary. Bill Douros introduced people to the sanctuary and showed slides of the sanctuary's incredible biological diversity. Finally, Dr. Sylvia Earle gave one of her most inspiring and magical presentations about ocean conservation and SSE. She showed digital footage of past SSE missions on the East Coast and Hawaii, all with an Enya soundtrack playing softly in the background. Several people in the audience were moved to near tears. After Sylvia's talk the lights dimmed, and participants were able to enjoy a special one-night showing of "The Living Sea," which proved to be a powerful ending to an overall inspirational evening.

The reception was made possible with generous donations from local businesses. The gorgeous Hearst Castle State Park Visitor Center and National Geographic Theatre donated the venue and movie. Castoro Cellars from Templeton donated a selection of its award

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winning "Dam Fine Wines" ("castoro" is Spanish for "beaver"), and the Cavalier Oceanfront Resort in San Simeon donated an incredible selection of cheeses, bread and olives. Audio-visual equipment was donated by Audio-Visual Solution in San Luis Obispo. The Expeditions received a gala start in the Monterey Bay National Marine Sanctuary!

Education Specialist Karen Grimmer and Education Coordinator Liz Love toast the new Monterey Bay National Marine Sanctuary monument and sign in Cambria, the Sanctuary's southern-most region.

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June 28, 2000 Students-at-Sea Check Out Operations

by Claire Johnson,
Program Specialist
National Ocean Service,
Special Projects Office

Mike Guardino talks about the internal systems of the *DeepWorker* with Lee, his former student at Carmel High School.

Seven students representing Carmel, Pacific Grove and Monterey High Schools as well as Carmel Middle School donned bright yellow floatation jackets and boarded the sanctuary vessel, *Shark Cat*, during the early foggy Monterey morning. These SSE Students-at-Sea were preparing for a half-day adventure onboard the NOAA ship *McArthur*. After climbing aboard the large oceanographic vessel with a spindly rope ladder, we were greeted by the ship's crew who just completed their journey up from Port Hueneme (south of Santa Barbara). An uneventful transit--just how they like it! LCDR Stacy Birk escorted the students and guests around the ship and provided a 20-minute comprehensive tour of this 175-foot vessel.

The transit having just been completed, submersible operations had not yet begun for the Monterey Bay National Marine Sanctuary SSE mission. So the students got a behind-the-scenes look at how the ship's crew track the submersible, and how the pilots and technicians prepare a sub for a mission dive. They also had an opportunity to interact with the Expedition photographer, Kip Evans, as he covered the National Geographic camera systems and editing equipment onboard.

The Students-at-Sea even got a chance to "pilot" the *DeepWorker* --

well, from where it sat perched onboard the *McArthur*. They climbed onto the port battery pod in turn, careful not to disrupt the labyrinth of cameras and lights outfitted on the submersible, and gently lowered themselves onto the deluxe pilot's seat in the pressure hull. The submersible is currently prepared for America's first Teacher-in-the-Sea, Carmel High School Teacher, Mike Guardino. Due to his height, the foot pedals that control the sub were out of reach for most, however the students still enjoyed themselves as we took photos and as Dr. Steve Webster and Mr. Guardino reviewed the internal systems with each of them.

Student-at-Sea, Alison, tries on the *DeepWorker 2000* submersible for size.

This unique opportunity to allow the students a chance to physically get into the submersible and imagine themselves as an actual *DeepWorker* pilot at 2,000 feet was an experience I highly doubt they will forget anytime soon.

Below are accounts of a day onboard the *McArthur*,as told by the Students-at-Sea themselves.

Alison D.
Monterey Bay Student-at-Sea

I've had the great honor of participating in the SSE Student-at-Sea program for two years. Some of the activities that I got to experience include scientific research via SCUBA diving in the Monterey Bay, as well as getting aboard the oceanographic vessel, NOAA ship *McArthur*,twice. Both times onboard the *McArthur*,I had an opportunity to sit inside the Nuytco submersible, *DeepWorker*.It was a remarkable experience to say the least. Today, we actually went through a pre-dive safety check. The checklist was very detailed and it was interesting to see just how the scientists prepare the submersible for a dive. Overall, the experience on the *McArthur*was educational and lots of fun!

Nancy G.
Carmel Middle School Student-at-Sea

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I was really excited about coming onto the NOAA ship *McArthur*.I hope to have a career in marine biology someday, so this was really interesting for me. I think the submersibles were amazing! We all got to go inside the subs and there were all kinds of compasses, scrubbers, computers, oxygen tanks, cameras, etc. It would be awesome to go into the water in one of these *DeepWorkers*! This was a great experience and, I had a lot of fun!

Tracking and Navigation Group

Lee L.
Monterey Bay Student-at-Sea

Scientist and educator, Dr. Steve Webster goes through the many complex systems of the *DeepWorker* submersible.

The Sustainable Seas Expeditions Student-at-Sea program was an unforgettable experience. We began the day with a tour of the NOAA ship *McArthur*and explored the living quarters, the bridge, the bow and stern of the ship, etc. We then met Kip Evans who taught us about the video documentation and editing images on the ship.

My group focused on the tracking and navigation systems. Dave Lott showed us the various systems he uses to track and chart the *DeepWorker's*position. The sonar system is archaic, but it is still a very effective way to track objects underwater. Along with the sonar system, Dave uses a lot of new computer technology to create maps and pinpoint areas that can be explored.

Michael C.
Monterey Bay Student-at-Sea

Today I learned about the submersible that our teacher, Mike Guardino, goes into in order to further the study that we started using SCUBA dives last year. I was designated to focus on tracking and navigation during my stay on the NOAA Ship *McArthur*. The *McArthur*uses radar to see where it is at in the world and the ship uses sonar pulses to see where the submersible is, at all times. It emits a ping from the ship and it bounces off the sub and is displayed on a digital readout in the tracking room. The technicians

on the ship then can tell the pilot inside the submersible which way to go via through-water voice communications. The *DeepWorker* also has a compass to assist in navigation. It is very important for the crew on the ship to always know where the submersible is for safety reasons.

Submersible Operations Group

Student-at-Sea, Ben, works with Dr. Webster as they discuss the joystick operation of the manipulator arm.

Paul M.
Monterey Bay Student-at-Sea

As Steve Webster of the Monterey Bay Aquarium Research Institute (MBARI) put it, the purpose of the *DeepWorker* is to bring everything we've gotten used to having up here along with us when we go beneath the surface. It's not surprising that, under the extreme conditions beneath 2,000 feet of water, the task Steve described might seem almost insurmountable. Indeed, the complexity of the hardware and instrumentation aboard the *DeepWorker* speaks to the significance of the designer's accomplishments. However, with complexity comes a myriad of potential problems--one or more for each of the thousands of parts that comprise the submersible. It's no wonder that the pre- and post-dive checklist is marked off only after painstaking examination of the *DeepWorker* before each and every dive, and at the end of every day.

Video Documentation and Editing Group

Jennifer T.
Monterey Bay Student-at-Sea

If a seven-gill shark approached the hatch of your submersible, what type of video camera would you use to film it? Well, as soon as you looked past the fact that the only thing separating you from a big, hungry shark is a dome of acrylic, I'm sure it would occur to you to use the spy-cam located inside the submersible.

Expedition photographer, Kip Evans, goes into detail with the Students-at-Sea about the camera systems and lights outfitted on the *DeepWorker 2000* subs.

Millions of organisms that don't even exist on land are seen from the *DeepWorker* during every dive. And what better way to share these amazing views with the world than through videography? With the aid of a $40K camera and state-of-the-art editing programs, National Geographic photographer, Kip Evans, is able to show this underwater world to the land-dwellers above. The high-resolution camera records images at twice the quality of your living room TV; the smallest details, like the individual tentacles of a brittle star, can be seen in incredible sharpness. These images are then downloaded into an editing program on a ship computer, where sound, text and transitions are added. The final product: a short film on the wonders of the deep waters.

Ben S.
Monterey Bay Student-at-Sea

Some high school students and I went on a research vessel today called the NOAA ship *McArthur*. We were all in the same SCUBA class together, where we did over 200 research dives last year to monitor the habitats of marine organisms. Here we saw some interesting things on a tour of the ship. We saw how to control the ship, how to monitor and track the *DeepWorker* submersible, how to operate the submersibles, and how to use photography equipment underwater. I had fun today learning a lot of the things about the ship, not to mention photography skills I could possibly use in the future.

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June 29, 2000
Students Play Scientist-for-a-Day aboard the *Sanctuary*

by Dawn Hayes, Program Director
Boys & Girls Clubs of Monterey County

Heidi Tiuri, operator of the charter boat *Sanctuary*, offers some navigation tips to one of the Boys & Girls Club students.

Twenty-nine members and three staff from the Boys & Girls Clubs of Monterey County joined Monterey Bay National Marine Sanctuary staff and the Sustainable Seas Expeditions on board the charter vessel *Sanctuary*. They got to experience, first-hand, how ocean research is done.

Two days prior to the cruise, 9 - 11 year-old members of the club attended a one-hour presentation by sanctuary education specialist, Karen Grimmer. She prepared them for their cruise through the use of slides and discussion. They were introduced to the *Sanctuary*,SSE, and were told what they would do on the cruise. Their stations would include water quality monitoring, plankton tow and identification, and navigation. On the day of the cruise, members excitedly boarded the *Sanctuary*and met Captain Heidi Tiura.

After donning life jackets, the children were seated and the boat disembarked. They were very quickly back on their feet to see the yearling male sea lion pups stretched out upon the back decks of moored vessels.

We passed the time looking for large jellies and marine mammals as the ship passed from the protected bay waters out into the open

Scientists-in-the-making observe the temperate ocean waters.

ocean. The ship slowed and our students quickly assumed their positions at one of the three stations.

The water quality group learned about temperature, density, and salinity as well as the use of a Van Doren collection bottle. After a few unsuccessful attempts, samples were taken and analyzed. They found their salinity calculation of 30 parts per thousand to be very close to the predicted 33 parts per thousand.

The navigation station was a huge hit, as Heidi explained how she was able to use her instruments to pinpoint exactly where the ship was and how to plot a course. Each student got a chance to "pilot" the ship -- and was quite pleased!

Claire Johnson, SSE Project Specialist, answers questions about ocean monitoring and science.

Of all the stations, the plankton station was the biggest hit. The collection of these tiny creatures was a completely new experience for all. An abundance of copepods made the samples a colorful pink soup, much to the students' delight. Cteneophores, fish eggs and jellies drew the kids back to the plankton station's microscopes each time we took a break.

We ended the cruise with several of the students convinced they were born to be scientists. Everyone had a chance to experience hands-on science and to understand a little more about how and why people study the ocean's habitats. Despite a few green faces, there were a lot of smiles and thank you's as we departed.

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Students learn to measure the water's temperature, density, and salinity using a Van Doren collection bottle.

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June 26 - 29, 2000 Personal Log: Dr. Steve Webster

by Steven K. Webster, Senior Marine Biologist
Monterey Bay Aquarium

Monday, June 26, 2000

Mike Guardino, Jennifer Makowka and I left about 7AM to drive to Port Hueneme to board the *McArthur*for the trip north and to become familiar with the *DeepWorker 2000* subs. We'd been trained last year in trainer subs, and some fundamental differences in these 2000-footers need to be learned and practiced. Monday evening was spent settling in onboard the ship and beginning to look over the subs.

Dr. Webster is an experienced *DeepWorker* pilot. He recounts the first few days of the Monterey expedition in his personal log. (Photo courtesy of Claire Johnson)

The 24-hour sail north to Monterey Bay began at 0800 Tuesday (the 27th) morning. Seas calm enough that we could spend the day in and out of the subs, practicing pre-dive sub checks, finalizing our dive plans and getting psyched up for our chance to explore below the SCUBA zone at Point Lobos State Reserve -- an area very familiar to Mike, as that's where he and his students have conducted their student diving research projects, conducting fish surveys inside and outside the boundaries of the Reserve. Jennifer is training as a member of our technical support team -- helping us do pre-dive and post-dive checkouts of the sub.

Teacher-in-the-Sea Mike Guardino performs last-minute checks before taking the *DeepWorker* down to explore the ocean's depths.

Mike and I plan to continue those surveys from 70 feet deep to as close to 300 or 400 feet deep as we can get. Depth limits will depend on how our training dives go, how the weather behaves, how well the underwater communications and tracking system work, etc.

Fire drills, abandon ship drill (getting in the exposure suit is major exercise!) and man overboard drills (we saved her) were sprinkled between our sub training drills. The California coast was somewhere to starboard, but the fog kept us from seeing it. The humpback whales and northern right whale, common dolphins and other dolphins kept us well-entertained, however.

Wednesday, June 28, 2000

The launch deck of the *McArthur* is filled with equipment to support the missions.

Went to bed early and woke up Wednesday off the Monterey Peninsula, and entered the bay about 0630. Anchored just off from the Monterey Bay Aquarium and Hopkins Marine Station. Nice foggy day, so hopefully the wind will remain calm and we'll get in some training dives before going to Pt. Lobos on Thursday. Sub preps take place all morning before and after the visit of the students from Mike's research classes. Then Mike goes ashore to practice for the Internet uplink from the kelp forest SCUBA dive on Friday.

About 1400 I begin my training dive off the aquarium. New sub, to me, but it still seems familiar to the trainers we had last year. Dome is closed and I now have to start paying attention to life support systems and readings (I'm now in a very small, closed environment). Oxygen needs to be monitored in about the same rate as CO2 is being scrubbed out. This maintains proper breathing

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air and constant cabin pressure. Phil Otalora (dive supervisor) and the skillful deck crew of the *McArthur* get me hoisted up into the A-frame and safely overboard in a slight swell. Matt the swimmer gets the launching lines disconnected and I'm given permission to dive to the bottom (wherever that is).

Preparing to launch the *DeepWorker* -- the perspective from the pilot's seat.

I flood the soft ballast tank and thrust my way to the bottom. In about two minutes I see the sandy bottom coming up to greet me -- about 115 feet deep. Light is dim as we're in a pretty green plankton bloom, so this is dilute "pea soup." Visibility is only 8 feet, but I can see clusters of squid egg cases -- bright white pom-poms here and there on the fine sands at this depth. Squids have been here all month mating and laying eggs at night, and the fishery for them has been going at full tilt. With the squid eggs are fields of brittle star arms coming up from the sediment (the central disk of the brittle star remains buried in the sand). Sand-dwelling anemones and an occasional sea pen (a soft coral relative) are also typical of this area, but brittle stars are most abundant (hundreds to thousands per square meter).

Light is dim due to the thick plankton, but there's enough light to see and navigate. I give the required life support readings to the topside dive supervisor, and am given a compass heading that will take me away from the ship and its anchor and chain. I lift off the bottom and begin motoring along a line toward Hopkins Reef. Along the way I spot a small gray fat ray with a black tail. The tail turns out to be an electrical cord (is this an electric ray?) and the box is a space heater. Ah ha! A chance to try out the manipulator arm and see if I can collect something. Just like diver cleanup day, only I'm in a sub and not at the Monterey Wharf! OK, remember how to enable the manip arm. Remember which switch controls what function. Trial and lots of error get me in position to grab the tail. I grab. I have it! Nothing to this!! Now, pull the heater in toward the sub so that it won't swing and bang into the lights and cameras. Oops. Opened the hand and dropped the cord. Darn. Remember which switch that is! Grabbed the cord again, tried again -- dropped it again. Hey, this is not as easy as it looks. Try again. Twice. Now I have it and I'm not letting go this time!

More life support readings, more brittle stars, a couple of sea stars and new compass headings. Lots of tiny comb jellies in the water. A small school of juvenile rockfishes swims by, unconcerned with alien invader of their realm. My hour goes by in an instant and Phil guides me back around the ship so I won't come across the anchor and chain. Permission is given to ascend and I thrust to the surface.

After motoring about 100 meters closer to the ship, Matt hooks up the lines and I'm hoisted aboard. The dome opens and I'm back in my native habitat after another short but comfortable visit to the largest habitat on earth -- the one containing 99% of the living space on our planet. Tomorrow at Point Lobos I hope to have the chance to explore below the SCUBA depth of the kelp forest and down to about 300 feet. Looks like the winds might remain calm -- let's hope! Time now for the post-dive sub ops!

A view of the *McArthur* as seen from inside the *DeepWorker*.

Thursday, June 29, 2000

Mike's dive has been completed (a great dive to 280 feet at Pt. Lobos), lunch is over, the sub batteries are recharged and Sylvia tells me the electrical techs have the color Aries (my sign!) camera operating. Great -- full video capability. We're about a half-hour from starting my dive, so I'll sign off now and finish this after the dive.

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June 29 - July 2, 2000 Personal Log: Mike Guardino

by Mike Guardino, Teacher-in-the-Sea
Sustainable Seas Expeditions

June 29, 2000

Dive Log: SSE dive # 2000-14 @ Pt. Lobos Reserve, Carmel Bay, California Conditions: Flat, calm, and clear seas. High overcast sky with a slight southwest breeze.

Mike Guardino and his students. (Photo courtesy of Kip Evans.)

Patience does have its rewards! Eighteen months ago I became involved with the Sustainable Seas Expeditions as America's first "Teacher-in-the-Sea." This opportunity has involved three basic components: learning to pilot the *DeepWorker* submarine, writing educational curriculum that will inspire other teachers, and involving students with a research effort in the Monterey Bay National Marine Sanctuary.

The most compelling part of my experience has been working with highly motivated students to complete some real science in the field. In order to achieve that end I recruited 26 young people from four local high schools and certified them as Open Water SCUBA divers before teaching them the basics of research diving in the chilly waters of Carmel Bay. To date we have completed over 200 research dives in and around Pt. Lobos Reserve, collecting data to document the relative abundance and diversity of fish species associated with this Marine Protected Area. The students have now amassed an impressive database that quantifies what their hypothesis suggested, that "the healthy reproductive stock in a no-take zone can help perpetuate fish species through larval dispersal to remote areas that do experience fishing pressure." There are limits to the depths at which SCUBA can be used as a research tool,

and we restricted our fish transects to a maximum depth of 20 meters (67 feet) with the hope of extending our investigation further into the Carmel Submarine Canyon with the *DeepWorker*submarine. Today that dream has finally come true!

Mike Guardino readies himself for another dive. (Photo courtesy of Claire Johnson.)

You have to get up early to make the most of precious ship time, and I found that our dive supervisor (Phil Otalora) was already hard at work preparing the *DeepWorker* for a busy day of diving when I arrived on the fantail of the *McArthur*at 6:00 am. Phil is the consummate professional. He knows how to put man (or woman) and machine together for safe transport to the bottom of the ocean and back. We began the extensive pre-dive preparation of the *DeepWorker* by systematically checking off almost 90 important procedures that are necessary to ready the sub for its visit to the bottom of the sea. Phil was the "top side" voice that I would deliver regular life support readings to, and receive sage advice from, throughout the duration of my adventure.

I could hardly suppress my excitement when Phil gave me permission to begin my dive near the mouth of Whaler's Cove at the northern boundary of Pt. Lobos. I slowly descended through a thick layer of comb jellies that refracted the light shining upon them to produce beautiful spectra that would rival any rainbow. The visibility in Carmel Bay was exceptional, and it got even better with depth as the ambient light gradually diminished. I gently settled on the sandy bottom in 80 meters (267 feet) of seawater to confirm our through-water communication and tracking systems with Phil. "*DeepWorker*, this is top-side, proceed on a 270 degree compass heading to your first way point."

Although I will never forget the vivid red gorgonians gracing the steep granite outcroppings along the side of Carmel Canyon I was glad I would be able to bring back a video record of my transect. I flipped on the *DeepWorker's*two quartz headlights and slowly followed my westward heading while noting the abundant demersal fish residing along the sea floor. It occurred to me that for the first time in my life I was actually in a place where no other human had ever been! Deep-sea research is almost as difficult as the exploration of space. As a matter of fact, more men have walked on

Guardino

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the moon than have been to the deepest trench in the Pacific Ocean. I am truly honored that the SSE chose me to be the teacher to join that fraternity of explorers that have had the opportunity to directly visit the deep-sea. If only my students could have the same opportunity...

It seemed like only a few minutes before Phil told me that my two-hour bottom time had expired and that it was time to ascend. It is vital that our visits to the deep sea be used to gather the data necessary to conserve and wisely manage the natural resources in our national marine sanctuaries. Still, on a personal note, I had to admit to Phil after emerging from the sub that I have never enjoyed myself as much as I did as the pilot of *DeepWorker*.

The *Deepworker* is recovered and returned to the *McArthur* deck. (Photo courtesy of Kip Evans.)

I have three more days of *DeepWorker* dives scheduled in Carmel Bay, and they should produce enough video data to complete the research that my students have initiated at SCUBA depth. Can a group of high school students and their teacher take an active role in conducting meaningful scientific investigations? We will soon complete the analysis of our data and the writing of a scientific paper. It will make suggestions for the progressive management of fisheries in the Monterey Bay National Marine Sanctuary. Perhaps the most important lesson that my students have learned by going into the field and applying the scientific method is that "science is what science does."

July 1, 2000

Dive Log: SSE dive # 2000-15 @ Hopkins Deep Reef, Monterey Bay, California
Conditions: Mild swell with moderate wind chop and clear seas. High overcast sky with 10-15 kt northwest winds.

Woke up this morning after pitching around in my bunk most of the night, as the *McArthur*was cruising into and out of Carmel Bay while in the process of making fresh water. We scouted out our preferred dive site at Pt. Lobos, but the seas were a bit too rough to launch

and recover the *DeepWorker*. Captain Michelle Bullock found a safe place to anchor the ship to the north end of Carmel Bay on the lee side of Pescadero Point in Stillwater Cove. As the name implies, this area is known for calm conditions even when other spots are blown out. Trouble is that just about every dive boat in central California had the same idea, and it was far too crowded to engage in submarine operations around so many SCUBA divers. I got on the VHF radio and checked the "Coconut Telegraph" to find out if (and where) we could find a calm enough dive site. Captain Dennis Cornejo of the *Silver Prince* reported much better conditions back in Monterey Bay along Cannery Row. One distinct benefit of diving around here is having two bays for the price of one! If conditions are marginal in Carmel Bay, they may be better in Monterey and vise versa.

Mike Guardino prepares to descend into the sanctuary waters. (Photo courtesy of Dave Lott.)

The decision was made to conduct shallow-water submarine operations and investigate the squid reproduction area along Cannery Row. As luck would have it we came across a rather large pod of Pacific White-sided Dolphin *(Lagenorhynchus obliquidens)* who were having a great time riding the bow of the *McArthur* on our way over. Less than an hour later we were dropping the hook right outside of Hopkins Marine Station. Hopkins is a part of Stanford University and has been a fixture on the Monterey peninsula for 100 years. It is, by far, the oldest marine station on the west coast of the Americas, and all marine life is protected to a depth of ten fathoms there so that researchers can conduct their studies in an undisturbed environment.

Cannery Row may have become famous because of the historical sardine harvest, but the squid *(Loligo opalescens)* fishery goes back even further in Monterey Bay. There was a thriving Chinese village on Cabrillo Point (the present site of Hopkins Marine Station) around the turn of the century. The Chinese fished for squid at night and dried the catch for export back to their homeland. Eventually the Chinese were forced out of the industry and other groups started catching the elusive and poorly understood cephalopod. Squid have a short life cycle that carries them far from shore for most of the year, but they return to mate, lay eggs, and die on the shallow sandy sea floor along Cannery Row. Squid fishers use light boats at night to draw huge schools of these animals near

the surface, where nets scoop them up. It is not unusual to see 20 or more squid boats anchored along Cannery Row waiting for darkness and another large haul of squid. Is the squid going to have the same fate as the sardine? Is the management of this resource capable of preventing the collapse of another fishery? I was anxious to directly observe the population of squid in the area and to determine whether they were laying enough eggs to perpetuate the species.

My dive started off in relatively shallow water (20 meters/67 feet) as I scouted the area for tiny squid egg cases. Squid deposit approximately 200 white, rice-grain-sized eggs inside of a transparent case about the size of your little finger. The cases are attached to the substrate and each other to form masses they may number in the hundreds. These fingers wave slowly with the ground swell until the larval squid emerge and begin the free-swimming portion of their life cycle.

I was in luck! I found the bottom covered with eggs virtually everywhere I went in *DeepWorker*. I filmed just about everything eating squid eggs, with sunflower stars and sea anemones among the most voracious predators. I covered a large area a few meters above the substrate in hopes of finding a school of squid and perhaps even filming their mating behavior, but only encountered a few individuals -- and they looked very near death after having mated the night before. Adult squid are a favorite food for cormorants, otters, and sea lions. Besides the sustainability of the squid fishery, I had to wonder how this ecosystem would change if the squid was no longer an integral link in the food chain.

The most exciting and challenging part of my dive was coming across a large octopus and filming it among the squid egg masses at 50 meters (167 feet). I am becoming a better *DeepWorker* pilot, and can now concentrate more on my research and photography and less on the mechanics of driving the sub.

July 2, 2000

SSE dive # 2000-16 at Hopkins Deep Reef, Monterey Bay, California
Conditions: Small swell with gentle breeze and clear seas. High overcast sky.

It must have been a good omen or maybe just a pleasant way to start the day, but we were treated to an up close and personal sighting of two blue whales *(Balaenoptera musculus)* as they swam by within 20 meters of the fantail of the *McArthur* this morning.

Mike Guardino pilots the *DeepWorker* at Hopkins Deep Reef. (Photo courtesy of Kip Evans.)

Dive Supervisor Phil Otalora and I got an early start preparing the *DeepWorker* for another day of submarine operations near the Hopkins Marine Life Reserve in Monterey Bay. The sub is now fine-tuned and running smoothly with high quality video being captured on every dive. I was determined to locate and film the schooling and mating behavior of the market squid *(Loligo opalescens)*, and the *DeepWorker* turned out to be the ideal platform to do just that.

My dive started in shallow water as National Geographic photographer Kip Evans donned his SCUBA equipment and followed my descent into 13 meters (40 feet) of water. It is Kip's job to document what is happening with the Sustainable Seas Expeditions, and he wanted to get some stills and video footage of the *DeepWorker* in action. After a brief photo shoot we parted ways and I followed a compass heading into deeper water. My first interesting encounter of the dive was an extensive granite outcropping in 20 meters (67 feet) of water. The reef was covered in large white-plumed anemones *(Metridium giganteum)* that can grow to as much as a meter tall. When they extend their tentacles to capture food, they remind me of enormous cauliflower that sway with the gentle surge.

After stopping briefly to check in with "topside," Phil gave me a new compass heading to follow that would lead me to the large field of squid eggs I had photographed yesterday. I can now report a full set of life support readings to Phil in less than a minute. Although necessary, it is important to get through life supports quickly and accurately in order to make the most of precious sub time. Phil told me that there was a minor faux pas in the tracking room, and that he would get back to me soon. I found out later that the *McArthur*got into a trough and the swell had emptied some of their equipment onto the floor. That evening in the galley, the topside crew summed up the fiasco as, "OH SWELL!"

My next close encounter brought me face to face with a ten-meter siphonophore (Praya sp.), pulsing and coiling its way through the water column.

These cnidarians are important predators of the midwater, and biologists only get to see living specimens with the help of remotely

operated vehicle (ROV) and small manned submersible technology. The Monterey Bay Aquarium Research Institute (MBARI) has used their ROV (Ventana) to shed new light onto the amazing biology of the Monterey Submarine Canyon. There seems to be a time and place to apply both ROV and manned submersibles in deep-sea research depending upon the task at hand.

A siphonophore pulses its way through the sanctuary. (Photo courtesy of Kip Evans.)

I had just settled on the bottom in an extensive field of squid eggs at 40 meters (132 feet) when the ambient light seemed to be eclipsed above me. When I looked up, I observed a school of squid that was so thick I could not even see any light through it. At last, a chance to capture *Loligo* on video to share with my students! I had intended to answer a request from topside to furnish them with my current life support readings, but I told Phil of my opportunity and he granted me a brief delay to pursue the squid school before I had to report back to him.

Slowly I used the vertical thruster on *DeepWorker* to rise into the school and achieve neutral buoyancy as the video camera captured some incredible images. The school would pulse from one direction to another in unison, even though I could detect no cue that they were responding to. Several times the school changed color all at once, as they used their chromatophores to make themselves lighter or darker. The squid did not seem to change their behavior at all, even though there was a submarine in their midst. Perhaps they did not recognize such an unusual object as a predator that they needed to avoid or fear. I spent the next 20 minutes filming the school before once again settling on the bottom in the field of egg masses. There were more squid among the eggs and many of the animals were embraced in their mating posture. The bodies of dead squid littered the bottom as well. It seems that the last act of the squid before it dies is one that perpetuates the species.

It was difficult to finish such a superb dive, but over three hours had passed and the voltage in the battery supply was running low (233 volts). I slowly ascended into the more brightly sunlit surface water, and ended the dive of my life! At dinner this evening, Dr. Sylvia Earle summed up the recent progress that our "sub ops" have enjoyed with, "Smashing successes are usually preceded with extraordinary efforts." Those efforts came from the dedicated crew of the *McArthur*,Phil Otalora, and all the folks associated with the

Sustainable Seas Expeditions.

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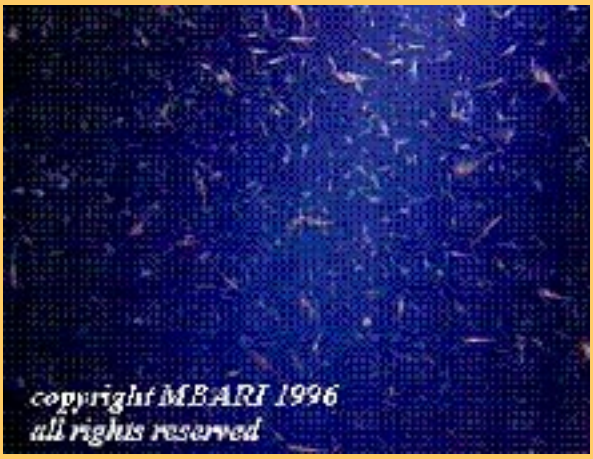
July 4, 2000
Underwater Fireworks

by Kip F. Evans, Photographer
Sustainable Seas Expeditions

Kip Evans, SSE Photographer

Sometimes the unexpected happens. Which is unusual because just about anything that can go wrong at sea does. Having spent over a year with SSE as its photographer, I've come to realize that this is particularly true with submersibles. After spending most of July 2nd and 3rd helping our electronics technician Mike Reay work out camera problems, I started to realize that diving subs and playing baseball are a lot alike. Just like baseball, we have hard innings from time to time. Translation: no subs in the water, frustrated scientists on board and a Nuytco crew that look like characters from the movie "Night of the Living Dead" (from a lack of sleep). We also get into winning streaks too, hitting a grand slam, or in diving terms, making two or three incredible dives. For the SSE team, that is like hitting the jackpot. In many ways we have, since diving a complex vehicle in the ocean is no easy task. To truly experience a home run at sea I think you have to suffer a little, or in our case, a lot. Which brings me to July 4th, our Nation's Independence Day.

While most people were home eating baked beans and hot dogs, we were out hitting home runs. The day started off well enough with the best seas we had seen in 3-4 days. In the morning, I made a 350-foot dive for about 3 hours that helped sort out a few problems we had been having with the subs. By early afternoon we were back on track and I was zipping about at 1,000 feet below the ocean's surface, wondering why I couldn't reach the ship on my underwater communication system (an uncomfortable feeling with thousands of pounds of pressure bearing down on you). For some, or maybe most Americans eating a hot dog at the time, this may sound horrible. Granted it doesn't sound great, but that's reality when you put electrical things in the ocean.



Euphausiid (Krill) Swarm

What most people don't know is that all SSE pilots are trained to deal with these kinds of problems. Whether it be communication problems, scrubber problems, or, in a worst case scenario, a fire, we have been trained to deal with it. I guess you could even go as far to say that we expect problems to some degree (not the fire). Even at a thousand feet, I feel comfortable with this fact. So what do you do when you're having trouble reaching the surface? Well -- you film krill; or least until you can telephone the surface. SSE protocols require us to try for an hour and then ascend. At this point it had only been about twenty minutes, so I had lots of time to contemplate the ins and outs of filming krill -- which took all of 30 seconds. It would have been quicker, but I waited until I had finished filming a ray, to turn out all the sub's lights. Yes, that's right, I turned off every darn light in the place and just sat there in the dark. I know this probably sounds insane, but so does driving on half the freeways in Los Angeles, and millions of people still do that everyday.

Anyway, I was sitting down there in the darkness and I started to realize that it wasn't really dark anymore. Believe it or not, I was in the middle of an incredible light show created by millions and millions of blinking krill. For those of you who have never heard of krill, they are small shrimp-like crustaceans that swim with small rows of tiny paddle-like feet called swimmerets. Like many deep-sea creatures, krill have light organs called photophores that blink. For 15 minutes I just sat there and watched in fascination. Their tiny photophores flashing on and off made the watery sky around me a virtual fireworks show, except that it was restricted to just one color -- a blue-green. While I was enjoying this incredible light show below, above, on the surface, Phil Otolara was trying to repair the underwater communications system that had failed just after my descent. Fortunately, Phil is a driven, resourceful man, and takes these minor disasters in stride. After wrestling through a myriad of wires, he was able to solve the problem and get back in touch with me.

For the rest of my dive, I concentrated on krill documentation, an objective proposed by Dr. Sylvia Earle and Dr. Baldo Marinovic. Most krill observations have been made over the years using plankton nets and ships echosounders -- something Dr. Marinovic was using during our cruise. The krill, Dr. Marinovic suggested,

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should be concentrated between 600-800 feet. It was my job to verify this using the *DeepWorker 2000* and its camera systems. When I hit 585 feet I started to encounter small patches of krill. By 623 feet I was surrounded. The krill stayed around the sub until I reached 845 feet and then disappeared as quickly as they had appeared. For SSE and Dr. Marinovic this was a home run!

Plankton nets set out to catch and monitor Monterey Bay krill. (Photo courtesy of Kip Evans.)

By late afternoon I was exhausted and looking forward to seeing the big blue sky again, so I started my ascent from 1,000 feet and slowly crept my way back towards the surface. After a 45-minute ride back up, I found myself once again looking at that big blue sky, but with a small obstruction, well actually a couple of large ones. Apparently when I surfaced I piqued the curiosity of three black footed albatrosses. For the next 15 minutes I sat motionless face-to-face, bill-to-bill, watching these glorious birds peer in at this alien from the deep.

Read more about krill in Dr. Baldo Marinovic's essay.

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July 6, 2000
Another Successful Dive

by Steve Webster,
Senior Marine Biologist
Monterey Bay Aquarium

Dr. Steve Webster is ebullient after another successful dive into the depths of the Monterey Bay sanctuary. (Photo courtesy of Kip Evans.)

Thursday dawned a foggy, calm day with little swell, so Pt. Lobos dives were once again a possibility. I joined the ship about 1 pm, just after Mike Guardino had completed a dive to 602 feet in the morning.

We prepped the sub, changed the batteries, and the dome was closed about 2 pm. The sun was now out -- no wind and a perfect day at Pt. Lobos. My plan was to reach bottom in about 200 feet of water, just seaward of the kelp forest and on the edge of the Carmel Canyon (a branch of the Monterey Canyon). From there I planned to do a video transect to 600 feet deep, and then a zig-zag pattern back to shallow water to survey the habitat types, rockfishes and spot prawns in this area below the SCUBA zone where Mike's students have been working the last two years.

All systems were "go" and I was given permission to dive. I activated the video camera and lights, flooded the soft ballast tank (to become neutrally buoyant), and began to thrust my way down to the bottom. Giving depth readings every 50 feet, I descended through green, plankton-rich water the first 50 feet, with some

Dr. Webster carefully studies his surroundings. (Photo courtesy of Kip Evans.)

large *Phacellophora* jellies (18 inches across with 6-foot tentacles). Below 50 feet the light began to dim and the water clarity improved (less phytoplankton here). In a zone of twilight shades of blue, I settled gently onto a gradually sloping sandy bottom at about 230 feet. There were some patches of drift kelp from the shallow nearshore kelp forests (this is a major source of food for deep sea animals down here where there isn't enough sunlight for photosynthesis). Several sea stars. No fishes visible in this flat sandy habitat. After getting myself oriented I started a compass course due north, as I knew this would take me directly to the edge of the canyon and deeper water. A set of life support readings (through-water communications were working pretty well) and I was off. Now the flashlight had to be used to read the instruments, as it was getting pretty dark at 300 feet.

A Thorny Head Rockfish is spotted 500 feet below the surface. (Photo Courtesy of Kip Evans.)

I came across a granite reef, so I decided to follow that to deep water. At the base of the reef was my first reminder of human influences from above: a bright red baseball cap. Colorful -- I was hoping it was a sponge! Didn't want to waste time and power collecting it with the manipulator arm, so I continued down toward 600 feet. At about 400 feet, I found myself in a field of spot prawns, a large shrimp that's trapped and trawled in a fishery that extends from Mexico to British Columbia. Huge numbers; densely packed.

Looked like 60-80 shrimps per square meter in this patch that seemed to go on for many meters (at 400 feet we can see only what is illuminated by the sub's lights, so it might have been an acre of shrimps, but one can't tell without taking time to swim its perimeter). I motored straight down the slope, left the shrimp fields and approached a mixed sand/rocky reef habitat at 600 feet.

Now the fauna had changed dramatically. The shallow water sea stars were now missing, and instead I could see Rathbunaster and other deep-water species, as well as feather stars (crinoids) and rockfishes typical of these depths. In the distance was a cloud of juvenile rockfishes, so I motored over to them to get video closeups for later identification. The adult and juvenile rockfishes were all

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over the rocky areas, not the sand. I expect they need the cover of the rocky boulder fields and reefs. There were none of the basket stars Mike had seen earlier, so I must have been in a different neighborhood. Habitats are patchy in the deep sea just as they are on land, so you don't have to go far to move from one dominant fauna to another.

A Kelp Rockfish was also spotted during the *DeepWorker* dives (Photo Courtesy of Kip Evans.)

Large white *Metridium giganteum* anemones were showing up in small patches and as solitary anemones all the way from 200 feet down here to 600 feet deep. They seem to have quite a depth range, as they also occur in kelp forest areas at 50-100 feet deep.

Communications were becoming sketchy. I moved out from behind a reef and comms improved, so we did life support readings, and then I continued up slope, surveying habitats and critters as I went. Five hundred feet, and here was another artifact from above -- an automobile tire. It had become an artificial reef and was festooned with anemones and sponges. Ooops, it'd been an hour -- I changed the tape in the digital video recorder so I could record the ascent from 600 feet to as shallow as the sub's power (voltage) would allow me to get. More crinoids, sea stars, sponges, rosy rockfish and others I couldn't identify. Back through the spot prawns at about 300 feet. Some sand, some rocky rubble and some large granite reefs. Again, clouds of juvenile rockfishes over some of the rocky areas.

At 200 feet, the voltage was now 237 (down from 257) and I had about 15 minutes left before I had to surface. I turned off the video lights to conserve power, and surveyed the habitats as I took a compass course due south to follow the contour up to the kelp forest. At 150 feet, I came across the base of a huge granite pinnacle, so I followed the ridge of it up to see where it topped out. At about 100 feet deep, the pinnacle began to look like a kelp forest turf with red algae, strawberry anemones, red coralline algae, and *Urticina piscivora* anemones. Amazing how all these species seem to come in right at 100 feet. What limits them from going deeper? I followed the reef to its summit at 79 feet, where some kelps were now growing sparsley. Still pretty dim light for abundant kelps.

Time to surface, so I turned seaward so as not to come up near the kelp. On the way I tried to get absolutely neutral to stay still while

taking video of a *siphonophore* chain (Portuguese Man-O-War relative) and more *Phacellophora* jellies. Voltage was down to 232, so it was time to surface. Stopped at 25 feet to ask final permission to surface. Permission given, so up we went and I was back to my native atmosphere (well, almost; I was still locked in the atmosphere of the sub). A short motor over to the stern of the *McArthur*. Matt attached the tow and lifting lines and I was back onboard in just a few minutes. The dome was opened and I had completed the sub dive of my dreams!

The coastline as seen from the cabin of the *DeepWorker* after surfacing. (Photo courtesy of Steve Webster.)

Not quite so fast, though. We still had to post-dive the sub and get it ready for tomorrow's dives. And annotate the video, including identifying the juvenile rockfishes and other critters I wasn't sure of. And write this log.

What a great opportunity -- to spend two hours below the SCUBA zone in one of the largest habitats in the Sanctuary. Little by little we'll figure out what's there, how it works, and how best to manage these resources for the future.

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July 6, 2000
Personal Log: Mike Guardino

by Mike Guardino, Teacher-in-the-Sea
Sustainable Seas Expeditions

Dive Log: July 6, 2000 SSE dive # 2000-20 @ Pt. Lobos Reserve, Carmel Bay, California
Conditions: Flat ocean with no breeze and clear seas. Warm, sunny day.

Mike Guardino (third from left, standing) inspects the *DeepWorker* with the SSE team. (Photo courtesy of Steve Webster.)

I was sitting at home on the 4th of July when Dr. Sylvia Earle called to offer me one more chance to dive the *DeepWorker* submersible, and to collect some additional data on ground fish populations inside and adjacent to Pt. Lobos Reserve. I still have trouble getting used to the fact that this eminent marine biologist has given me such a unique opportunity to participate in the Sustainable Seas Expeditions. I am honored and flattered to represent the teachers of America and will soon share my experiences at the National Marine Educators Association Conference in Long Beach, California. My student research team and I will now analyze the video footage I collected, and will complete the paper we have been writing about the effectiveness of marine protected areas in fisheries management.

This turned out to be the finest dive of my life! The weather was perfect and the sea was as flat as I have ever seen it when the NOAA Ship *McArthur*entered Carmel Bay early this morning. After pre-dive preparations I was briefed by dive supervisor Phil Otalora about the live boat launch he was planning today. Rather than dropping the anchor, a live boat launch allows the ship to maneuver

The *McArthur* as seen from the *DeepWorker* submersible. (Photo courtesy of Steve Webster.)

closer to the dive site and adjust its position while the dive is in progress.

I was given permission to begin my descent in approximately 90 meters (300 feet) of water just outside of Bluefish Cove on the border of the Reserve. There was a thin blanket of ctenophores layering the top five meters before the visibility opened up, and I could see an honest 20 meters as the *DeepWorker* dropped from the sunlit surface water into the darker depths of Carmel Submarine Canyon. My first way point was on a steep slope that featured granite outcroppings separated by the fine sediments which rain down from the productive area above. It is amazing how different the assemblage of life is below the range of scuba observation. The organisms common to the Pt. Lobos kelp forests, that my students and I have studied so carefully, gave way to an entirely different community.

One of the many types of deep water larvaceans in the Monterey Bay. (Photo courtesy of Kip Evans.)

The rocky areas were covered by large crinoids *(Florometra serratissima)* and basket stars *(Gorgaonocephalus eucnemis)*, while the deep sediments on gradual slopes are dominated by large populations of spot prawns *(Pandalus platycerus)*. There are numerous spot prawn pots outside of the park that I could see off the bow of the *McArthur*. The fishery for this large crustacean is doing well despite the relatively deep and inaccessible water in which these animals thrive.

I have only encountered basket stars on rare occasions while scuba diving in Carmel Bay, and the individuals I have seen were relatively small with central discs about three centimeters in diameter. The specimens I videotaped today at 120 meters (400 feet) were enormous with central discs at least 10 centimeters across! I was so excited about my find that I reported the discovery

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to top-side along with my regular life support readings. Either the quality of our through-water coms were lacking, or my emotions made my transmissions hard to understand, but National Geographic photographer Kip Evans thought I had reported seeing a "basking shark" rather than a "basket star."

A beautiful basket star was observed by the pilot. (Photo courtesy of Kip Evans.)

He may have been disappointed when the correct message was finally received, but I was thrilled with what I had encountered. I guess I have a soft spot in my heart for invertebrates over the charismatic megafauna that are so noticeable.

Although my original dive plan called for a maximum depth of 150 meters (500 feet), Phil was satisfied with the progress I was making and gave me permission to descend a little further to 180 meters (600 feet). As luck would have it I found two organisms to videotape that I really did not anticipate. The most bizarre of the two was a large mushroom soft coral *(Anthomastus ritteri)* that looks more like a extraterrestrial than a marine organism. I settled the *DeepWorker* down and captured ten minutes of quality video before moving on to an even more exciting find. A friend of mine, Phil Sammet, who regularly conducts deep technical dives in this area with tri-mix has told me of large white vase sponges that he has encountered at 60 meters (200 feet). Most of the sponges that we encounter at typical scuba depths are quite small and of low profile.

Imagine my surprise when I came across, and filmed, a vase sponge that was greater than one meter tall with a large osculum filled with numerous symbiotic organisms.

Like all good things, my dive had to come to an end. I prolonged my visit to the depths by slowly ascending along the canyon wall, and

Dr. Sylvia Earle prepares to pilot the *DeepWorker*. She and Mike Guardino both enjoyed successful dives. (Photo courtesy of Kip Evans.)

filmed my journey back into the brightly lit surface waters of Carmel Bay. Fortunately my memory of this experience will remain fresh as I begin annotating the three hours of video I captured. I would also like to take this opportunity to publicly thank Dr. Sylvia Earle for her confidence in me and her commitment to protecting the wild ocean. Her current efforts, through the Sustainable Seas Expeditions, have the potential to inspire people to study, understand, and protect the ocean that we so directly depend upon.

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July 8, 2000 Personal Log: Jennifer Makowka

by Jennifer Makowka,
Research Intern
Monterey Bay National
Marine Sanctuary

Jennifer and Sylvia pose for a picture aboard the *McArthur*.

Jennifer Makowka began an internship with the MBNMS Research Program in January 2000. After successfully assisting program staff with numerous research projects, she was asked to assist with the Sustainable Seas Expedition. Jennifer was scheduled to participate in the education leg (the first 4 days) of the project. During this stint she began learning and assisting in DeepWorker maintenance, launch and recovery operations, and cataloguing video tapes. Dr. Earle, so impressed by Jennifer's abilities to assist the expedition, requested that Jennifer participate in the entire cruise. Jennifer was excited to stay on board and sanctuary staff are glad to have her enhance our expedition. Below is an account of Jennifer's experiences.

-- Dr. Andrew De Vogelaere, MBNMS Research Coordinator

My first opportunity to go out to sea, and with Dr. Sylvia Earle no less! I wasn't really sure what I would be doing on the trip but I was determined to learn all that I could.

I started by exploring the systems of the subs -- inside and out. The dive supervisor, Phil Otalora,

walked me through a complete pre-dive of the sub and explained all the systems along the way. Most of these sounded really familiar, since I took a class on submersible technologies the semester

Jennifer studies the *DeepWorker*.

before. On our transit day from Port Hueneme to Monterey Bay, I learned how the pilot flies the sub and all of the emergency procedures. On dive days, I would go through the pre-dive checklist with the pilot and maintain radio contact to receive life support readings during the dive. During some dives, I assisted with the launch and recovery of the sub. The subs encountered a few mechanical and electrical problems, including intermitent video signals and losing an air tank over the side of the ship! I assisted the Nuytco technicians in fixing most of the problems, but the air tank is lost forever. I also worked with the National Geographic photographer, Kip Evans, to organize the tapes shot by the pilots and to copy and edit videos for the various organizations involved in this project.

Baldo Marinovic, an invertebrate specialist from UCSC, joined us for a few days to sample krill. In my mission to learn all I possibly could, I asked if I could assist with the sampling. After being tied to the deck so I wouldn't fall over board, we deployed the nets. I was on deck with him until 3 am deploying the Tucker tow net to 200 meters in order to sample the krill over Soquel Canyon. We pulled samples of krill and preserved the specimens.

The next night, we used a smaller net to capture live krill at a depth of only 50 meters. By the end we were both very tired and very wet -- but satisfied with the abundance of krill and a job well done. The sub pilots concentrated on this area the next few days in order to video krill in their natural environment. Sylvia Earle reached 1013 feet that day and shot footage of krill dancing all about the sub. The footage was amazing. Later that night while she was annotating her tapes, she explained to me all that she saw and described the experience of being under 1000 feet of water.

Our trip was blessed with serene weather, although you wouldn't know it from the decks of the *McArthur*. The ship rolled constantly

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making work a never ending challenge. I learned a lot during my time with the Sustainable Seas Expedition from the technical end of the subs to the biology of specific anemones, but the most important lesson I learned was never go out to sea without bungee cords, tie-wraps, and duct tape.

Jennifer assisted Baldo Marinovic gather his krill nets in the early morning hours.

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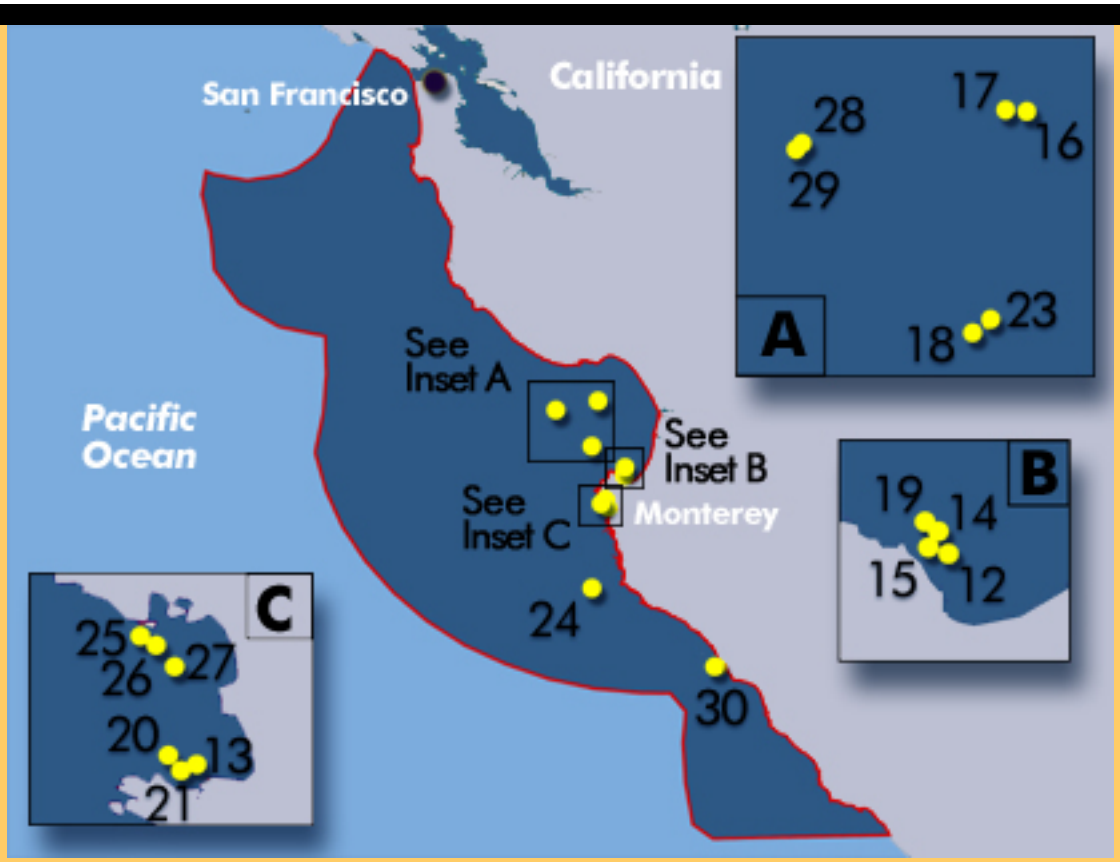
June 28 - July 12, 2000 Dive Maps

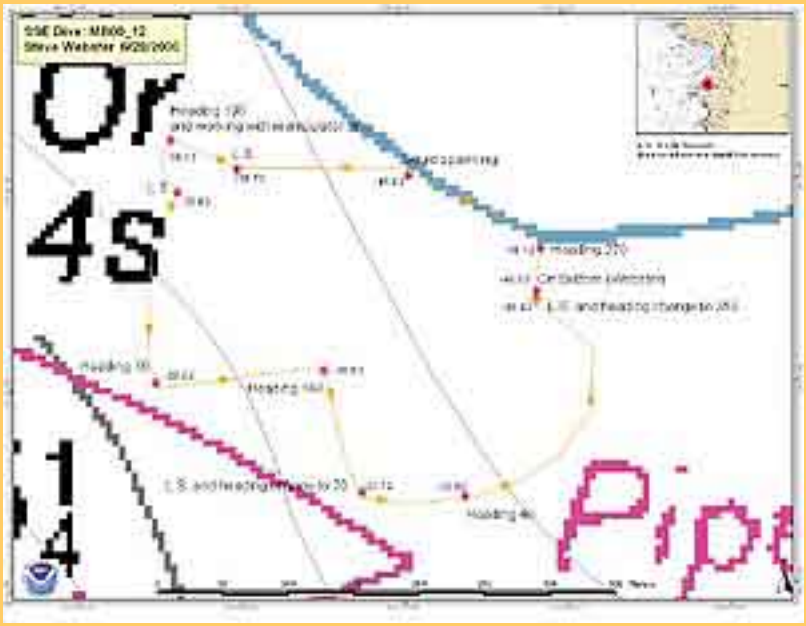
Dave Lott and Craig Russell, GIS specialists from NOAA's National Ocean Service, Special Projects Office, tracked and mapped the *DeepWorker* submersible during the SSE mission to the Monterey Bay sanctuary. Using a combination of GIS and sonar technologies, they produced this series of dive maps. The maps depict the underwater track of each *DeepWorker* dive, and include depth readings, life-support readings and pilots' comments. Together, they represent a critical component of the underwater log of the expedition.

During the Monterey Bay mission, from June 28 to July 12, 2000, pilots completed Dives 12 to 30. The yellow dots on the reference map below approximate where these dives occurred in the sanctuary. The sanctuary boundary is outlined in red. **Click on any dive number or individual map to view a large-scale version of that specific dive.**



Dive 12
June 28, 2000
Steve Webster

Click image to view a larger map.



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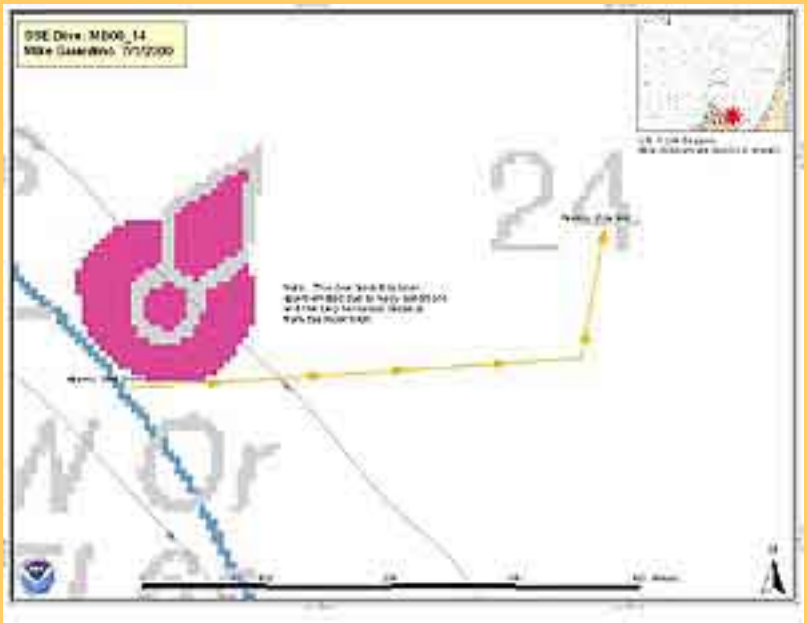
Dive 13
June 29, 2000
Mike Guardino

Click image to view a larger map.

Dive 14
July 1, 2000
Mike Guardino

Click image to view a larger map.

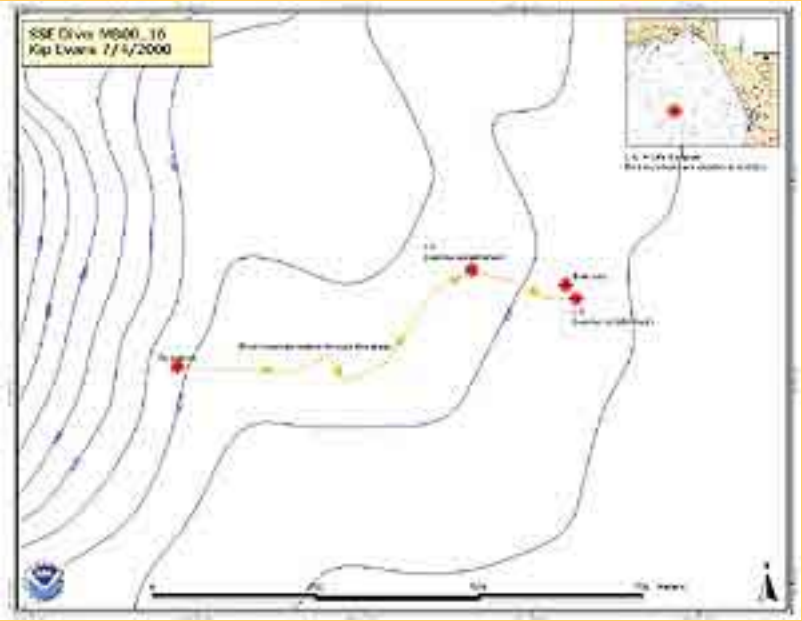


Dive 15
July 2, 2000
Mike Guardino

Click image to view a larger map.

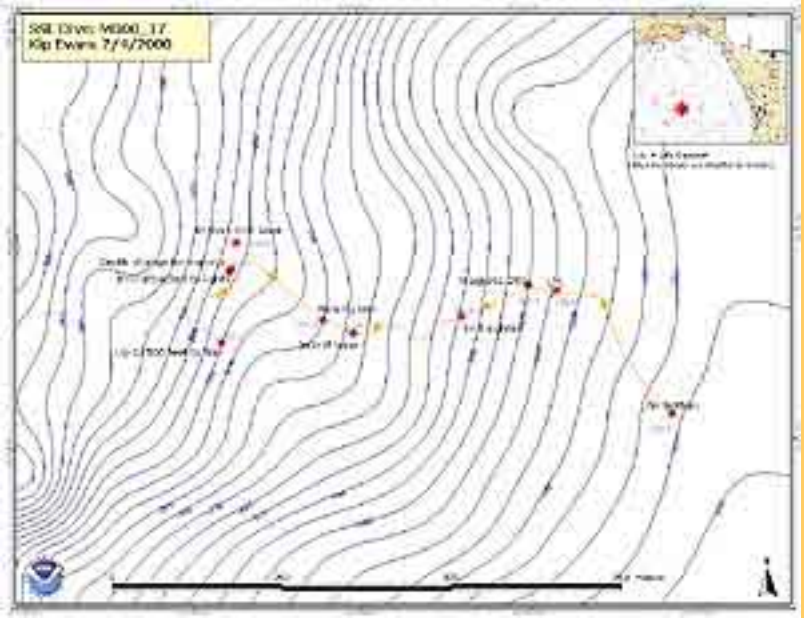
Dive 16
July 4, 2000
Kip Evans

Click image to view a larger map.



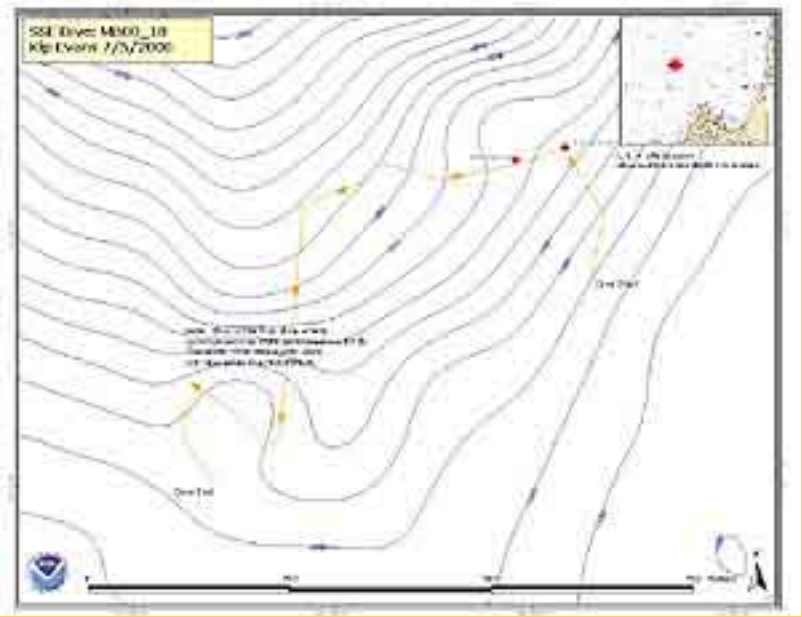
Dive 17
July 4, 2000
Kip Evans

Click image to view a larger map.



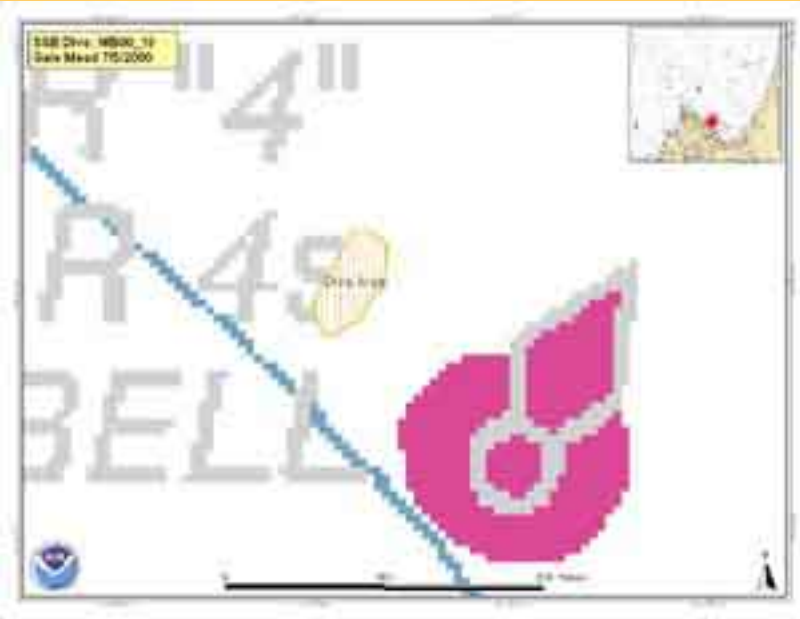
Dive 18
July 5, 2000
Kip Evans

Click image to view a larger map.



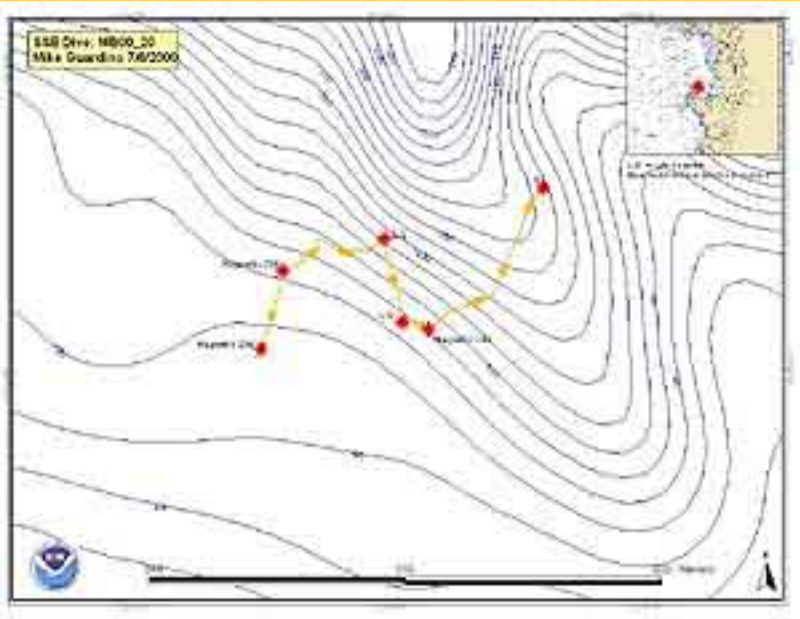
Dive 19
July 5, 2000
Gale Mead

Click image to view a larger map.



Dive 20
July 6, 2000
Mike Guardino

Click image to view a larger map.



Dive 21
July 6, 2000
Steve Webster

Click image to view a larger map.

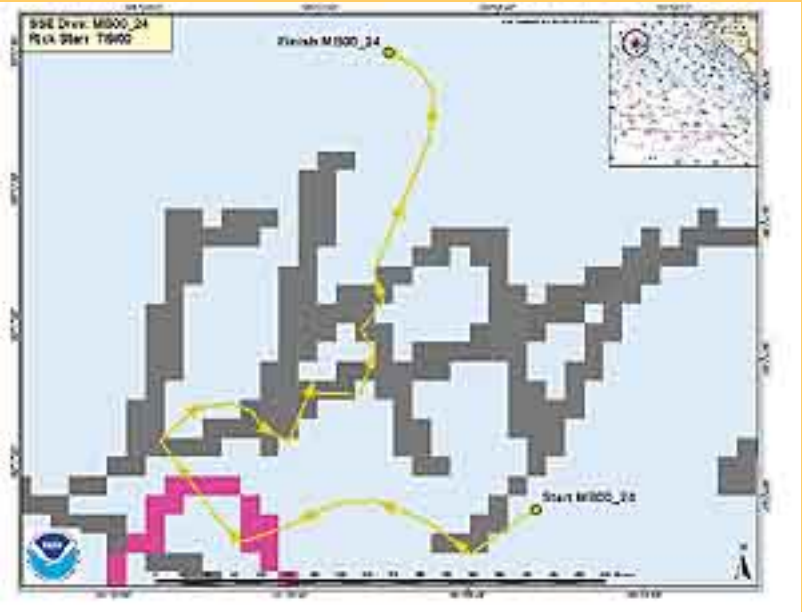
Dive 22 Dive aborted

Dive 23
July 8, 2000
Sylvia Earle

Click image to view a larger map.

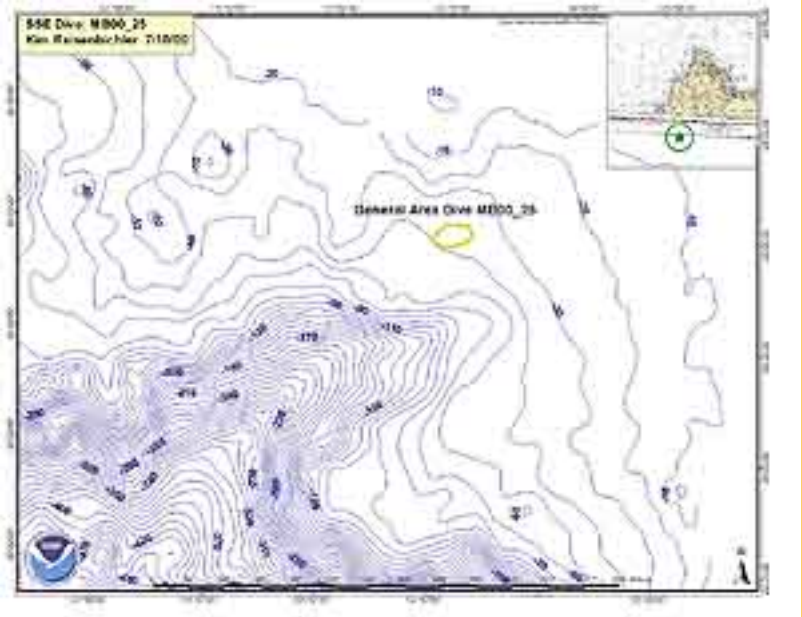
Dive 24
July 9, 2000
Rick Starr

Click image to view a larger map.



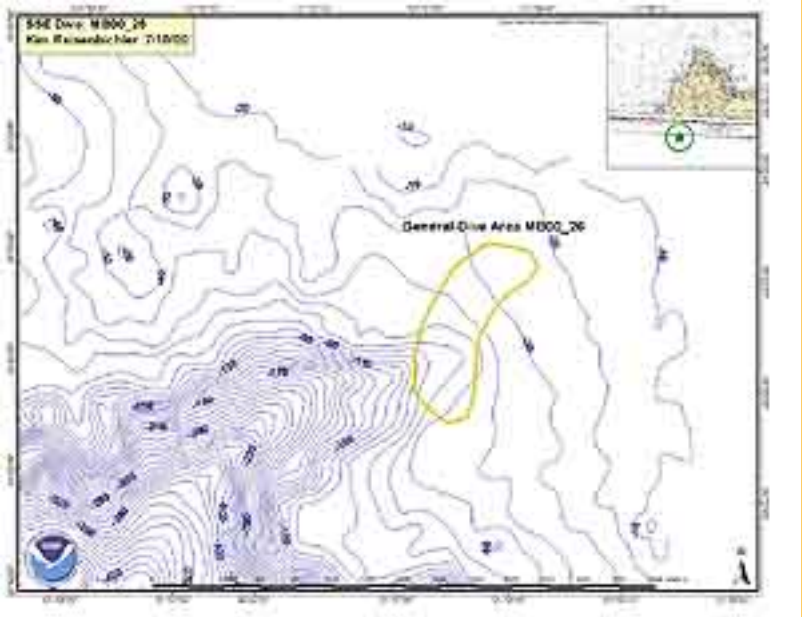
Dive 25
July 10, 2000
Kim Reisenbichler

Click image to view a larger map.



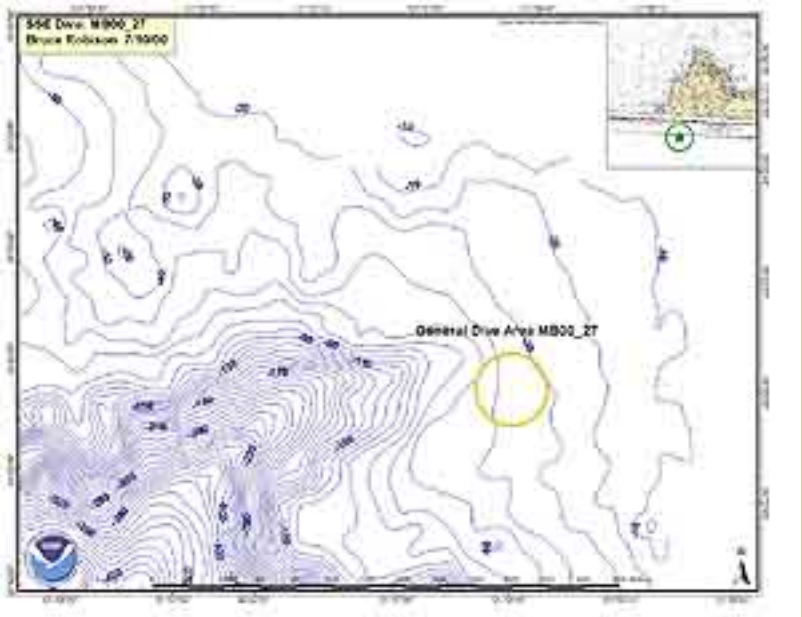
Dive 26
July 10, 2000
Kim Reisenbichler

Click image to view a larger map.



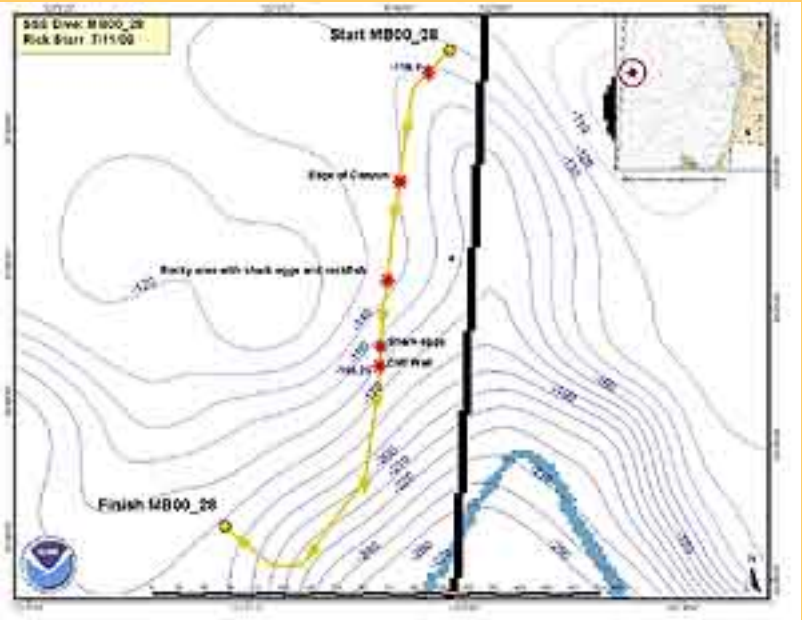
Dive 27
July 10, 2000
Bruce Robison

Click image to view a larger map.



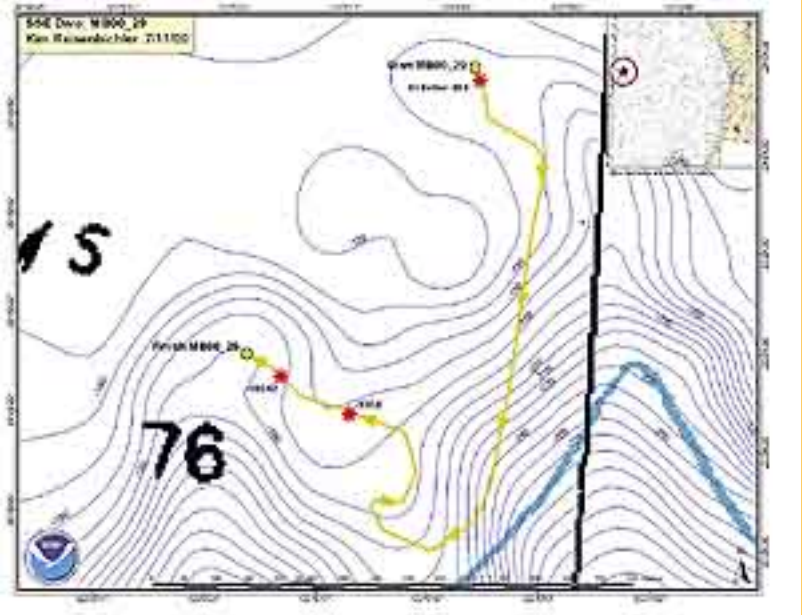
Dive 28
July 11, 2000
Rick Starr

Click image to view a larger map.



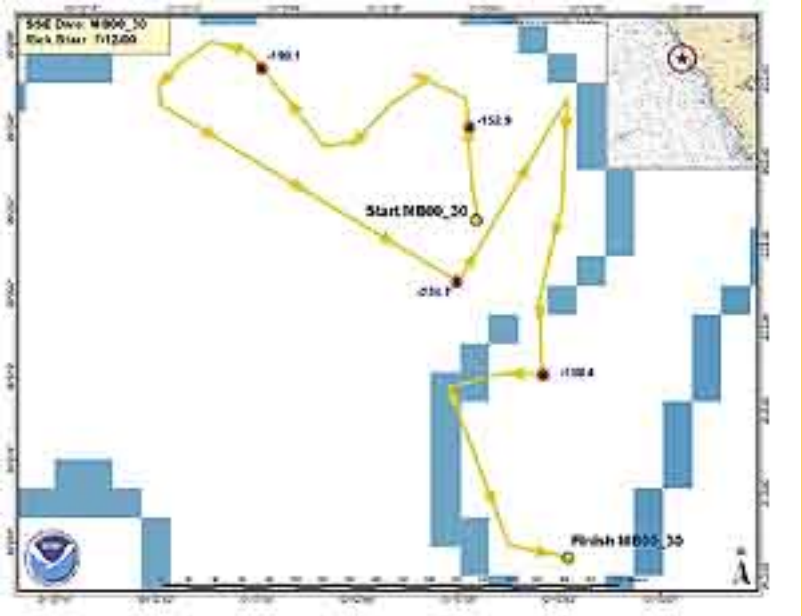
Dive 29
July 11, 2000
Kim Reisenbichler

Click image to view a larger map.

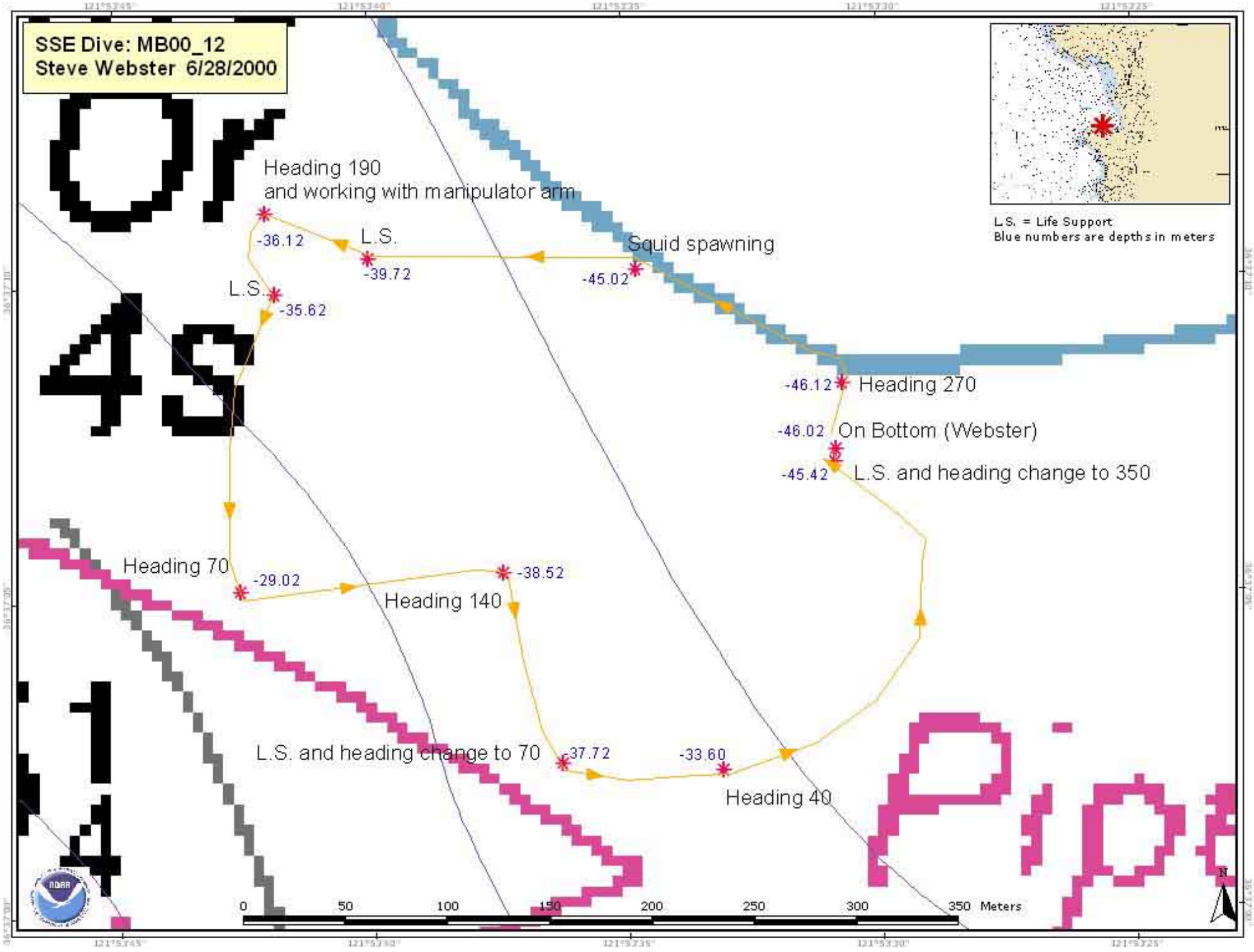


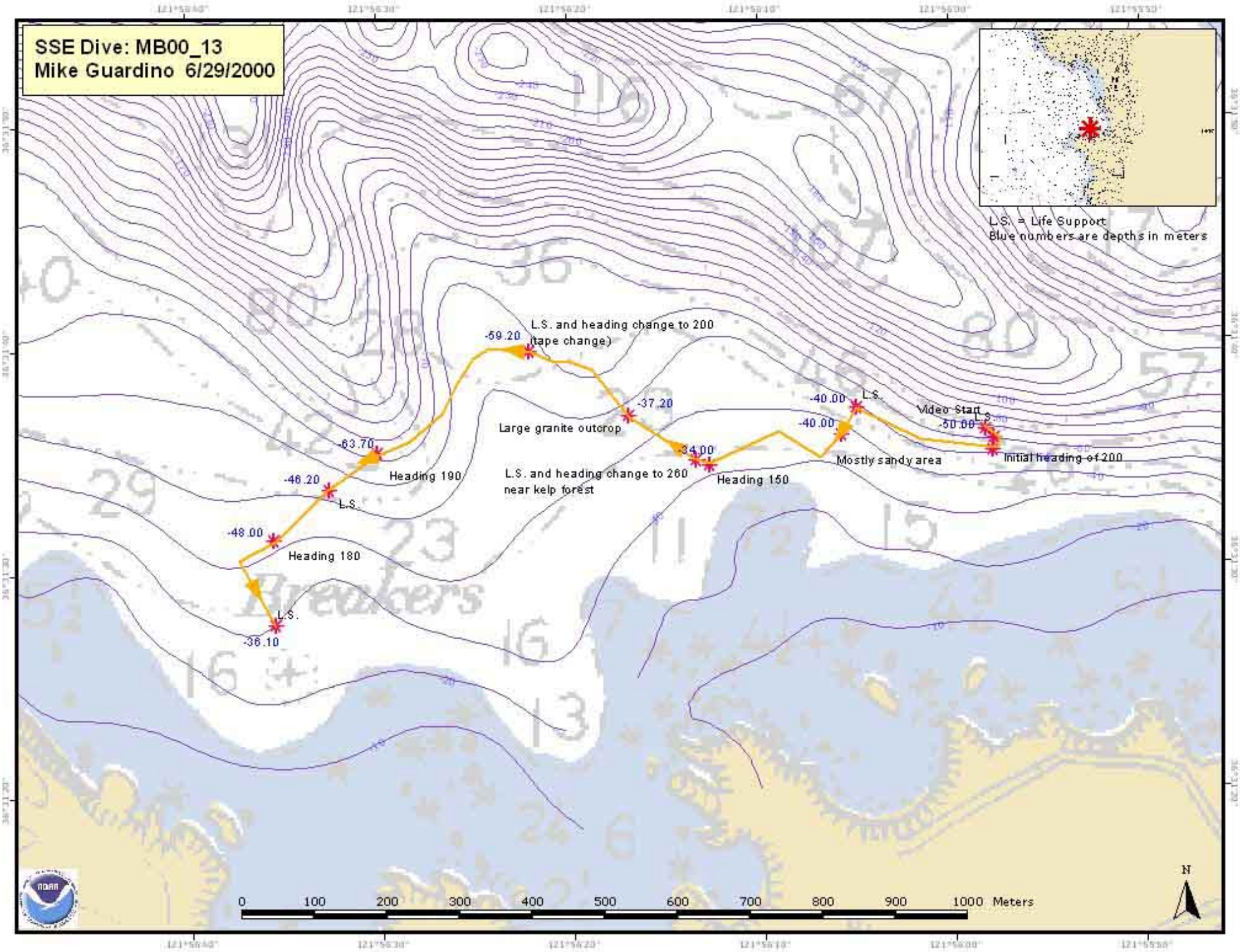
Dive 30
July 12, 2000
Rick Starr

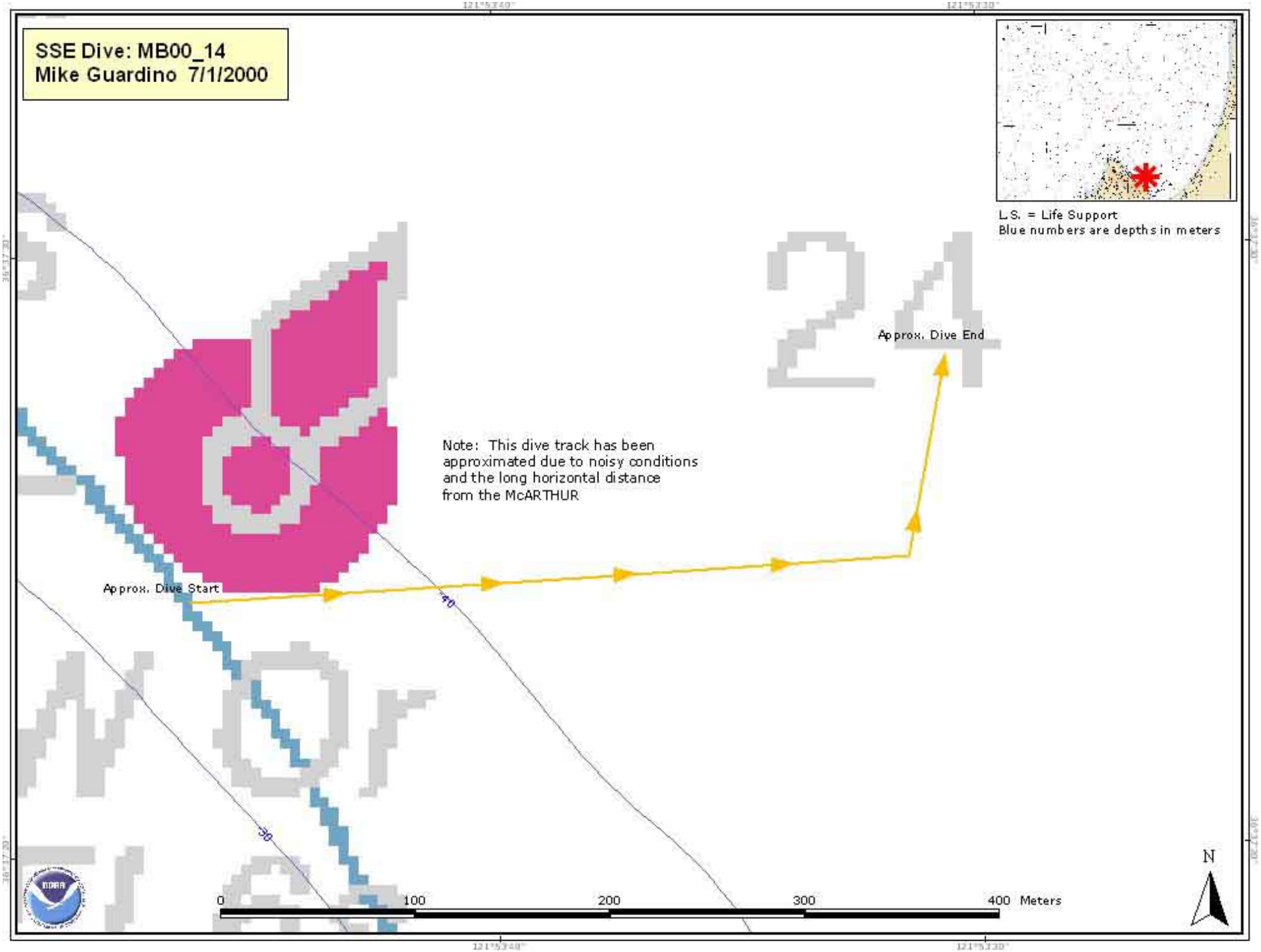
Click image to view a larger map.

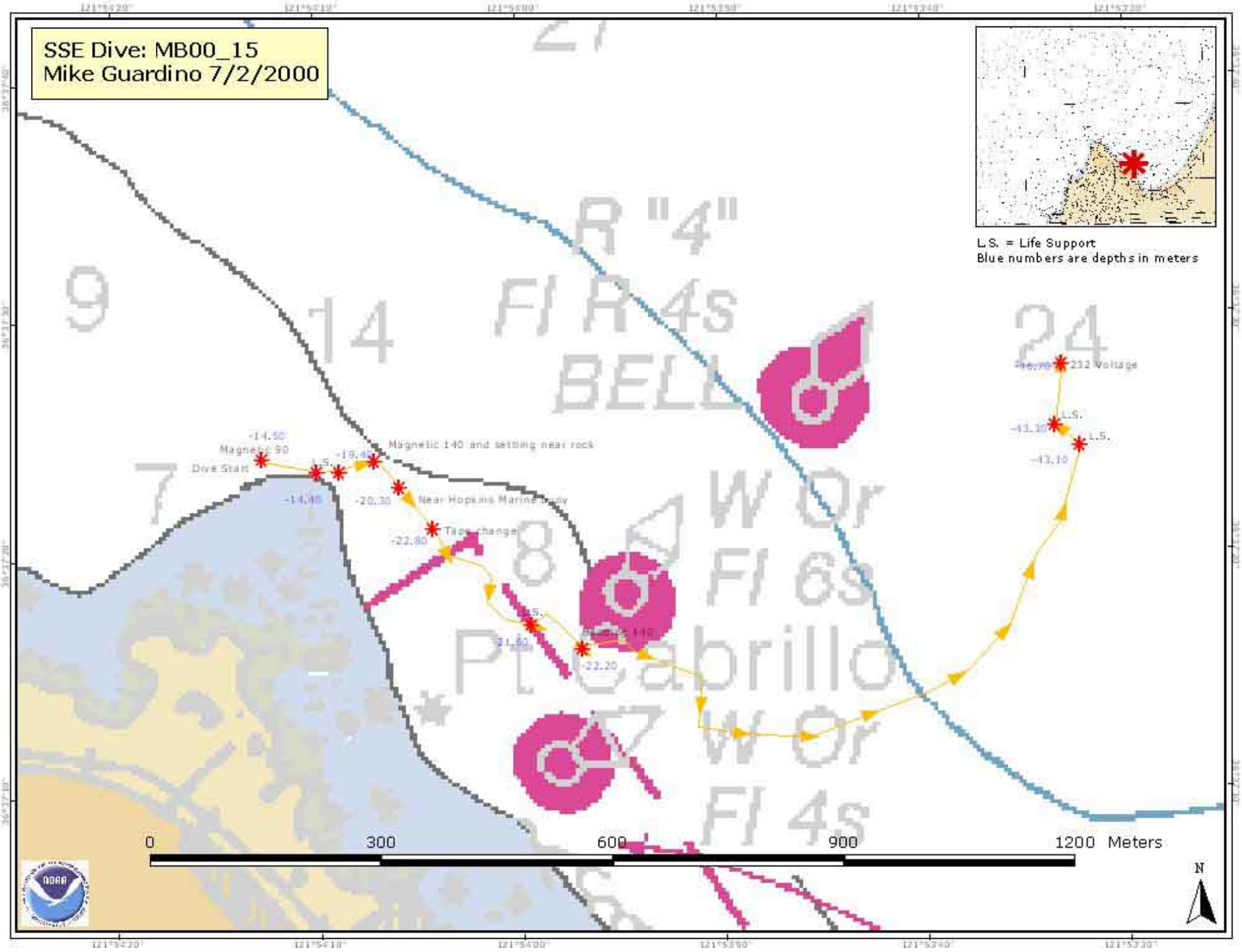


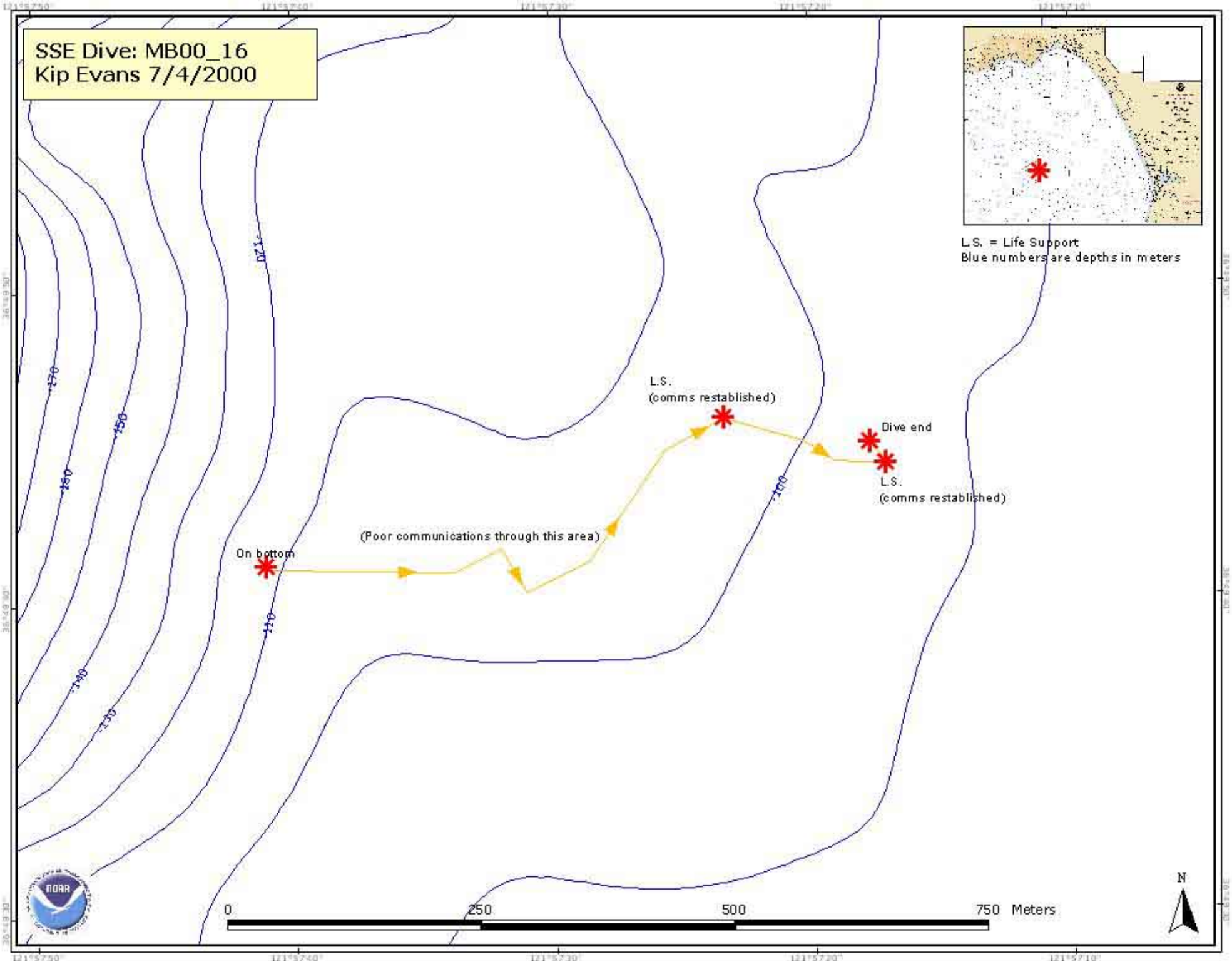
Top | Return

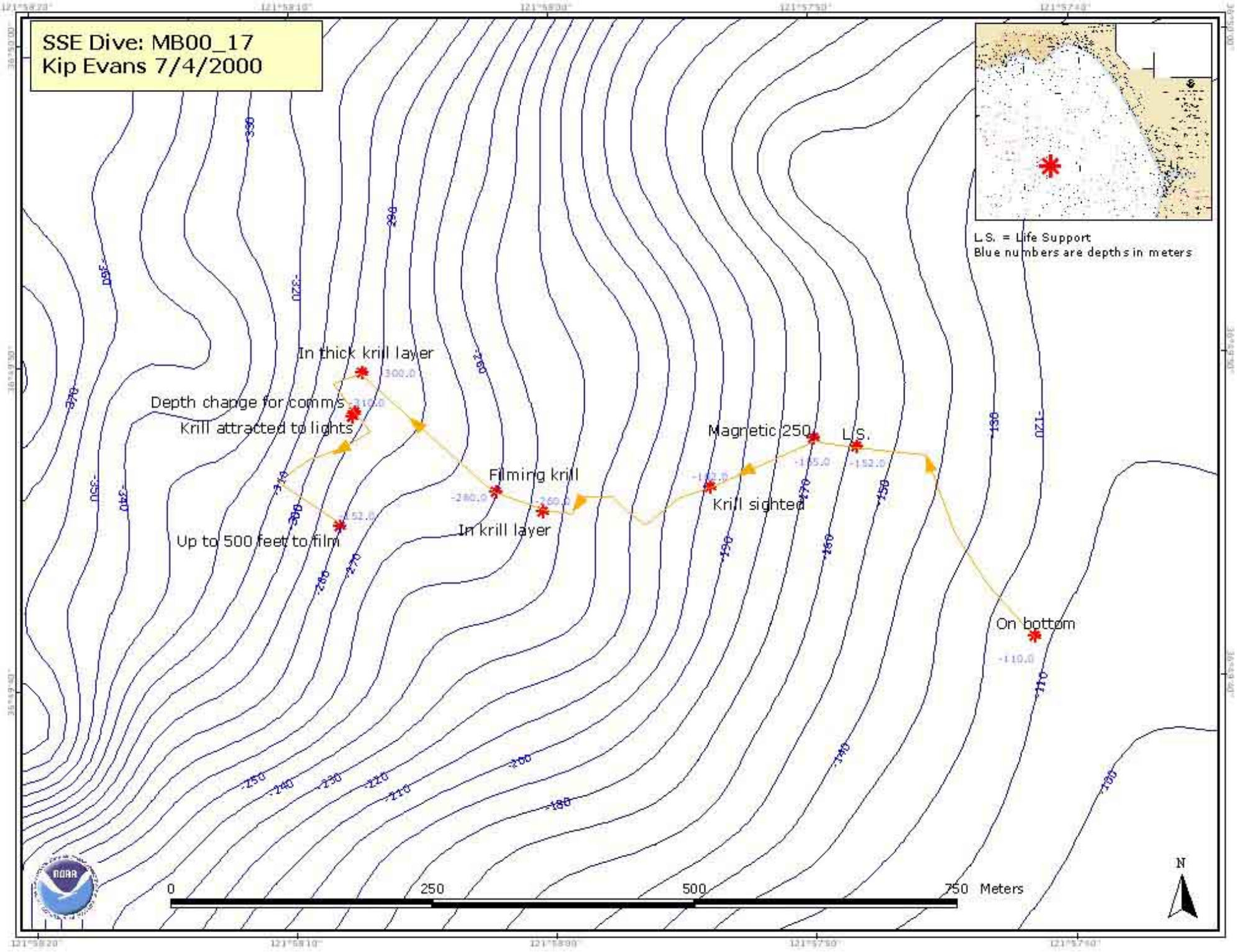

SSE Dive: MB00_12
Steve Webster 6/28/2000
Heading 190
and working with manipulator arm
-36.12
L.S.
-39.72
L.S.
-35.62
Squid spawning
-45.02
-46.12
Heading 270
-46.02
On Bottom (Webster)
-45.42
L.S. and heading change to 350
Heading 70
-29.02
-38.52
Heading 140
L.S. and heading change to 70
-37.72
-33.60
Heading 40
L.S. = Life Support
Blue numbers are depths in meters
0
50
100
150
200
250
300
350 Meters
N

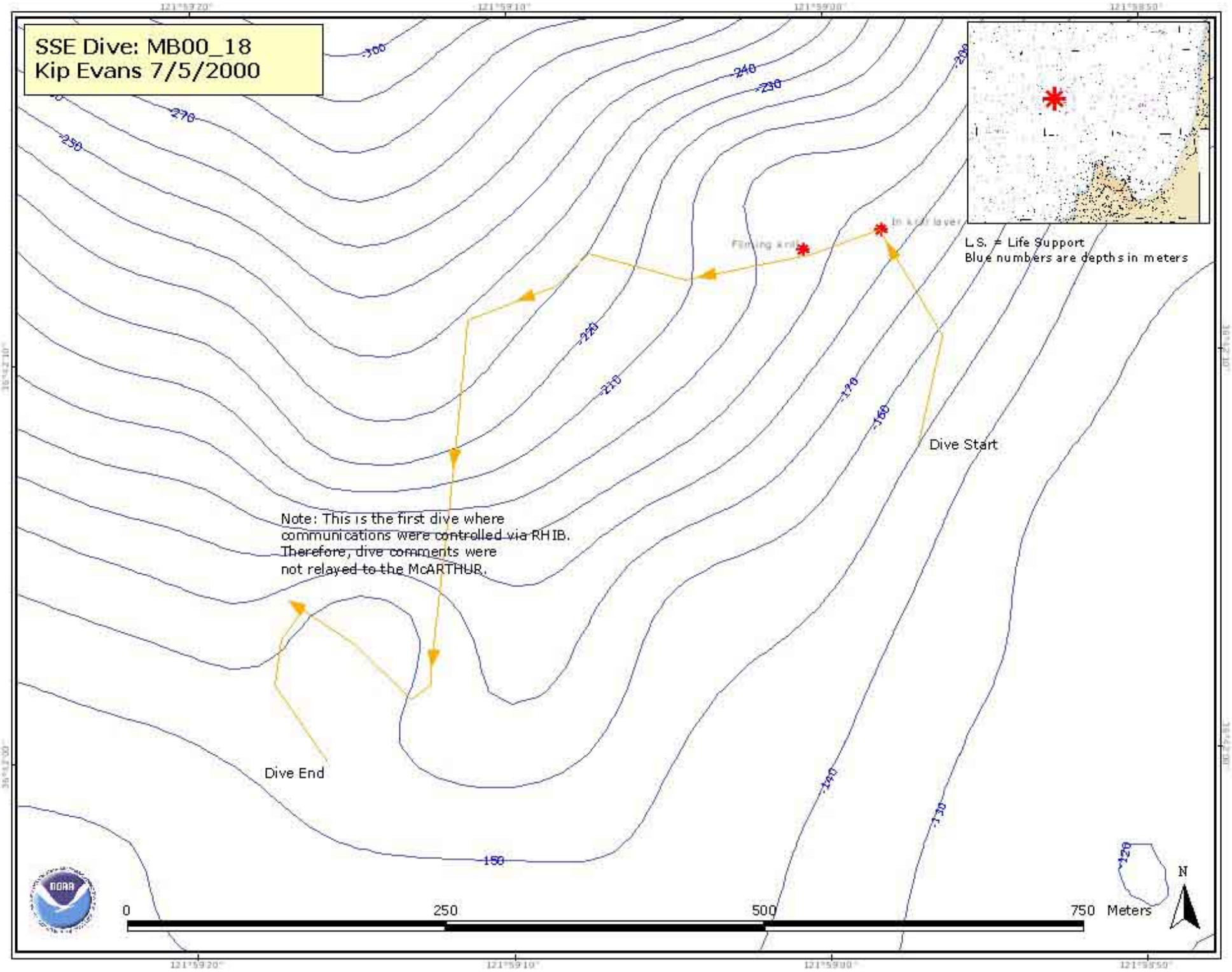

SSE Dive: MB00_13
Mike Guardino 6/29/2000
L.S. = Life Support
Blue numbers are depths in meters
-59.20
L.S. and heading change to 200
(tape change)
-37.20
Large granite outcrop
-40.00
L.S.
Video Start
-40.00
L.S.
-50.00
Initial heading of 200
-34.00
L.S. and heading change to 260
near kelp forest
Heading 150
Mostly sandy area
-63.70
Heading 190
-46.20
L.S.
-48.00
Heading 180
L.S.
-36.10
Breakers
0 100 200 300 400 500 600 700 800 900 1000 Meters
N

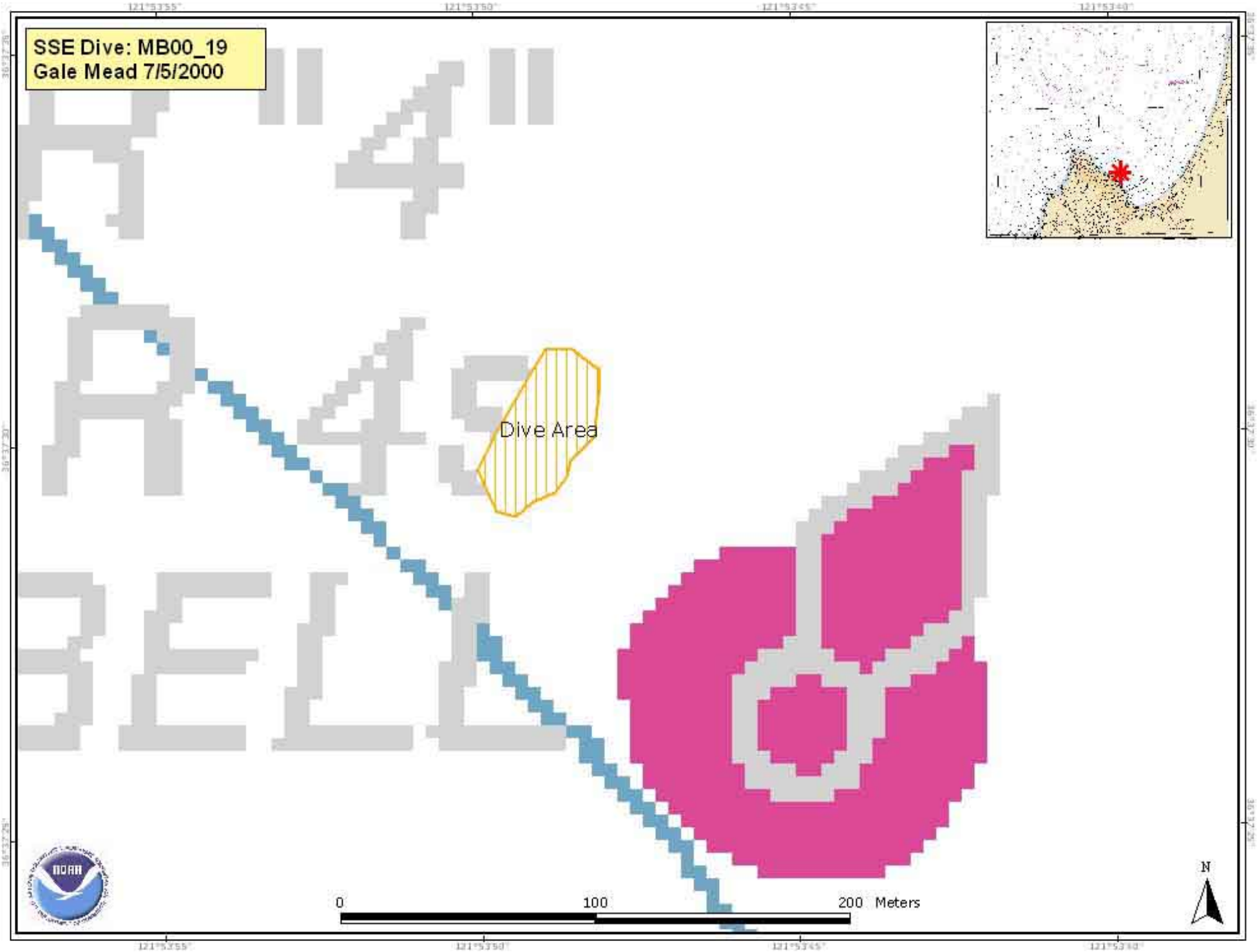

SSE Dive: MB00_14
Mike Guardino 7/1/2000
L.S. = Life Support
Blue numbers are depths in meters
Approx. Dive End
Note: This dive track has been approximated due to noisy conditions and the long horizontal distance from the McARTHUR
Approx. Dive Start
-40
-30
0
100
200
300
400 Meters
N

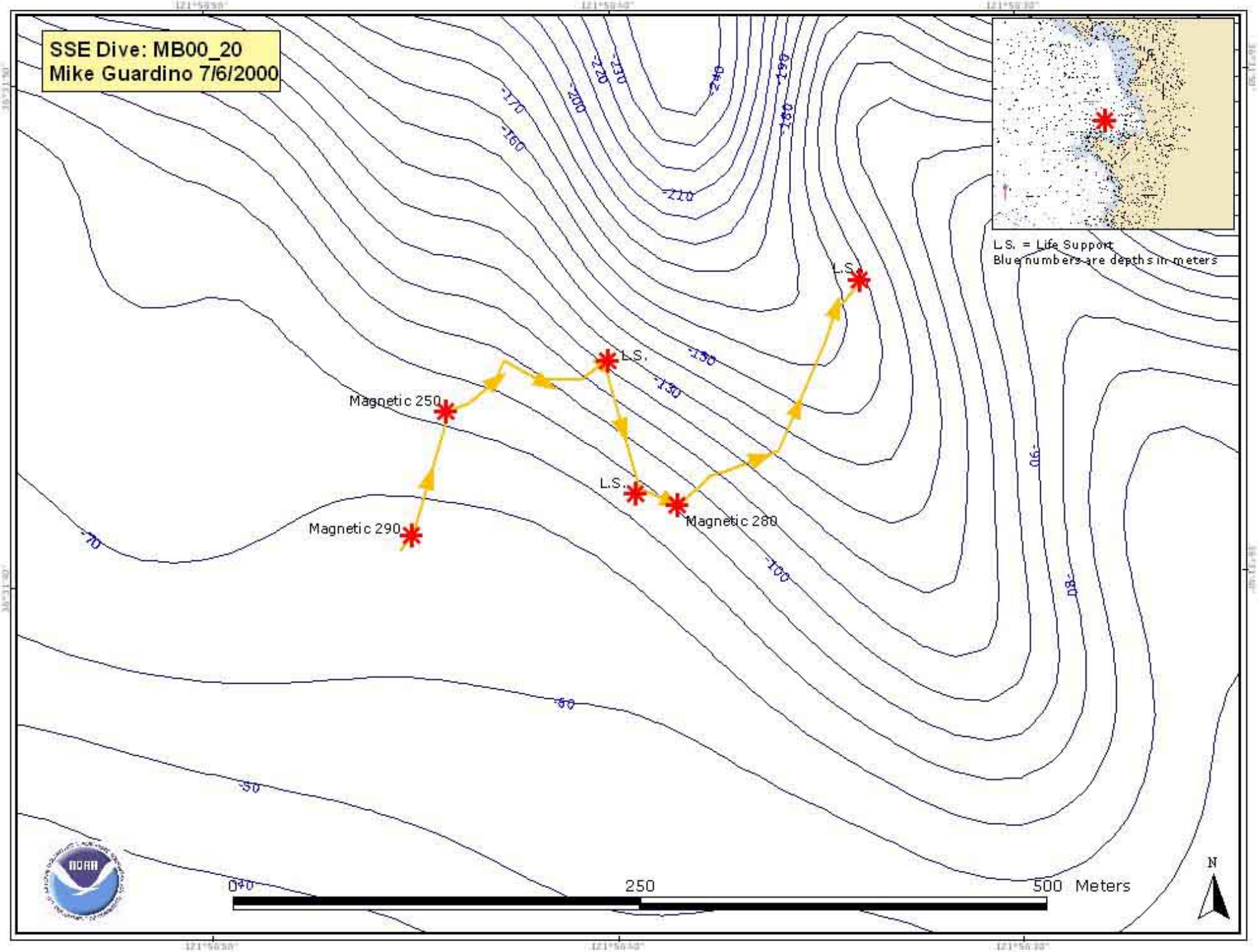

SSE Dive: MB00_15
Mike Guardino 7/2/2000
L.S. = Life Support
Blue numbers are depths in meters
-14.50
Magnetic 90
Dive Start
L.S.
-19.40
Magnetic 140 and setting near rock
-20.30
Near Hopkins Marine Lab
-22.80
Tape change
-14.90
L.S.
-21.80
-22.20
232 Voltage
L.S.
-13.30
L.S.
-13.10
0
300
600
900
1200 Meters
N

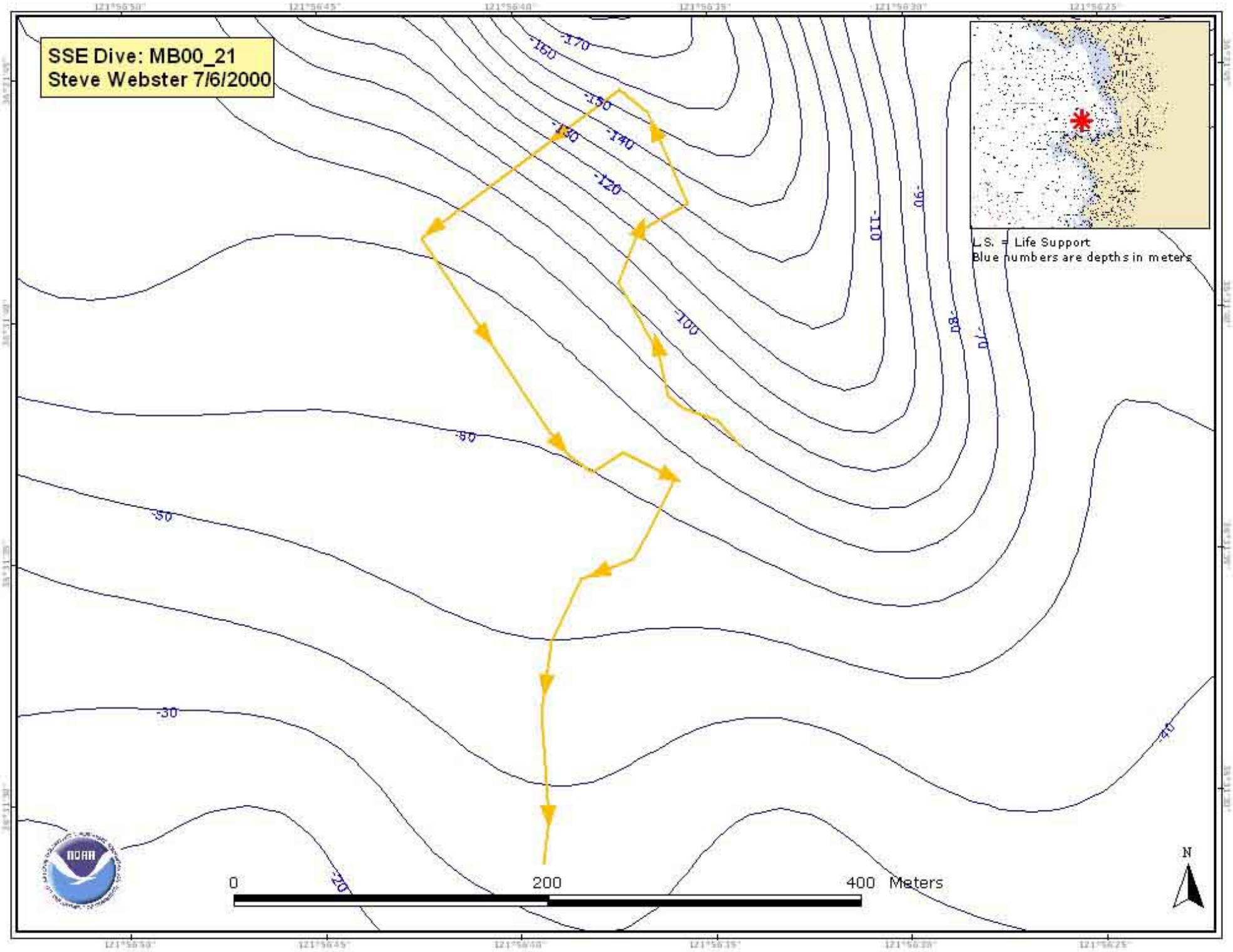

SSE Dive: MB00_16
Kip Evans 7/4/2000
L.S. = Life Support
Blue numbers are depths in meters
L.S.
(comms restablished)
Dive end
L.S.
(comms restablished)
(Poor communications through this area)
On bottom
120
130
140
150
160
170
180
0
250
500
750 Meters
N

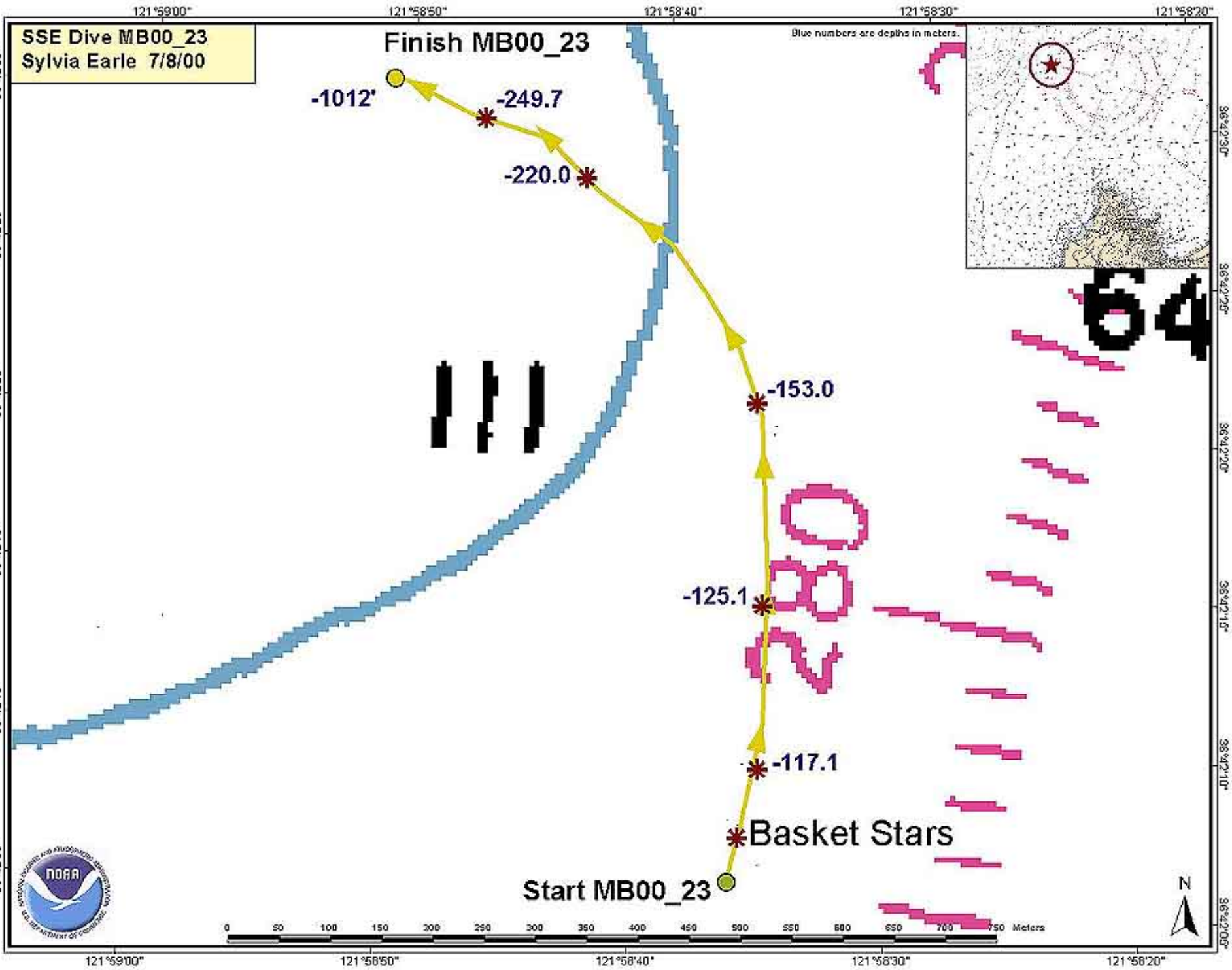

SSE Dive: MB00_17
Kip Evans 7/4/2000
L.S. = Life Support
Blue numbers are depths in meters
In thick krill layer
Depth change for comms
Krill attracted to lights
Up to 500 feet to film
Filming krill
In krill layer
Magnetic 250
L.S.
Krill sighted
On bottom
0
250
500
750 Meters
N

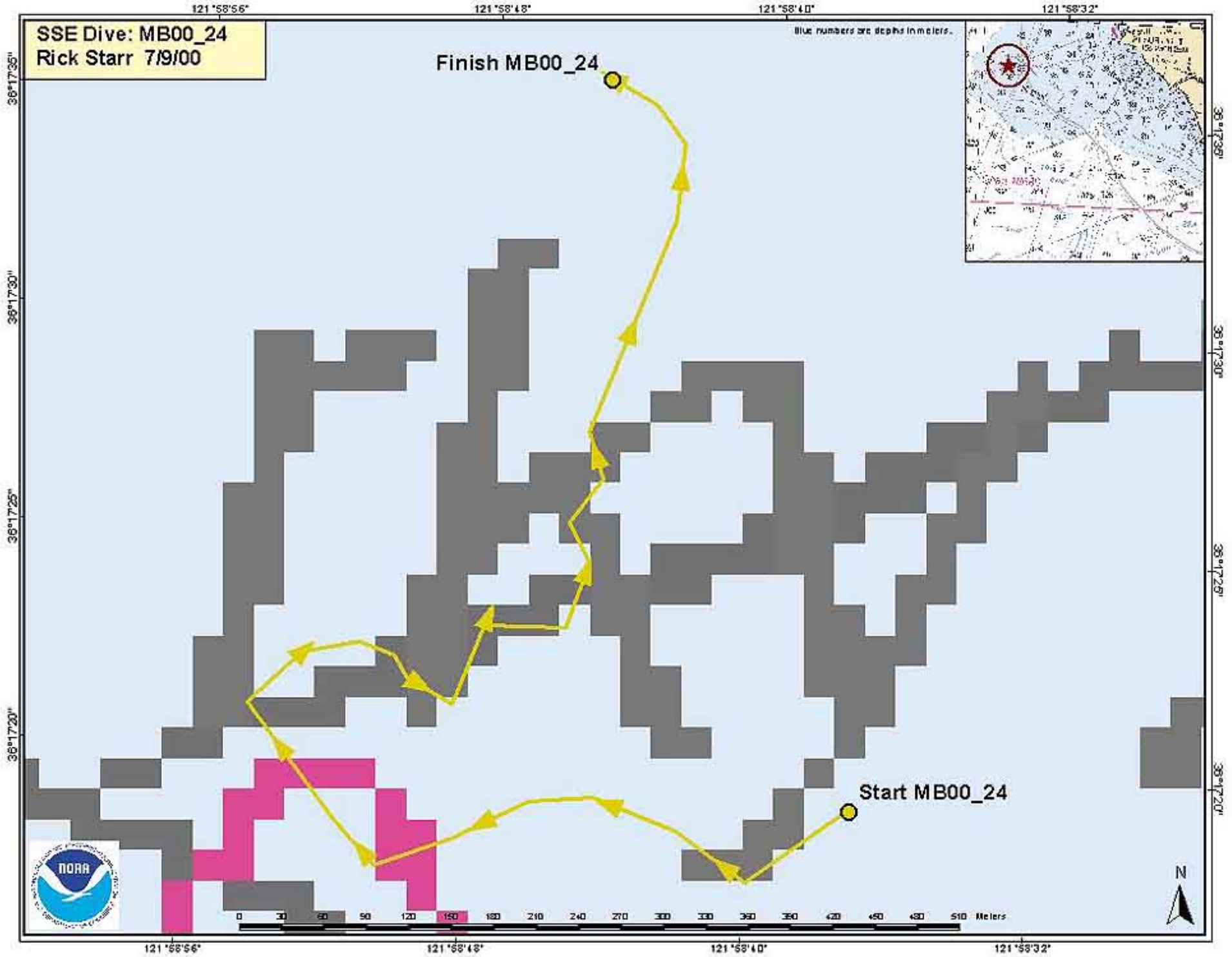

SSE Dive: MB00_18
Kip Evans 7/5/2000
L.S. = Life Support
Blue numbers are depths in meters
Dive Start
Dive End
Note: This is the first dive where communications were controlled via RHIB. Therefore, dive comments were not relayed to the McARTHUR.
0
250
500
750 Meters
N

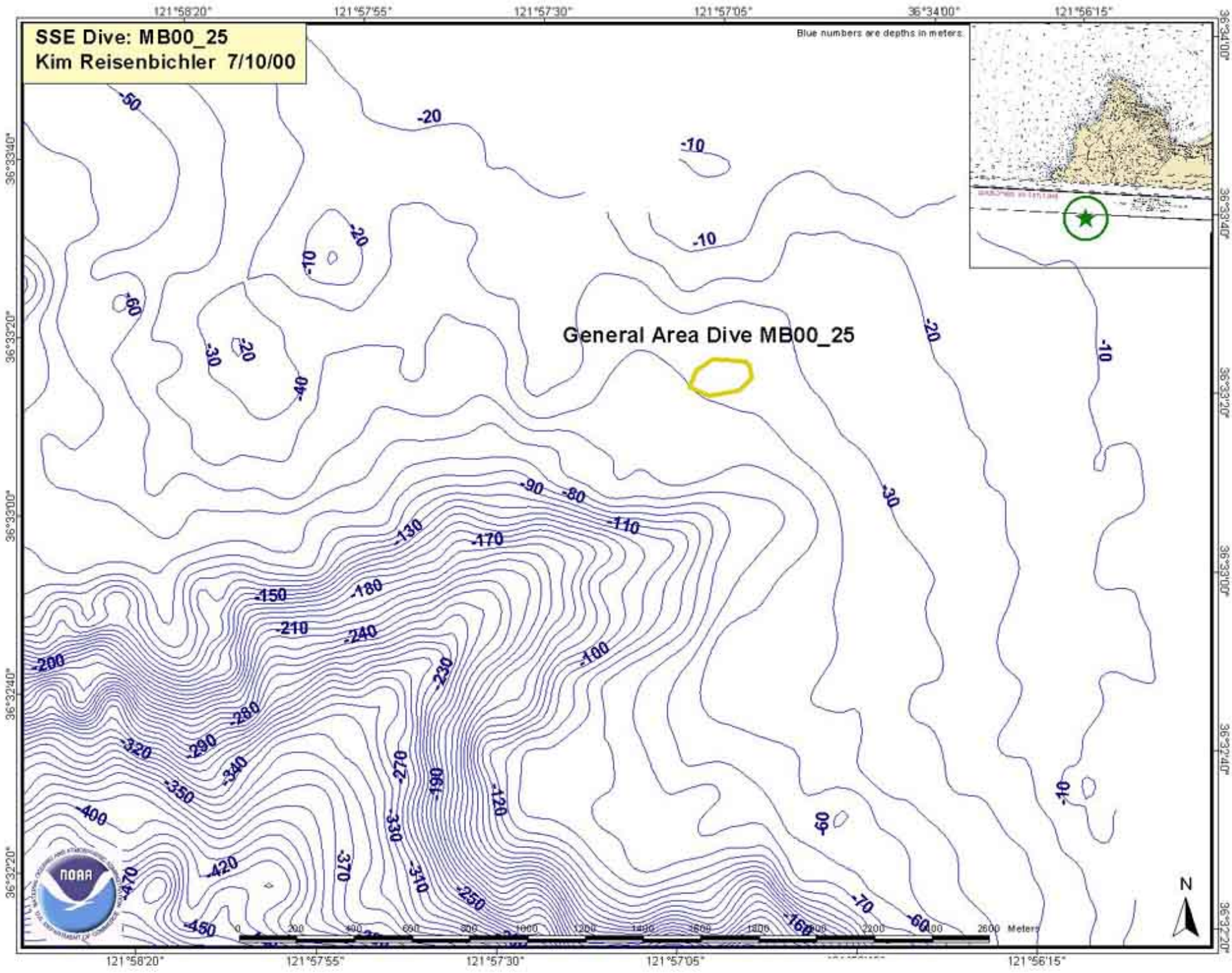

SSE Dive: MB00_19
Gale Mead 7/5/2000
Dive Area
0
100
200 Meters
N

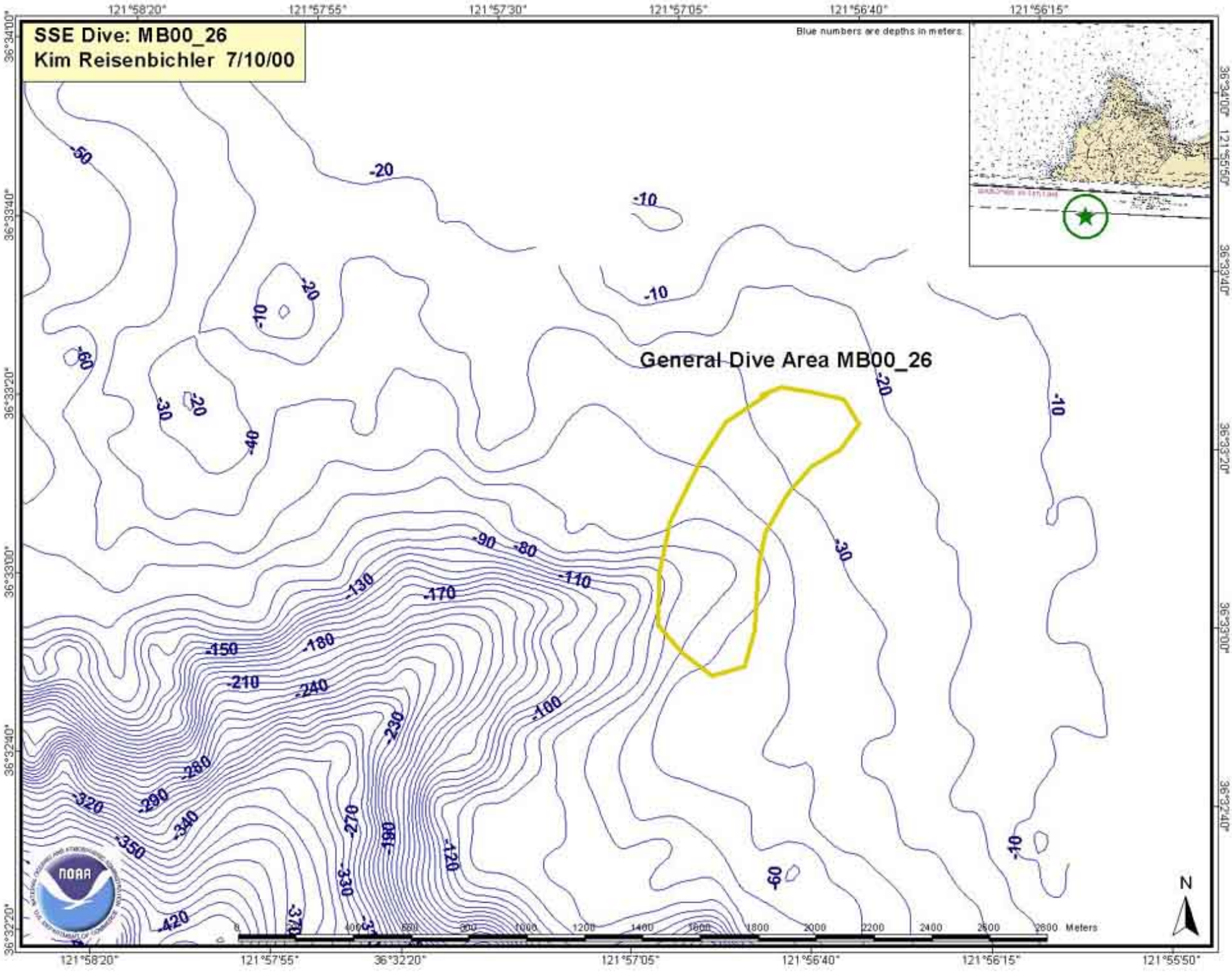

SSE Dive: MB00_20
Mike Guardino 7/6/2000
L.S. = Life Support
Blue numbers are depths in meters
Magnetic 250
Magnetic 290
Magnetic 280
L.S.
L.S.
L.S.
L.S.
-70
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
-230
-240
-50
-60
-80
040
250
500 Meters
N

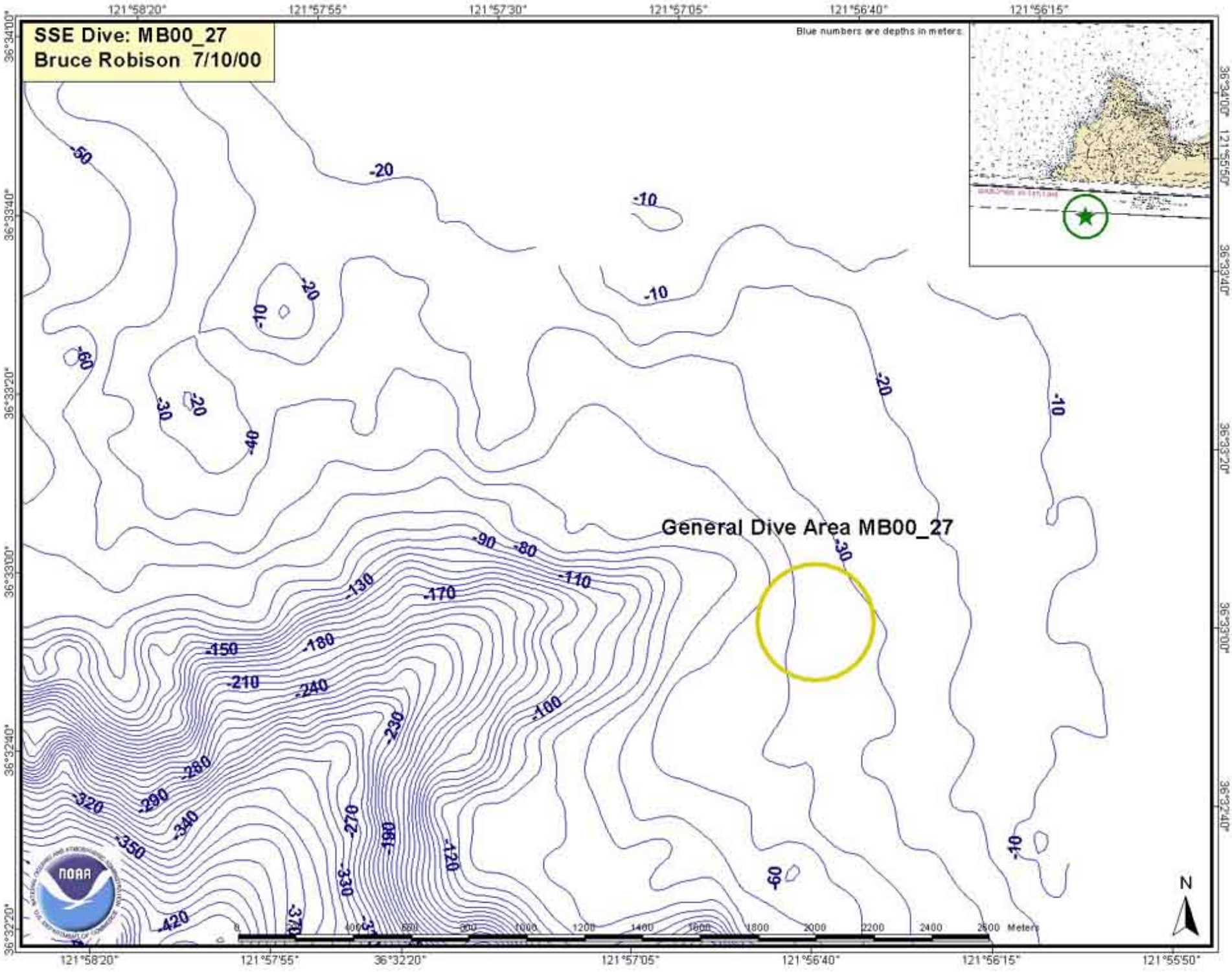

SSE Dive: MB00_21
Steve Webster 7/6/2000
L.S. = Life Support
Blue numbers are depths in meters
-170
-150
-130
-140
-120
-110
-90
-100
-80
-70
-50
-50
-30
-40
-20
0
200
400 Meters
N

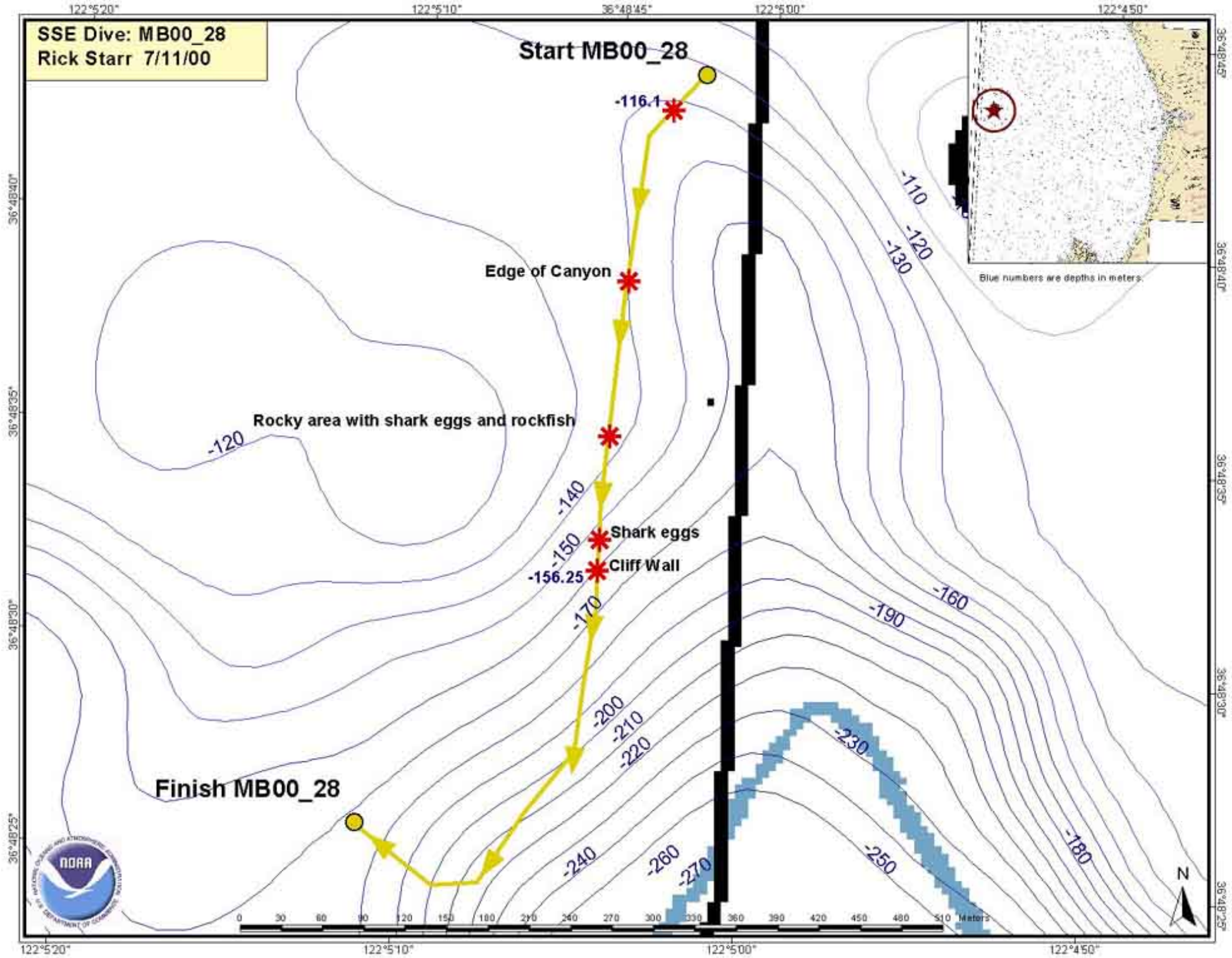

SSE Dive MB00_23
Sylvia Earle 7/8/00
Finish MB00_23
Blue numbers are depths in meters.
-1012'
-249.7
-220.0
-153.0
-125.1
-117.1
Basket Stars
Start MB00_23
64
N
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 Meters
121°59'00"
121°58'50"
121°58'40"
121°58'30"
121°58'20"
36°42'30"
36°42'25"
36°42'20"
36°42'15"
36°42'10"
36°42'05"

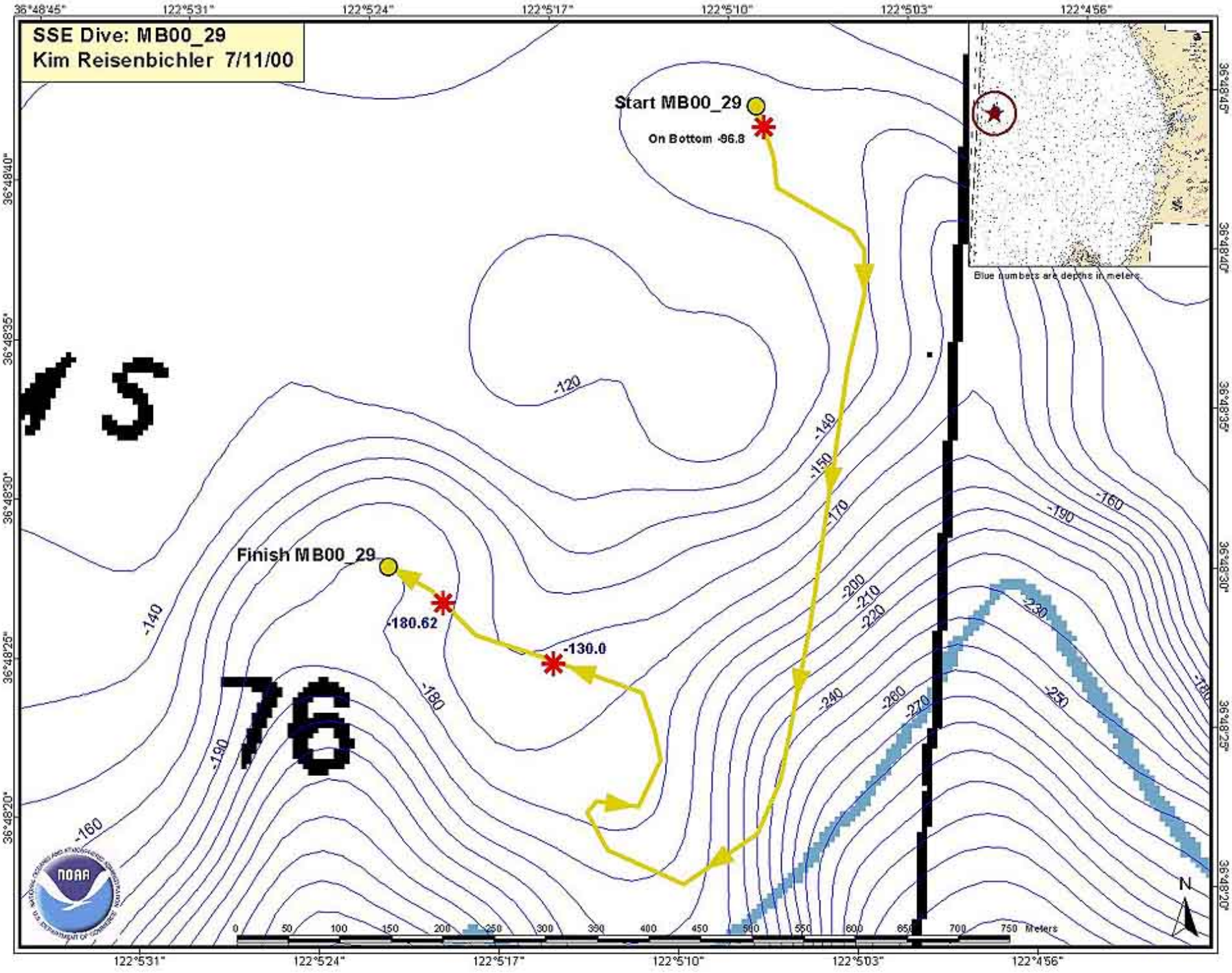

SSE Dive: MB00_24
Rick Starr 7/9/00
Finish MB00_24
Start MB00_24
Blue numbers are depths in meters.
121°58'56"
121°58'48"
121°58'40"
121°58'32"
36°17'35"
36°17'30"
36°17'25"
36°17'20"
N
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 Meters

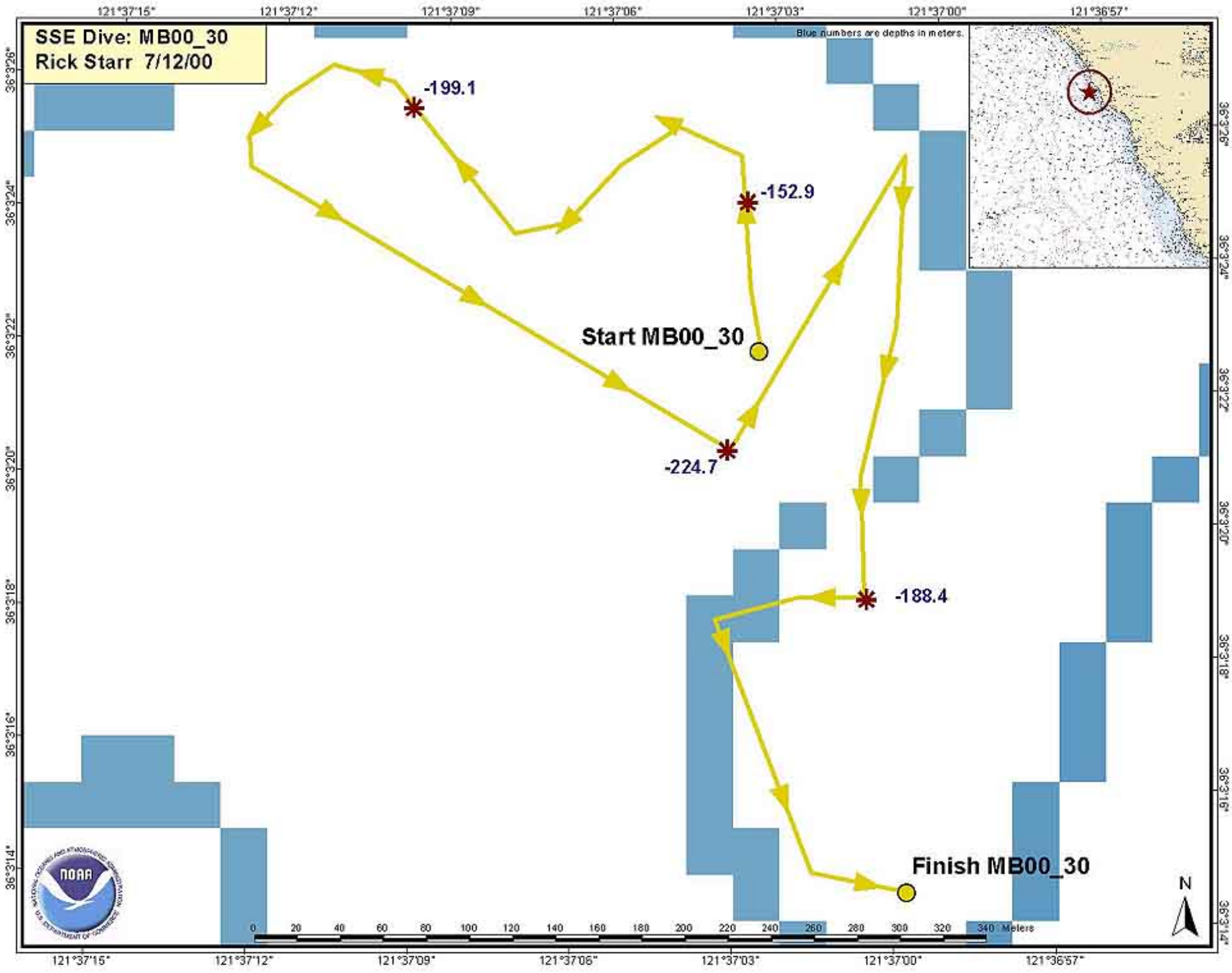

SSE Dive: MB00_25
Kim Reisenbichler 7/10/00
Blue numbers are depths in meters
General Area Dive MB00_25
121°58'20"
121°57'55"
121°57'30"
121°57'05"
36°34'00"
121°56'15"
36°33'40"
36°33'20"
36°33'00"
36°32'40"
36°32'20"
N
Meters


SSE Dive: MB00_26
Kim Reisenbichler 7/10/00
Blue numbers are depths in meters.
General Dive Area MB00_26
121°58'20"
121°57'55"
121°57'30"
121°57'05"
121°56'40"
121°56'15"
121°55'50"
36°34'00"
36°33'40"
36°33'20"
36°33'00"
36°32'40"
36°32'20"
N
Meters


SSE Dive: MB00_27
Bruce Robison 7/10/00
Blue numbers are depths in meters.
General Dive Area MB00_27
121°58'20"
121°57'55"
121°57'30"
121°57'05"
121°56'40"
121°56'15"
121°55'50"
36°34'00"
36°33'40"
36°33'20"
36°33'00"
36°32'40"
36°32'20"
N
0
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600 Meters
NOAA


SSE Dive: MB00_28
Rick Starr 7/11/00
Start MB00_28
-116.1
Edge of Canyon
Rocky area with shark eggs and rockfish
Shark eggs
-156.25
Cliff Wall
Finish MB00_28
Blue numbers are depths in meters.
122°5'20"
122°5'10"
36°48'45"
122°5'00"
122°4'50"
36°48'40"
36°48'35"
36°48'30"
36°48'25"
-110
-120
-130
-120
-140
-150
-160
-170
-180
-190
-200
-210
-220
-230
-240
-250
-260
-270
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 Meters
N
NOAA


SSE Dive: MB00_29
Kim Reisenbichler 7/11/00
Start MB00_29
On Bottom -96.8
Finish MB00_29
-180.62
-130.0
75
76
Blue numbers are depths in meters
N
Meters


SSE Dive: MB00_30
Rick Starr 7/12/00
Blue numbers are depths in meters.
-199.1
-152.9
Start MB00_30
-224.7
-188.4
Finish MB00_30
N
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 Meters
121°37'15"
121°37'12"
121°37'09"
121°37'06"
121°37'03"
121°37'00"
121°36'57"
36°3'26"
36°3'24"
36°3'22"
36°3'20"
36°3'18"
36°3'16"
36°3'14"

July 12, 2000 Summary Log: SSE Researchers Pleased with Monterey Bay 2000 Mission

by Jennifer Makowka, Research Intern
Andrew De Vogelaere, Research Coordinator
Monterey Bay National Marine Sanctuary

SSE's return to Monterey Bay was met by chilly but calm weather. The balmy conditions allowed for numerous terrific dives this year and helped the pilots further research efforts of the sanctuary. Our goals this year were to (1) familiarize the pilots with improvements to the subs, (2) further studies on krill distribution and behavior, (3) survey fish populations inside and outside of harvest refuge areas, and (4) perform geologic and benthic habitat assessments.

Sylvia Earle enjoying a moment below the surface of Monterey Bay. (Photo courtesy of Kip Evans.)

A total of 19 dives were made in six locations: Soquel Canyon, Sur Canyon, Monterey Canyon, Big Creek Reserve, Cannery Row and Carmel Bay. All of the pilots were veterans from last year; however, each made at least one training dive to re-familiarize themselves with the subs. The pilots gave the sub modifications, including the new launch and recovery procedures, the thumbs up and were ready to head into deeper water.

Benthic and Fish Assessments

Mike Guardino extends his research to deeper waters by participating in the expedition. (Photo courtesy of Kip Evans.)

In order to extend the depth of fish and invertebrate assessments already completed by his students, Teacher-in-the-Sea Mike Guardino performed deep transect surveys in Carmel Bay. Focusing on the area from Whaler's Cove to Pt. Lobos, Mike's deeper dives ranged from 280 feet to 608 feet. These data will be compared to information already collected by his students at SCUBA depths, where they found that the protected status of Pt. Lobos Reserve resulted in the presence of larger fish. Dr. Steve Webster also participated in collecting fish and substrate-type data in this area.

Krill and their Habitat

Baldo Marinovic conducts krill research aboard the *McArthur*.

Dr. Baldo Marinovic of the University of California at Santa Cruz sampled krill in three locations over Soquel Canyon in order to build on his project addressing basic krill biology, and linking to the congregating behavior of marine mammals. Pilots Kip Evans and Dr. Sylvia Earle each dove past 1000 feet in order to demarcate krill layers and observe krill behavior. One behavior of particular interest was the light show put on by the krill photophores, perhaps an effective method of communication. The data collected during this trip will add to Dr. Marinovic's monitoring data sets, and will give insight on krill behavior that cannot be assessed with the more traditional sampling methods of net tows and echo-sounders.

Geologic and Fish Assessments

Monterey Bay Aquarium Research Institute pilot Kim Riesenbichler and Sea Grant collaborator, Rick Starr, followed contour lines at the mouths of Sur and Soquel Canyons, and at deep depths in Big Creek Reserve. The former sites are natural harvest refuges from

Guardino

July 8
Personal Log:
Makowka

June 28 - July 12
Dive Maps

July 12
Summary Log

DeepWorker pilot conducting research during the expedition. (Photo courtesy of Kip Evans.)

fishing because of their rugged geology, while Big Creek has legal boundaries that prevent harvest. Video footage from these dives will be used to correlate bottom types to fish species for critical habitat assessments, and to groundtruth geological surveys made with multibeam scans earlier this year. The number of juvenile rockfish seen in these sites appeared promising for this widely fished species.

Summary

This year, SSE helped to further the goals of the Monterey Bay National Marine Sanctuary, especially site characterizations. Many thanks go out to the SSE crew, the crew of the NOAA Ship *McArthur*, the sanctuary staff, and the all of the people who worked so hard to put this project together.

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SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

June 30, 2000

2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific time)
Explore Monterey Bay and NOAA's Monterey Bay National Marine Sanctuary

Introduction

Join us on June 30, we will take you to Monterey Bay and the Monterey Bay National Marine Sanctuary. We will explore this amazing underwater environment and you will learn first-hand why this is such a special place.

You will be able to ask your questions live via an Internet chat room. To view the program you will be able to tune in via RealPlayer on the Internet or via direct satellite downlink using C-Band or Ku-band.

Now that the program is complete you can **click here** to:

... View the archived program on the Internet
... View the questions asked via an Internet chat room

Helpful tips for participating in the chats -- includes a description of registration, participation, and observation.

About the Video Broadcast

All broadcasts require the use of RealPlayer. If you do not have RealPlayer installed please click **here** to find out how to obtain it. Otherwise **click here** (not yet been provided) to view the broadcast.

For those of you with a satellite the coordinates are:
Ku-band: GE 3, Transponder 15
C-band: Telstar 4 Transponder 1
Event time: 2:00 pm - 3:00 pm Eastern time

Test time: 1:45 pm - 2:00 pm Eastern time

Web Chat Transcript

Claire - SSEChatHost - Hello and thank you for joining us for our second live underwater broadcast this field season. You will be able to ask questions of America's first Teacher-in-the-Sea, Mike Guardino, and his high school students who have participated in over 200 research dives last year. Mike is a DeepWorker 2000 pilot and is planning on continuing the research that he and his students completed at SCUBA depth in even deeper waters using the DeepWorker2000 submersible.

Q1: Juliette - What type of education programs does the Sustainable Seas Expeditions offer students? It sounds like there is a students-at-sea program, how would one get involved with this?

A1: Claire - The Sustainable Seas Expeditions offers quite a few educational opportunities for students. We have Student Ocean Summits, Open Houses and Ocean Fests, where students and their families can tour a NOAA oceanographic vessel and see the DeepWorker 2000 submersibles that are being used for exploration, research, education, and public outreach. One of the great opportunities is our Students-at-Sea program, where these select students shadow scientists, educators submersible pilots, technicians, and the ship's crew as a normal day of manned submersible operations take place onboard an oceanographic vessel. In order to get involved, your best bet would be to contact the Education Coordinator at the nearest National Marine Sanctuary to you (there are now 13 in the United States) and look into this program and time it just right when the Sustainable Seas Expeditions are at their location.

Q2: Charlie - Has Mike Guardino had a chance to dive yet during this year's Expedition? If so, what has he accomplished?

A2: Claire - Mike Guardino did get a chance to make a DeepWorker submersible dive yesterday (the second day of the Expeditions here in the Monterey Bay National Marine Sanctuary). Apparently, he dove to approximately 290 feet yesterday in very clear and flat conditions.

Q3: Paty - What is the temperature in the water right now?

A3: Claire - Paty, the water temperature in the Monterey Bay is about 51 degress. All the divers are wearing dry suits, which aids in keeping them quite warm while diving.

Q4: Judy - Do you see any otters?

A4: Claire - We will try to ask the divers if they have seen any otters during this dive. I was down at the Monterey Coast Guard pier earlier today and saw quite a few otters around the kelp beds.

Q5: David - What is the most common fish in the Monterey Bay?

A5: Claire - The most common fish in the Monterey Bay National Marine Sanctuary are probably sardines or anchovies, which are making a comeback. Sylvia Earle made a good point about how the seas are ever changing, some years they are cooler, some years they are warmer. It is hard to say at any precise moment what the most common fish is in the area.

Q6: Maria - Are there sharks in Montery Bay?

A6: Claire - Liz Love of the Monterey Bay NMS is currently answering your question live. She says that there are great white sharks in the area and more common are relatives of these creatures, skates and rays.

Q7: Judy - Is the diver taking any precautions against the dangers of talking and diving?

A7: Claire - Precautions should always be taken while diving in the underwater. The effects of talking underwater are not significant, other than consuming more of your air for less bottom time.

Q8: Rex - What has been your most memerable experience of your 200 research dives?

A8: Claire - Mike's most memorable dive was yesterday's dive in the DeepWorker 2000 submersible at 290 feet in Blue Fish Cove. Any California diving is what he considers some of the best diving in the world and always memorable.

Q9: Jesse - What has influenced all of you to work in the undersea?

A9: Claire - Laura Francis was inspired in sixth grade when her teacher took a group of children out to Anacapa Island for a snorkeling adventure. She thought it was such a memorable experience that she was forever hooked on the sea. Liz Love grew up near the wild ocean and has always admired and been inspired by the ocean depths.

Dr. Sylvia Earle was once knocked over by a wave when she was three years old, the ocean got her attention then, and has kept her attention since. The plants and animals that live in the sea have captured her imagination and she will continue to pursue this passion for the years to come.

Q10: Jeremy - Are blue and fin whale sightings fairly common in the bay area and has tourism had any effect on there activity?

A10: Claire - Blue whales are sighted in the Monterey Bay area, but the world's largest population of blue whales in down south a bit in the Channel Islands National Marine Sanctuary in the Santa Barbara Channel. Local tour boat companies are respectful of the regulations required in marine mammal sightings and I cannot say for certain how it has impacted these whale populations in the area.

Q11: Tina - Do you use videoconferencing to deliver any educational programs to classrooms?

A11: Claire - We have done some video conferences with the Sustainable Seas Expeditions (SSE). In January, we completed a video conference Student Ocean Summit with four of the Hawaiian Islands and American Samoa. We also have plans to be conducting our first SSE Virtual Teachers Workshop in the next few months. The Education section of the SSE Web site will provide more information as it becomes available (http://sustainableseas.noaa.gov).

Q12: Judy - Are there any live coral reefs in the bay area?

A12: Claire - There are no live coral reefs in the Monterey Bay National Marine Sanctuary, the water is much too cold for coral reefs to thrive.

Q13: Juana - Are there opportunities for foreign students in the sanctuary?

A13: Claire - Juana, there are always opportunities that can be made possible through the National Marine Sanctuary Program. Please visit the Web site http://www.sanctuaries.nos.noaa.gov and make contact with an site's Education Coordinator or Volunteer Coordinator to find out more about the intern and volunteer opportunities that are available. The Sanctuary Program is sometimes able to accommodate students from foreign countries, and they are always willing to try to make it work. Good luck with your pursuits!

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Procedures and Participation Tips for the Sustainable Seas Expedition's Live Events

This page provides requirements and suggestions for participating in the live events. Each event has a featured learning objective that seeks to highlight Sustainable Seas research being conducted at the sanctuary.

Software

The chat software being used for these events is designed to ensure that the chat environment is appropriate for participants of all ages. Each discussion will have professional moderator to foster a quality discussion and prevent inappropriate remarks. The chat environment is easy to use and does not require either special software or a high-speed Internet connection to the Internet. All Internet users with access to the World Wide Web, even low speed access, will be able to participate.

During the live interactive video events participants will be able to view the activities of the expedition live from the marine sanctuaries. With RealPlayer, audience members with a 14.4Kbps connection to the Internet will be able to hear the program. Users with 28.8Kbps or higher connection to the Internet will be able to view and hear the program. RealPlayer client software is available at no cost at:

http://www.real.com/products/player/index.html

Registration

To participate in one of the web chats, you must to register. Number of registrtants will be limited to ensure that all that join will have an opportunity to interact with the expert. Registration is a simple process, but read the instructions carefully. Answer all of the questions. Read the chat rules. When you have username and password accepted, note them both down. Your username and password are case sensitive, and have been stripped of any blank characters you might have entered. Also note that you can (and should) use the same username password for other chats, in a much shortened registration process.

Participation

To participate, click on the participation link and enter the chat room. If you are registered, you will be able to enter the chat room and leave your question up to 24 hours in advance of the event. Many of these questions will be the first to be answered during the event. Once in the chat room, feel free to ask questions and join in the discussion. But, please be aware of these common sense rules:

Be polite, our guests want to answer as many questions as they possibly can!
Offensive or inappropriate language of any kind is prohibited.
Focus questions on the topic of the chat. All chat topics are described.

During the live event, the expert will attempt to answer all questions, but time might be limiting.

Observation

Anyone can observe the event, simply click on the observation link at the time noted in the event description.

A Few Tips and Suggestions on Participation

Usernames and Passwords. Enter the userame and password EXACTLY as you were given in your confirmation. If you delete or add spaces...you wil be denied entry and will have to try again.

Identify Yourself. You should always begin a chat by identifying yourself! Above the large white chat box, you will find a smaller white box that asks for your "first name." If you do not type anything in this box the name that you used in registration will be added to your posted message. If you are sharing your log-in or computer with other classmates and you want to identifyyourself specifically, you may type your name in this box.

Examples: Your class registered as Lincoln Elem. If you do not type anything in this box only Lincoln Elem. will be posted. If you are one of the students at Lincoln Elem and your name is Carla, you should type in Carla in the box. The following will be posted when you submit a message: Carla-Lincoln Elem.

You registered as Sherie/Woodland H.S. Another classmate is using your log-in. If she does not type in a name in the box the message she posts will have Sherie/Woodland H.S. If she wants to identify herself as another user, then she should type in her name. If her name is Candra and she types it in, the following will be posted when she submits a message: Candra-Sherie/Woodland H.S.

Showing Posted Messages and Scrolling Back. Under the chat dialogue box are the choices" Show at least_" and "Scroll back_ messages." The show at least is set at 10. If you leave this number at 10 you will see the last 10 messages that havebeen posted each time you click "Refresh screen or Submit New Message." If for some reason you wish to see more messages, you can change this number. We have found that 10 seems to be an ideal number and recommend you leave this default.

As the chat progresses, there will be more than 10 messages posted and they will not all shown on your screen. If you want to go back and see some earlier posted messages you can enter a number in this box and click on refesh screen. This willpost that number of messages.

If you type a number in the scroll back box and click on refresh screen it will bring you back that many messages. This is helpful if you think you may have missed dialogue or if you want to go back and see more than the last 10 posted messages.

The small numbers after each dialogue posted tells you the dialogue number posted and the time. For example in this posted message:

[Emily-Woodland H.S. - 21 - 12:22:26]
This is the 21st message posted and it was posted at 12:22 p.m.

Sending Messages and Viewing Dialog. To send a message or question, type it into the large white window. Click "Refresh Screen or Submit New Message" to send your message out to the other participants.

You must click this button (Refresh Screen or Submit New Message) each time you want to see new dialogue. We suggest about every 15 seconds.

Capturing Text. To save any or all of the dialogue text yourself you can simply cut and paste it into any word processing document.

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SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

June 8, 2000

2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific time)
International Oceans Day at Anacapa Island in NOAA's Channel Islands National Marine Sanctuary

Introduction

Join us on June 8, National Oceans Day as we take you to Anacapa Island in the Channel Islands National Marine Sanctuary and Channel Islands National Park. You will enjoy a great underwater adventure as we tour the Anacapa Island cove and meet up with the DeepWorker.

You will be able to ask your questions live via an Internet chat room. To view the program you will be able to tune in via RealPlayer on the Internet or via direct satellite downlink using C-Band or Ku-band.

Now that the program is complete you can **click here** to:

... View the archived program on the Internet
... View the questions asked via an Internet chat room

Helpful tips for participating in the chats -- includes a description of registration, participation, and observation.

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Preparation

As you prepare for the live event on June 8, we thought we could help by providing some pointers to web sites that will help you learn more about where we are located, and hopefully help you to prepare some questions in advance.

First we challenge you to some questions! We hope that as you explore the suggested web sites for the answers, you will come up with some questions of you your own. You are invited to leave your own questions in the chat room before the event, or ask them during the program.

Finally, during the program we will have students with us on Anacapa Island and at the Channel Islands National Park Headquarters. These students will be filling out data sheets as they observe different marine life. We have provided that sheet for you to print and fill out.

Activity one

Challenge Question 1: What is the range of ocean sea surface temperatures around Anacapa Island during the late spring/early summer?

Challenge Question 2: Where is the deepest part of the Channel Islands National Marine Sanctuary (which island is closest to the deepest spot)?

Challenge Question 3: What marine species that is found in the Channel Islands National Marine Sanctuary can grow 50-60cm per day?

Challenge Question 4: Which marine vertebrates, found in the Channel Islands National Marine Sanctuary, can live to be 140 years old?

Look through the following web pages for the answers:

Channel Islands National Marine Sanctuary
The local Web site for the sanctuary

Channel Islands Sanctuary Log for SSE
Background information and (semi) daily updates from the SSE team

Channel Islands Sanctuary SSE site
The sanctuary's own SSE site

Channel Islands National Park
The official Web site for the Channel Islands National Park

Email your responses to the challenge questions to **SSEeducation@noaa.gov**

Activity Two

You may also want to explore these web sites in order to get a preview of the marine life we might see during the broadcast in the Channel Islands National Marine Sanctuary (CINMS):

CINMS Marine Life
List of marine life in the sanctuary

CINMS: The Living Sanctuary
An annotated photo collection of sanctuary resources

The Love Lab: Everything you wanted to know about fish
More fish photos

Channel Islands 3D Underwater Fly-through
A QuickTime video that simulates underwater flight

Activity Three

During the live event you may want to fill out the Student Data Sheet that lists the various critters that we may encounter while in the sanctuary waters. We invite you to download this file and complete it during the program. Download: **Student Data Sheet** (378k PDF file). This data sheet requires Adobe's free Acrobat Reader. It can be **downloaded here**.

About the Video Broadcast

All broadcasts require the use of RealPlayer. If you do not have RealPlayer installed, please visit the **Advanced Features** section of this Web site to find out how to obtain it.

For those of you with a satellite the coordinates were:

Ku-band: GE 3, Transponder 15
C-band: Telstar 4 Transponder 1
Event time: 2:00 pm - 3:00 pm Eastern time
Test time: 1:45 pm - 2:00 pm Eastern time

Web Chat Transcript

Andrea/NASAChatHost - Welcome to the chat room for the live interactive event from the Channel Islands National Marine Sanctuary and Channel Islands National Park. You are invited to leave your questions in the chat room. You will not see you question right away - a moderator will need to read the question and post it to the chat room. Thank you for joining us - we look forward to "seeing" you on June 8 at 11:00 am Pacific / 2:00 pm Eastern.

Claire/SSEChatHost - Thanks for diving into National Oceans Day, June 8th, with the Sustainable Seas Expeditions and NASA Oceanography online. We will take you to California's Anacapa Island in NOAA's Channel Islands National Marine Sanctuary and the Channel Islands National Park. Enjoy a great virtual underwater adventure as we learn about the new technology used in the Sustainable Seas Expeditions, including the DeepWorker, a one-person submersible. In the Internet chat room, viewers like yourself can ask live questions of ocean explorer and expedition leader, Dr. Sylvia Earle, National Geographic Society Explorer-in-Residence; view the live underwater exploration of the Channel Islands National Marine Sanctuary; and ask questions of researching divers. I hope you all enjoy the broadcast.

Claire/SSEChatHost - Thank you for logging on today to participate in the live underwater broadcast with the Sustainable Seas Expeditions that will be starting at 11 AM Pacific/ 2 PM Eastern. An update from the NOAA ship McArthur has just arrived&emdash;the new submersibles and launch and recovery are taking longer than anticipated to fully integrate. Seeing as safety is our first priority, the ship and crew will spend one more day testing the systems before launching into the wild ocean. We will still be broadcasting live from underwater with SCUBA divers on AGA Masks, and you are invited to ask questions that will be answered by experts and divers in the field.

Marcy/CampInternet - Good Morning - Camp Internet reporting in here for this exciting day. We have students who will be watching the broadcast and using the chat room as part of their Explore the California Channel Islands program here at Camp. Thanks for making such an enriching - and exciting - learning technology available.

Marcy/CampInternet - Questions compiled from Camp Internet classrooms : What is the rarest sea life you have seen in the Channel waters ? Why is it no one has ever seen the giant squid ? Do the sea caves on Anacapa go under the island into caverns with air ? Are there any sea otters in the Channel ? Do you think they should be brought back ? Which whales live in the Channel ? Are there endangered birds or sea life at Anacapa ?

Marcy/CampInternet - More Camp Internet questions : When the Ice Age made the sea level lower, and Anacapa was only 5 miles from the mainland, how much more of the island was exposed ? When the wooly mammoths crossed over, was Anacapa part of the big Santa Rosea Island or still a seperate island ? What animals or creatures lived in the Channel waters in prehistoric times that are not there today ? How did

small mammals get out to the islands since they can't fly or swim that far ? When you are under the water, can you see down to the cliffs that would have been above the water in the Ice Age ?

Timothy - Camp Internet Base Camp checking in. We have a group of homeschoolers taking part today. First question is for Dr. Earle. Do you feel the SSE research being done today is going to have an impact on current issues such as coastal pollution.

Claire / SSEChatHost - Welcome to Camp Internet! Thanks for all of your wonderful questions, we will be answering many of your questions once the broadcast has begun at 11 AM PST.

Claire / SSEChatHost - On a side note, please identify your name and where you are from (i.e. Madison School, Ohio) so that when we communicate with the divers underwater and the support staff on Anacapa Island they will be able to identify you and where you are from. Thanks for your cooperation.

Jessica Callarman - Dr.Earl I was wandering how a women could be on a submarine when the Navy said that women aren't aloud on submarines? Do you like being on submarines and doing recearch?

J**essica Callarman** - Dr. Earl why are national marine sanctuaries important? Do you enjoy your research? What is your favorite part of the research that you do? Have you ever been on a navy nuclear submarine? If you have, how did you do that when the Navy said that women aren't aloud on submarines yet? especially nuclear submarines. When i get out of high school i plan on going into the navy and i wanted to work on submarines but i was told that women aren't aloud on submarines but they were working on it. Will i ever be able to work on a submarine when i go into the navy?

David Ackerman - Dr. Earl How much room is in your somll sub? are you having fun in the sub? is it cold in the sub? How do you keep your windows from geting fogging?

Shadow - Dr. Earle what was it that made you want to take this up as a profession? do you enjoy going down in a sub? have you eva taken your grand children with you and if so did you enjoy it? how do you keep warm if it's cold? what does it take to do something like this?

CA Indio madison school pygmy mammoths - What kinds of plants and animals did you see?

Jellyfish Madison School - How does it feel to be inside a submarine?

Madison School Otters - What is the largest Sub Marine?

Silvia Camp Internet - Dr. Earle - how will this years dive differ from last years work in the Channel?

CA Indio madison school pygmy mammoths - Do you go underwater or is there a camra in the submarine?

Dustin Stadium HS - How is you research sub powered, nuculear? Where was you sub designed and built? What is the maximum depth your research sub can go? What if any is the role of the Navy in todays session? How are you connected to the internet, radio to coast or satillite?

Claire/SSEChatHost - RE: **shadow well how dose it feel to be in a sub cause i have never been a sub.**
Being a DeepWorker pilot is not for everyone. Anyone that is prone to claustrophobia would feel very comfortable in this type of single person submersible. For those that have no problem with small spaces, piloting a submersible can be one of the most incredible experiences of a lifetime. The DeepWorker 2000 submersible is a new tool that can be used to explore and research the wild ocean.

Derek/Channel Islands National Park Expert - RE: **Jellyfish Madison school Whats the weirdest animal you have ever seen under water?**
There are lots of strange critters in the ocean, butMantis shrimp would be at the top of my list

Derek/Channel Islands National Park Expert - RE: **Jellyfish Madison school Have you ever seen the giant squid?**
NO, Giant squid are deep water animals that are very rare world wide. The majority of squid we see are market squid that are only 6 inches long.

Derek/Channel Islands National Park Expert - RE: **Dolphin group Madison Why do you go under water?**
We SCUBA dive underwater to monitor kelp forest ecosystems. Most of the work involves counting species from algae to fish and comparing the counts from year to year to have a better understanding of ecosystem dynamics

Derek/Channel Islands National Park Expert - RE: **Madison school Otters Have you ever seen a sea otter?**
Not underwater. The only sea otters I have seen were either from a boat near Point Conception or in an aquarium.

Jellyfish Madison school - Whats the weirdest jellyfish you have ever seen under water? whats its name?

DolphingroupMadison - Have you ever been attacked by an animal under water?

CCHS - Hi! The Marine Science class from Camden County High School in SE Georgia will be joining you as we finish our final exam.

David/Channel Islands National Park Expert - RE: **Dolphin group Madison What animal do you see most under water?**

The animals that are most abundant from site to site vary a lot. Some sites are dominated by sea urchins with densities of over 100 per square meter, while other sites have rich kelp forests with a high diversity of orgnisms

Claire/SSEChatHost - RE: **CA Indio madison school pygmy mammoths Is it hard to breathe in the submarine?**
No, it is not hard to breathe in the DeepWorker 2000 submersible, it is as if you are breathing on land. The submersible works at one atmosphere of pressure, therefore you are not affected by the pressures of the ocean depths.

Derek/Channel Islands National Park Expert - RE: **Linh Stadium Hschool WA Are there a lot of sharks around you**
Sharks are common at the Channel Islands. However, most of the sharks we observe while SCUBA diving are benthic sharks, sharks that live on the bottom. As with most sharks these are harmless to humans. The most common sharks we observe at kelp forest monitoring sharks are Horn sharks, these feed mostly on invertebrates

Derek/Channel Islands National Park Expert - RE: **LeAnne Stadium How did you get in to this kind of work?How old where you when started doing it? What turned you to doing this line of work? Do you eat sea food or red meat?Is there any way that sea by-catch can be less wasteful? How do you feel about people going out to sea and killing mammals for sport?**
1) I studied Marine Biology in College and always had an interest in the ocean. I started college at 18 and began working in Oceanography/Biology at the age of 22. 3) I turned to Marine Biology because I loved the ocean and its communities and felt that the best way to contribute to the system was to work with it directly. 4) Yes I eat seafood and red meat. 5) we can start to utilize some bicatch and use new methods to reduce it. 6) No I don't agree on killing mammals for sport.

Claire/SSEChatHost - RE: **Zach Erica Aaron/Stadium How deep are you going to dive today? What are your emergency systems in case of an emergency? How long will you be in decompression?**
Today we will be diving in the Channel Islands National Marine Sanctuary at a depth of approximately 30-60 feet with SCUBA divers. Unfortunately the DeepWorker 2000 submersible will not be deployed in conjunction with the live underwater broadcast today, due to an unexpected delay in intergrating the new DeepWorker submersible systems with the modified launch and recovery system.

Derek/Channel Islands National Park Expert - RE: **DolphingroupMadison Have you ever been attacked by an animal under water?**
If you consider getting poked by sea urchins being attacked, then I have been attacked. All of the animals I have encountered in kelp forest have never shown aggression enough to attack. But of course we treat the animals with respect.

JellyfishMadisonschool - How far low have you gone under water in the submarine?

Derek/Channel Islands National Park Expert - RE: **Kevin stadium What kind of biology do you expect to see down there? Have you seen any great**

whites? How thick is the hull of the submersible? What kind of geologic activities are down there? How fast does the submersible go?
In the deep biological community we expect to see basket stars, urn sponges, urchins, and lots of deep water rock fish. 2) No I have never seen a great white underwater in over 1000 scuba dives. 3) The submersibles hull is approximately 1 and half inches thick (steel).4) Their are no obvious geological activities visible. 5) The sub goes 3 to 4 knots about 5 miles per hour

Claire/SSEChatHost - RE: **Warren What depths can DeepWorker dive to?**
The DeepWorker 2000 submersible that the Sustainable Seas Expeditions is using for exploration, research, education and public outreach has the capabilities to go to depths of 600 meters or 2,000 feet.

Derek/Channel Islands National Park Expert - RE: **Michelle Stadium WA Is it really dark under water?**
At the depths that we SCUBA dive it is usually quite bright underwater if we are not diving at night. Diving in a submarine below a depth of 150ft it becomes very dark and lights are needed. Also below 150ft, there are few plants, algae, because of the lack of light.

Derek/Channel Islands National Park Expert - RE: **LorinStadium How long will you need to be in decompression after this mission?**
Their will be not need to decompress after this mission. The diver in the sub in under normal surface pressure a nd the scuba divers will not be deep enough for long enough to go into decompression,

DeleenStadiumWA - How did you get into this career? How old were you when you decided to become a marine biologist?

Sanderstadium - Have you guys seen any sharks today? big ones?

Derek/Channel Islands National Park Expert - RE: **Linh Stadium WA How deep are you down under water? Are you the only one that's under water right now?**
No, there are at least two divers underwater at a time. The other diver is the one filming so you can view them

Derek/Channel Islands National Park Expert - RE: **Jellyfish Madison school Have you ever seen a animal that you would not like to see again?**
No, I am interested in everything I see underwater dangerous or not. Each new interaction is a learning experience.

Derek/Channel Islands National Park Expert - RE: **Mrs Bridgans Class/StadiumHS How much Money do Scientists like you Make? Have you ever been attacked by a sea squid? (or a Great white... whichever is realistic to you)**
Marine biologist typically start at 30,000 and go up to about 100,000 depending on who you work for. I have never been attacted by a giant squid or great white but

would like to see either of them if I had the chance.

Claire/SSEChatHost - RE: **Daniel stadium high how big is the sub?**
The actual DeepWorker 2000 submersible weighs approximately 1.3 tons, yet is one of the lightest submersible systems in production. It is what we call a flyaway system that can be used of ships of opportunity.

Derek/Channel Islands National Park Expert - RE: **David Phillips Stadium how deep under the water do you plan on going? are there a lot of sharks around? how much visibility do you have? how old were you when you 1st started as a marine biologist?**
Typically SCUBA divers usually stay above 100 ft. At 100 divers can only stay about 15 minutes before going into decompression diving. This time of year, visibility can be between 3-50 typically. I have been interested in aquatic environments since the age of 5, but believe I began my career at age 16 when I began SCUBA diving.

Derek/Channel Islands National Park Expert - RE: **Ryan Stadium How far can someone dive without diving gear or vehicle?**
The world record for breath hold diving is just over 450 feet . More typically dives to 50 0r 60 feet is good for a in shape biologist like myself.

Derek/Channel Islands National Park Expert - RE: **Daniel stadium high do you have a lot of stuff for diving?**
Yes, Scuba diving is very gear intensive.

Derek/Channel Islands National Park Expert - RE: **Sanders Stadium do like to eat fish? or the other way around?**
I love it and perfer to catch it myself so their is no waste or bicatch.

Derek/Channel Islands National Park Expert - RE: **Trish/CCHS how is the "la nina" weather pattern that is bring us firestorms in Florida effecting CINMS?**
Strong La Nina's have a big influence on the marine ecosystems around the Park. Water temperatures tend to be cooler than normal. Along with this cold water comes nutrients which benifit many of the organisms. Typically in cold water years we often have high recruitment of cold water species such as rockfish, and most of the algae, such as giant kelp also tend to do well in cold water. The other species that use giant kelp for food and shelter also tend to benifit.

Derek/Channel Islands National Park Expert - RE: **Jellyfish Madison school Have you ever seen the bock jellyfish?**
NO

Derek/Channel Islands National Park Expert - RE: **Madison School Brown Pelicans In the sub what kinds of kelp fish did you see?**
Kelp fish are typically shallow water fish. Their are many different species and they tend to stay near kelp or other algae.

Derek/Channel Islands National Park Expert - RE: **Fred Helen Keller Elementary Washington What do you feel when you are down so deep in the water?**
The deeper you go the more pressure is exerted on your body. This is really noticeable when SCUBA diving in a wetsuit or drysuit, because the deeper the more the suit compresses, and it feels like you are being squeezed. Often there are thermalclines with the water being colder as you go deeper.

Derek/Channel Islands National Park Expert - RE: **cypress with camp internet 1. How deep is the ocean water around Anacapa island? 2. Can you see the sea kelp still growing to the surface in the water from Anacapa Islands? 3.If the whole world was made of water well sea kelp grow all the way to the top? 4.How do animals live on the Island? 5.How deep is the water around Anacapa Island? 6.Did you like it there on the Island? 7.What do sharks and dolphins look like? 8.How deep is the middle of the ocean? 9.How big is the ocean how tell are the waves,is the kelp tell? 10.I want learn about dolphins how do they breath out of the water? Where do the seastars live in the ocean? 12.I hope you guys learn alot. 13.Is the sea ke 11.Wher do theseastar live in the ocean?**
The water around Anacapa varies in depth but within one mile the depth gets to 1000 feet. Yes you can see kelp grow all the way to the surface at Anacapa. Kelp grows in water no deeper than 100 feet. Dophins breath with lungs just like you and I but over heat out of the water. Seastars live every where in the ocean from the surface to very deep in the ocean.

Claire/SSEChatHost - RE: **Jon How does the study of the sea sanctuary effect our daily lives?**
Studying these sanctuaries is important to our daily lives, because the world's oceans cover over 70% of the earth's surface and we must learn to protect and better understand this watery realm for our future on this blue planet.

Derek/Channel Islands National Park Expert - RE: **Sea Snail/Madison School Hello. We are students from Madison School in Indio. We are fourth graders. The students want to know if the Alaska airlines crash damaged the waters, sea life and caves around Anacapa because of the oil and fuel leakage.**
Not that we know of. The plane crashed in water nearly 700 feet deep and the majority of the bottom in that area is sand. Its more likely that some birds and marine mammals where effected by the fuel that was spilled on the surface.

Derek/Channel Islands National Park Expert - RE: **DolphingroupMadison What animal do you see most under water?**
Sea Urchins

Derek/Channel Islands National Park Expert - RE: **Jon How does the study of the sea sanctuary effect our daily lives?**
At Channel Islands National Park and Sanctuary we monitor kelp forest ecosytems to have a better understanding of how healthy these are. This information has and will continue to aid in the management of these areas both as natural areas and as areas that we can continue to harvest resources from. One of the main species that is

harvested at the Channel Islands is the giant kelp plant macrocystis pyrifera. Products from this plant include carageen, look at the ingreadients of the toothpaste you use every day, most likely this is one of the ingredients. If not try looking at the icecream, frozen foods, cosmetics, beer etc that you probably consume often.

Derek/Channel Islands National Park Expert - RE: **David stadium Do you have e-mail accsess in the submersible? Do you have a cell phone and what satellite do you comeunicat to?**
No, the sub communicates through VHF and through water communications.

Mellie - Dr. Earle, With the reports in this year, how would you rate the health of our National Marine Sanctuaries? What would you suggest teachers and students to do improve the funding for important ocean research projects? Thank you for all the work you have done to protect our oceans. Atholton Elementary School Columbia, Maryland

Derek/Channel Islands National Park Expert - RE: **CA Indio madison school pygmy mammoths Do you go underwater or is there a camra in the submarine?**
The sub is outfitted with a still and video camera supplied by national geographic.

Derek/Channel Islands National Park Expert - RE: **LinhStadiumHschoolWA Are there a lot of sharks around you**
No, sharks are not as common as everyone thinks especially in the deep ocean. Most sharks are harmless and are no threat to humans,

Pygmy Mammoths - Thank you.

Jellyfish Madison school - We have to go thank you very much for answering our questions bye.

Madison School Brown Pelicans - Thank you for chating with us!

Dolphin group Madison - Thank you everyone who answered our questions. i hope you have a nice day.

Madison school Otters - Thank you for letting us asking questions to you!

Derek/Channel Islands National Park Expert - RE: **Daniel stadium high do you use cameras when diving?**
We use both still 35mm camera's and didgital video cameras to document the kelp forest monitoring sites every year. Cameras are excellent tools to document the visual aspects of communities, but it is often difficult to acquire accurate counts due to difficulty in counting and identifying species. This is why most monitoring needs to be conducted using SCUBA divers.

Claire/SSEChatHost - RE: **Josh/Stadium is it true this is the first attempt at**

national web communication and higher learning
No, we have done quite a few live underwater Web broadcasts and chats in conjunction with NASA and other collaborators during the first field season of the Sustainable Seas Expeditions. This is our first live broadcast during our second field season and it appears to be going quite well.

Derek/Channel Islands National Park Expert - RE: **Daniel stadium high how many times have you dived?**
Over a 150 times per year and over 1500 dives in my lifetime.

Derek/Channel Islands National Park Expert - RE: **sandersstadium can you write underwater?**
We use underwater slates than can latter be erased and also have special underwater paper. We use regular pencils to write with.

Derek/Channel Islands National Park Expert - RE: **Jordan How Deep have you been. I am a diver and i dive alot and i think it is really cool. i have seen many animals and it is really fun**
I have been to 160 ft but more regulaly we work in depthes from 40 to 60 ft.

Derek/Channel Islands National Park Expert - RE: **Josh/Stadium how far is the regular dive with normal mixtures and gear**
40 to 60 feet

Derek/Channel Islands National Park Expert - RE: **Jellyfish Madison school Whats the biggest animal you have ever seen?What is the smallest animal you have ever seen?**
The biggest animal was a humpback whale, the smallest was well really small, less than o.5mm and were small copepods.

Claire/SSEChatHost - RE: **JulieCamarillo How long do you expect to be on this particular expedition? Where will you go next?**
The Channel Islands National Marine Sanctuary Expedition will run until June 24th, ending with an Ocean Fest/Open House tour of the NOAA ship McArthur at Stearn's Wharf in Santa Barbara, CA. We will then be continuing on to the Monterey Bay National Marine Sanctuary at the end of June and the beginning of July. Later in the summer, we will be heading to the east coast to explore and research the Florida Keys National Marine Sanctuary in August/September 2000. Keep posted to the SSE Web site at http://sustainableseas.noaa.gov

Derek/Channel Islands National Park Expert - RE: **sandersstadium have you ever discovered any new species?**
I beilieve I have discovered an new species of worm, but have not described it. New species are still discovered on a regular basis and typically are small invertebrates. Many species, especially in the deep ocean are sure to be discovered in the future.

Derek/Channel Islands National Park Expert - RE: **sandersstadium is there bicatch in the stuff i eat at skippers?**

Yes, Some bicatch is associated with nearly all fisheries weather or not they keep it or disgard it dead or alive depends on which species are targeted.

Derek/Channel Islands National Park Expert - RE: **Pedro/Universum Sci Museum Mexico Why Channel Islands were considered as a marine sanctuary?**
Channel islands were deemed a special biological area and because of the multiply users associated with the area some protection was needed. The sactuary basically only protects the area from being utilized for oil drilling and mineral extraction.

Claire/SSEChatHost - RE: **Daniel stadium high how many of you are there?**
In order to run a live underwater broadcast to the Internet and two seperate audiences, it takes quite a few staff members to pull it off. Today we are working with staff from the Channel Islands National Marine Sanctuary, NOAA, NASA, the Channel Islands National Park, Central Coast Uplink, and National Geographic Society. The staff members are too many to say. Currently there are three of us attempting to answer your questions via the Internet and with all of your great questions, you are keeping us quite busy! :)

Derek/Channel Islands National Park Expert - RE: **lorinstadium what is the biggest danger in a shallow dive like this?**
Gear failure resulting in a emergency assent causing possible air embolisms.

Derek/Channel Islands National Park Expert - RE: **lewis/cchs with la nina do species that thrive in warmer waters migrate tough it out or just die off**
Quite often fish that prefer warm water will migrate during cold water years. However, many invertebrates are unable to move large distances. Some of these may die, however most to not. Typically warm water species will not recruit to areas in the Channel Islands during cold water years, but adults present will survive. This works the opposite during warm water years. Cold water species don't tend to recruit during warm water years. The Channel Islands are special place for marine biodiversity because both warm and cold water currents mix around. The Channel Islands are the norther extent of many warm water species range and the souther extent for many cold water species. As a result diversity is higher.

Corey Wilson - Thank you I am really enjoying your work

Claire/SSEChatHost - RE: **Mr Bartletts class How big is the submersible? How long have you been woriking on it? How much oxygen does it hold?**
The DeepWorker 2000 submersible has approximately 72 hours of life support systems with redundant oxygen systems in the back floatation pack after an eight hour dive. The submersible is quite compact and is approximately 8 feet in length, 6 feet in height and 6 feet wide, weighing about 1.3 tons. The Sustainable Seas Expeditions have been using the DeepWorker submersibles since the beginning of the project and we are expecting to use these subs for the remainding life of the project.

Claire/SSEChatHost - RE: **M Bridgan Stadium Give Laura my greetings, I will stay on line with you from Stadium until 1:00 and then to Oakbrook**

Elementary at 1:45. Can you stay on a few minutes for a group of 60 elementary students to interact with you?
We will be continuing to answer questions for the next half an hour online and will have answered all of your questions and they will be posted by next week at the latest. I will pass along a hello to Laura Francis for you.

Derek/Channel Islands National Park Expert - RE: **Marcy at Camp Internet If the most common creature seen is the urchin, how is that impacting the kelp beds ? Are there large beds or do the urchins eat them up ?**
The urchin kelp dynamics are very complex. When sea urchin densities are greater than 20 per square meter we typically have sea urchin barrens. These barrens are areas where the sea urchins have grazed all of the algae present and the bottom appears mostly bare with little else but sea urchins. These areas typically have a much lower diversity of species than areas that have healthy kelp forest. Sea urchin barrens can return to kelp forests and vise-versa in less than 6 months, so these are very dynamic ecosytems that are very complex.

Claire/SSEChatHost - RE: **Madison school Otters Thank you for letting us asking questions to you!**
Your welcome and thank you very much for your great questions!

Derek/Channel Islands National Park Expert - RE: **Wes Stadium HS How far up on the coastline do abalone live? How much abalone was being fished before it was noticed to be overfished? Does abalone live near Great Whites? is the abalone endangered threatend or what? ... A note form Mrs. Bridgan... The visibility is very poor from the camera... is it possible to make less jolting movement of the camera... the connection is very poor. Thanx!**
Their are seven species of abalone on the US west coast and they vary in range and distribution but occur from central baja california to Alaska. Five species of abalone (black, green, white, red, and pink) were heavily fished and in the amount of several thousand tons per year. Great whites do inhabit waters around abalone but have little interaction with them. None of the abalone are currently listed as threatened or endangered but we anticipate that at least the white and maybe the green and pink abalone will gain that distinction very soon.

Captain - Hi all! Greetings from Austria

Derek/Channel Islands National Park Expert - RE: **Wes Stadium HS Do you ever feel like being down under water could be fatal one day and would give it all up for some popcorn and a movie?**
No I try not to think that an accident will be fatal and that I am prepared enough to survive any such incident. Working underwater beats a movie and popcorn anyday.

Derek/Channel Islands National Park Expert - RE: **corey wilson what made you what you are today?**
Hard work, persistence, and a love for the outdoors.

Derek/Channel Islands National Park Expert - RE: **Wes Stadium HS How**

often are you called to "duty" and "dunked" in the water? Do you enjoy your work because that is very important when you have a job like this.... Have you ever been frightened or had a malfunction with your gear that was near fatal? do you ever feel like you need to take a break from this wonderful science that you are achieving?
I manage the kelp forest monitoring program for Channel Islands National Park. Typically, we conduct our monitoring during seven five-day cruises from June - October. Our first sampling cruise to our monitoring sites at the Channel Islands in this monday, June 12. Yes, I enjoy my work, but it is very physically demanding to dive 5-days at a time. No, I would rather not do anything else, and I have been working on this project for over 10 years. I really do not worry about dive gear malfuntion. I feel my training is sufficient that in the case of a malfunction I will be able to deal with the situation and survive.

Derek/Channel Islands National Park Expert - RE: **corey wilson what made you what you are today?**
Will, perserverance, lots of hard work,and support from family and friends.

Derek/Channel Islands National Park Expert - RE: **Wes Stadium HS It is important to keep a good sense of humor in your life... Do you scientists constantly joke around about what you see or have accomplished in your work? Do fish make sound? if so, how can you detect them when your soo far under the surface?**
A good sense of humor is vital when you work under dangerous and varying conditions. We have fun with each other and the animals we study on a daily bases. Fish make various sounds and since sounds travel efficently through the water we hear various fish sounds.

Claire/SSEChatHost - I have some Web sites that may be of interest to all of you:
Marine Careers

http://life.bio.sunysb.edu/marinebio/mbweb.html
http://marinecareers.net
http://id-www.ucsb.edu/lovelab/index.html

Kelp

http://www.biology.ucsc.edu/people/raimondi/readdie
http://www.biology.ucsc.edu/classes/bio161

Educational Sites

http://www.vims.edu/bridge
http://endeavor.des.ucdavis.edu/NPS

Ocean-related Web sites

http://www.pbs.org/oceanrealm

http://www.volunteer.nos.noaa.gov
http://www.kids.earth.nasa.gov
http://www.oceanicresearch.org

And of course, please keep posted on the Sustainable Seas Expeditions Web site at http://sustainableseas.noaa.gov as we continue exploration, research, education and public outreach in the Channel Islands National Marine Sanctuary.

Derek/Channel Islands National Park Expert - RE: **Stadium/CoreyWilson what convice you to come into these type of career?**
I have been interested in aquatic invironments since the age of 5 and have persued my interests since.

Derek/Channel Islands National Park Expert - RE: **Stadium/CoreyWilson what do you really want to study towards the future?**
I would like to work more closely with the management of the resources and cultivate the link between biology and resource management.

Claire/SSEChatHost - RE: **Wes Stadium HS Whats the name of your ship?**
We are currently using the NOAA ship McArthur to deploy the DeepWorker submersibles in the Channel Islands National Marine Sanctuary.

Derek/Channel Islands National Park Expert - RE: **lewis/cchs typically how often do la nina and el nino alternate and have you noticed changes in marine populations prior to the arrival of these events**
The long-term kelp forest monitoring project at Channel Island National Park began in 1982. Since then we have experience two major El Ninos and at least two other smaller ones. I believe two events that can be considered La Nina have occured since monitoring began. With 18 years of data and these two El Nino cycles we are just begining to observe trends that are associated with these events. It also appears that we may be able to predict some of the outcomes of strong events. It appears that several years following a major el nino, sea urchin population greatly increase inhibiting kelp growth....

Claire/SSEChatHost - Thank you for all of your great questions, we will be working to answer all of the questions that have already come through. Your participation has been greatly appreciated, but please hold any following questions. Thanks again and you are all welcome to join the mission team at Stearn's Wharf in Santa Barbara, CA on June 24th at the Channel Islands National Marine Sanctuary, National Geographic Society, and Sustainable Seas Expeditions Ocean Fest/ Open House. You will be able to have an opportunity to tour the NOAA ship McArthur and catch a glimpse of the real DeepWorker 2000 submersibles, as well as talk to submersible pilots about their research. Many members of the Marine Educators Regional Alliance (MERA) will have informational booths available as well for you to browse. Looking forward to seeing you!

Claire/SSEChatHost - RE: **Stadium/CoreyWilson How old were you when you first became intreasted into these work?**

I am from Hawaii and have been very interested in the marine environment from an early age. I got involved by becoming a volunteer for various marine related organizations, such as the Waikoloa Marine Life Fund, and the Santa Barbara Marine Mammal Center. In my opinion, perserverance is often the answer in becoming involved in the field of your dreams.

Derek/Channel Islands National Park Expert - RE: **JamesStadiumHS I have always wondered what it feels like while submerging under the ocean. Could you describe what it feels like to you?**
The feeling is truely wonderful. You feel weightless, calm, and your senses overwelmed. There is very little if no sound so it seems as if you are dreaming. Typically you feel a little cool and feel some pressure on your mask.

Wes Stadium HS - Thank you for your answers hard work and discoveries, this was an all out fun activity that you have invited us to work in... please send me any info or sites that you are currently running to my e-mail address @ Web85@juno.com Thank you for your time.

Claire/SSEChatHost - RE: **M Bridgan Stadium The live feed from the sub is scrambled.**
We apologize for the scramle of the live satelitte feed. Apparently, while we were feverishly typing answers to all of your questions the satellite truck had a small electrical fire that caused the satellite link to shut off for the last ten minutes of the program. Even with all the hard work and intensive planning, some things are out completely out of your control.

Derek/Channel Islands National Park Expert - RE: **Pedro/Univer sum Sci Museum Mexico Do "The niño" and "Niña" have affected the biological richness in that zone ?**
El Nino and La Nina greatly affect overall richness at the Channel Islands. The Channel Islands are unique in that they are in a area where they are the northern most limit for many of the southern species and the southern limit for many northern species. This is mainly due to the oceanographic patters that normally exist, this patters change during el nino and la nino conditions. So, during warm water years, warm water species recruit to the Islands and during cold water years cold water species recruit. Both increasing biodiversity.

Derek/Channel Islands National Park Expert - RE: **Stephanie/StadiumHS What got you interested in Marine Science? How many different job fields are out there in Marine Science? What kind of technology skills do you need? What is your depth? What kind of marine life have you been encountering out there so far? How many people do you have on the ship right now?**
I got interested in Marine science through my love for the ocean and water sports. There are 100's of jobs in the marine science fields. Field experience and understanding of computer, photographic, and GIS technology is a must. Our depth is 40 to 60 ft. Kelp forest species, mostly lobster, urchins, snails of various types and associated fish. There are 13 scientists and 10 crew members.

Claire/SSEChatHost - RE: **cypress with camp internet 1. Is the sea kalp growing from the holdfast to the canopy? 2. Could you see sharks and octopus under the ocean? 3. What does sea kelp look like when it's underwater? 4. Is it scary to see all kinds of sea animals underneath the canopy?**
The kelp is attached by a holdfast on the ocean floor and the canopy is growing up towards the surface. Did you know that kelp is the fastest growing plant in the world? Do you know that we use kelp everyday? That is if you brushed your teeth this morning, or had ice cream last night for dessert. When diving with kelp, it is a very magical experience and you feel as if you are in an underwater forest. I highly recommend diving in a kelp forest and experiencing all of the amazing marine animals and invertebrates you may see!

Claire/SSEChatHost - RE: **JulieCamarillo Great! At the Ocean fest/Open House you mentioned, will people be able to see the "DeepWorker" up close?**
Yes, at the Ocean Fest/Open House, a tour of the NOAA ship McArthur will be all you need in order to see the actual DeepWorker submeribles inperson. You may actually get a chance to talk with a scientist or educator pilot!

Claire/SSEChatHost - RE: **Wes Stadium HS How often do you have this experience and shar it with this audience... you should have thse more often.. and im not just saying it to have an interesting class for once! =O)**
This field season we are planning on having at least one live uplink at the three Sanctuaries that we are planning on exploring, Channel Islands, Monterey Bay and the Florida Keys National Marine Sanctuaries. Keep posted to the Sustainable Seas Expeditions Web site and you will find out when these live events are.

Claire/SSEChatHost - RE: **JonStadium Can you do this again soon in Commencement Bay in the Puget Sound, because i would like to see the bottom of the Puget Sound.**
Unfortanetly we will not be visiting the Olympic Coast National Marine Sanctuary this field season, so therefore we will not be doing a live uplink from Commencement Bay this year.

Trish/cchs - Thank you for this session it was very informative. see you in july!!!

Claire/SSEChatHost - RE: **Wes Stadium HS COuld you explain the time delay from my letter leaving here, and the time you recieve my note?**
When you type in question, it gets sent to a moderator, which in today's case is me. I quickly review the question and add it to the Web chat, assuming it is appropriate for the most part. That is where the delay comes in for you to see your question on your computer.

Claire/SSEChatHost - RE: **Stadium/Corey Wilson what would the range of the NOAA be? the price**
The DeepWorker 2000 submersibles would cost approximately half a million dollars without any additional equipment included. The manufacturers of the DeepWorkers are Nuytco Research Ltd. based out of North Vancouver, Canada.

Claire / SSEChatHost - RE: **David Stadium ¿How deep can your submarines go? ¿Are you taking any styrofoam cups with you, to shrink?**
The submersibles that the Sustainable Seas Expeditions are using can go to depths of 600 meters or 2,000 feet. No, we have not been taking down styrofoam cups, but they are sure neat and small when you see them come up from depths like 2,000 feet.

Claire / SSEChatHost - RE: **James / Stadium HS Did you get your basic training from the Navy? If so, how long is training and what was it like?**
Basic submersible pilot training was provided by the submersible contractor, Nuytco Research Ltd. in our case. Every DeepWorker 2000 pilot went through a one-week training course at the Monterey Bay Aquarium Research Institute's "tank farm". All pilots also went through various training courses to refresh their memories as well as learn about new systems that were added to the submersibles along the way.

Claire / SSEChatHost - RE: **AlainaStadiumHS What type of equipment do you use?**
The DeepWorker 2000 submersibles are oputfitted with a variety of different equipment. The pilots navigate using a compass, and Imaginex sonar. The subs we are using are outfitted with many varieties of high quality still and digital video cameras provided by the National Geographic Society, along with very bright lights that enable images to appear well in dimly lit areas in the ocean. The sub is also outfitted with a CTD, this unit tests Conductivity, Temperature and Depth. The CTD is fired approximately every 4 seconds to capture thsi information while a pilot is making a dive in the submersible.

Claire / SSEChatHost - RE: **Wes Stadium HS Whats the deepest you have ever dove in a submersable or otherwise**
Dr. Sylvia Earle has dove the deepest to date on the Sustainable Seas Expeditions project, her depth during the last dive of the Hawaiian Islands Humpback Whale National Marine Sanctuary mission was to 1,300 feet. She happened upon a pelagic octopus and was able to capture this rare species on videotape for about an hour of incredible footage.

Claire / SSEChatHost - RE: **Christina Stadium HS how big is it in there?**
The DeepWorker 2000 submersible can comfortably fit someone that does not exceed in a height of 6'2" and weighs no more than 250 pounds. The pilot sits in a very comfortable chair that is similiar to a type of chair you would find in an aircraft for a pilot. Your legs extend out into the leg tube, where you control the submersible with foot pedals, leaving your hands free to write down observations, work the manipulator arm and cameras and to run the computer and sonar if need be.

Claire / SSEChatHost - RE: **Alaina Stadium HS What kind of life do you see down there?**
I am not the diver down below right now, however I have been diving many times in the precise location that they are in. In the video it appears that they are seeing garibaldi, kelp forests, kelp fish, sea cucumbers, sea stars, and many, many other exciting species.

Claire / SSEChatHost - RE: **Alicia Stadium HS What kind of equipment do you have to use to take pictures of things you find under the ocean?**
Special cameras that have been pressure tested and can withstand depths of 2,00 feet are needed when diving the DeepWorker 2000 submersible. Very high-energy lights are necessary as well in order to capture things at depths in the ocean that light cannot get to. We are lucky that the cameras outfitted on the submersibles are provided by the National Geographic Society.

Claire / SSEChatHost - RE: **Jon Stadium this was very interesting watching you dive it kind of makes me wanna do this someday.**
I hope that we are doing will inspire many of you to want to dive and experience what the quiet ocean has to offer. We especially love divers who take pictures and only leave bubbles!

Claire / SSEChatHost - RE: **Wes Stadium HS i dont know if the last question go through because my computer had an error... But How long can One live inside of the deep sea worker?**
One can stay inside of a DeepWorker for approximately three days. But what happens when you have to go to the bathroom?

Claire / SSEChatHost - RE: **JonStadium what kind of technical skills do you need to do this kind of work?**
There are all kinds of different skills needed to be involved with a project such as the Sustainable Seas Expeditions (SSE). Of course we work with scientists who have backgrounds in a variety of different capacities. Educators are needed in SSE and other ocean-related projects, ship's crew members are essential in order to get the Expedition even off of land and into the water. Whatever your interest, there is most likely a way to tie it into getting involved with the world's oceans if that is what you choose.

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Sustainable Seas Expeditions Underwater Broadcast
Student Data Sheet

Directions: Place a check mark next to each fish or shark species observed. Record the number of each species observed.

Moray Eel  Numbers observed:	**Kelp Bass**  Numbers observed:	**Treefish**  Numbers observed:
California Sheephead (male)  Numbers observed:	**Garibaldi**  Numbers observed:	**Blacksmith**  Numbers observed:
CA Sheephead (Female)  Numbers observed:	**Black-eyed Goby** Numbers observed:  Numbers observed:	**Señorita**  Numbers observed:
Swell shark  Numbers observed:	**Other Species: (Draw picture)** Numbers observed:	**Other Species: (Draw picture)** Numbers observed:

Sustainable Seas Expeditions is a project of the National Geographic Society, funded by the Richard and Rhoda Goldman Fund in partnership with NOAA's National Marine Sanctuary program.

Sustainable Seas Expeditions Underwater Broadcast Student Data Sheet

Directions: Place a check mark next to each invertebrate species observed during the dive. Record the number and size of each species observed.

Phylum Mollusca  Abalone Species Name: Numbers observed:	**Phylum Mollusca**  Wavy top turban Species Name: Numbers observed	**Phylum Mollusca**  Giant Keyhole Limpet Species Name: Numbers observed
Phylum Echinodermata Sea Urchin Numbers observed Size:  Sea cucumber Species name: Numbers observed:	**Phylum Echinodermata**  Sea Urchin Species Name: Numbers observed Sizes:	**Phylum Echinodermata**  Seastar Species Name: Numbers observed
Phylum Arthropoda  Spiny lobster Species Name: Numbers observed:	**Phylum Cnidaria**  Sea Fan Species Name: Numbers Observed	**Phylum Cnidaria**  Sea Anemone Species Name: Numbers observed
Other Species: (Draw Picture) Species Name: Numbers observed:	**Other Species: (Draw Picture)** Species Name: Numbers observed:	**Other Species: (Draw Picture)** Species Name: Numbers observed:

Sustainable Seas Expeditions is a project of the National Geographic Society, funded by the Richard and Rhoda Goldman Fund in partnership with NOAA's National Marine Sanctuary program.

CINMS SSE Student Research Team Chat
Ventura and Oxnard, CA High School Students

Julie Goodson, CINMS SSE Educational Coordinator
Laura Francis, SSE Educational Coordinator

May 31, 2000

Thu Jun 1 13:09:07 2000

[**Laura/SSEeducation** - 1 - 14:44:50]
Welcome to the CINMS SSE Student Chat! Please enter your name and school when you send in a question to the chat.

[**Julie/CINMSeducation** - 3 - 14:48:22]
Welcome to today's chat session! Here is what we'd like to accomplish during the chat: 1. figure out what kind of information we want on the data sheets for CA sheephead and invertebrates like the Gorgonians 2. images/data from the sub we can use in our student summit conference presentation on June 24

[**Laura/SSEeducation** - 4 - 15:03:54]
Hello. Are there any students out there? If so, please let us know your name and school and ideas for what you would like us to look for during the DeepWorker Dives.

[**Nick** - 7 - 15:13:53]
My Name is Nick from Oxnard High School

[**Laura/SSEeducation** - 8 - 15:15:23]
Welcome Nick, Do you have some suggestions for what type of data we should collect from the DeepWorker Submersible to to help you present your student project at the June 24th summit conference?

[**Nick** - 9 - 15:15:44]
What type of information will you be looking for when you guys check out the tides

[**Nick** - 10 - 15:17:36]
no but we need to make charts to turn in to Mr. Flint

[**Laura/SSEeducation** - 11 - 15:20:37]
Nick, I am not sure exactly what type of information you are trying to find out about tides, can you make your question more specific? I do want to emphasize that the purpose of this chat is to discuss the student

project dives for SSE, so we would appreciate questions and ideas on that topic.

[**Nick** - 12 - 15:20:54]
sorry i mean the currents

[**Julie/CINMSeducation** - 14 - 15:22:11]
Nick, You guys are interested in the Gorgonian Sea fans right?

[**Julie/CINMSeducation** - 15 - 15:24:12]
Laura will be one of our pilots during the SSE Leg 1 and she will be collecting the data on CA sheepheads and invertebrates. She is looking for input from you all on the kind of information she should be recording.

[**Laura/SSEeducation** - 16 - 15:24:55]
Welcome Dorothy, do you have any thoughts or questions about what data you would be interested in having us collect related to the sutdent project dives. Just as a reminder to everyone - the student project dives are focussed on distribution, abundance and size of CA Sheephead, distribution of gorgonians, and comparing DeepWorker technology to that of the Conqfish1 underwater habitat. What we want to know from you is how you would design a data sheet to collect that information. What sort of questions would you ask and what sort of information would you like the DeepWorker Pilots to record on their dives?

[**Nick** - 17 - 15:25:36]
I need to know what information you are going to reserch on the habitat characterization for my chart

[**Dorothy** - 18 - 15:26:02]
got anything on rock fishies or squids??

[**Julie/CINMSeducation** - 20 - 15:26:47]
I think students are still getting out of class. More of them should be logging on soon.

[**Laura/SSEeducation** - 21 - 15:27:15]
RE: **[Shannon] Um, yeah. So what's goin on here?**
Shannon, Where are you from and what are some questions or ideas you have for the SSE Data sheet

[**Dorothy** - 22 - 15:27:44]
hi---i really need to make a chart about the data that you should be collecting...what exactly are you guys going to be doing...because i need to make a data table to fill in what you will collect

[**Julie/CINMSeducation** - 24 - 15:29:34]
Nick: For the habitat characterization, you will be interested in depth and location. also you will want video images to classify habitat types.

[**Laura/SSEeducation** - 25 - 15:30:50]
RE: [**Nick**] **I need to know what information you are going to reserch on the habitat characterization for my chart**
The types of things we are looking at in a habitat characterization are, biological components (algae, plants and animals), currents, water temperature, human uses, etc.

[**Shannon** - 26 - 15:31:39]
I'm from OHS, and I havent done my chart yet.. so I don't quite know what id ask

[**Dorothy** - 27 - 15:31:39]
we are making BLANK---read--no DATA--data tables to be filled out later...but we need the appropriate headings

[**matt/laura/katie** - 28 - 15:31:39]
we had a question concerning wheter we should include other types of fish on our data sheet...what if we don't see any sheepheads when we are reviewing the tapes..?

[**Laura/SSEeducation** - 29 - 15:33:54]
NOTE to all students. this chat room is being moderated so if your question does not appear, it is because it does not relate directly to the content of the chat.

[**Dorothy** - 30 - 15:34:53]
my partner, andrew, and myself are doing the two rockfish and the squid projects...please send me appropriate headings and categories, etc. so that the data table i make will best suit the data you will be collecting and need

[**Julie/CINMSeducation** - 31 - 15:35:09]
RE: [**Nick**] **I need to know what information you are going to reserch on the habitat characterization for my chart**
Oxnard students: the data sheets you all are creating should be contain all the components suggested today by the entire team. Laura and the other SSE pilots will use these during the dives. Therefore it will be important for you work up your draft data sheets by tomorrow and email them to us so we can use them.

[**matt/laura/katie** - 33 - 15:36:41]
data sheet questions we were thinking of involve number of sheephead in take vs. non-take zones...looking at the dive sites..we are not quite sure if these two specific areas will be observed or only looking in non-take zones (unless of course all of the sb channel is made into a non-take zone..saw this in todays LA times..)

[**Julie/CINMSeducation** - 34 - 15:37:11]
RE: [**matt/laura/katie**] **we had a question concerning wheter we should include other types of fish**

on our data sheet...what if we don't see any sheepheads when we are reviewing the tapes..?
you should include categories only on the data sheet. for instance the sheet should include species name, number, size behavior toward submersible etc.

[**Julie/CINMSeducation** - 36 - 15:38:17]
RE: [**Dorothy**] **my partner, andrew, and myself are doing the two rockfish and the squid projects...please send me appropriate headings and categories, etc. so that the data table i make will best suit the data you will be collecting and need**
The fish survey data sheet should contain information on species name, location, depth, size, number, comments, behavior etc.

[**Laura/SSEeducation** - 37 - 15:40:25]
RE: [**matt/laura/katie**] **data sheet questions we were thinking of involve number of sheephead in take vs. non-take zones...looking at the dive sites..we are not quite sure if these two specific areas will be observed or only looking in non-take zones (unless of course all of the sb channel is made into a non-take zone..saw this in todays LA times..)**
The Anacapa landing cove (one of our dive sites) is a no-take marine reserve out to 60 feet. THe other sites are open to fishing. It will be interesting to see if there is some spillover effect of fishes into the deeper water outside of the no-take reserve.

[**Julie/CINMSeducation** - 38 - 15:40:57]
to all students: Also think about the kind of information you want to collect for the student summit conference on June 24. We have access to video, overhead projector, and computers for a power point presentation. THis conference will be broadcast live on the GATV channel 20.

[**Wendy** - 40 - 15:41:42]
What does it mean to describe flow and hydrographic character of the coastal eddy in the western half of the Santa Barbara using TOWYO and ADCP.Describe flow and hydrographic character of the island pases.

[**Shannon** - 41 - 15:42:06]
Thank you for the email addresses, I appreciate it

[**Nick** - 43 - 15:43:17]
Hey guys, I got all the info I need some I'm outta here... thanks again, bye bye

[**Julie/CINMSeducation** - 45 - 15:45:49]
RE: [**Wendy**] **What does it mean to describe flow and hydrographic character of the coastal eddy in the western half of the Santa Barbara using TOWYO and ADCP.Describe flow and hydrographic character of the island pases.**
Researchers are interested in how the current patterns and water profile characteristics affect fish and invertebrate larval recruitment within the Santa Barbara Channel. By using the TOWYO and ADCP to

measure these parameters at different locations within the Santa Barbara Channel we can learn what water profile parameters and current patterns are during this time of the year.

[**Dorothy** - 46 - 15:46:45]
ok--i'm outa here--thanks...if i need anything else, i'll e-mail you---thank you very much for your time and effort. i appreciate it.

[**matt/laura/katie** - 48 - 15:47:20]
For our data sheet..we would like the deep sea divers to have four catagories to choose from...take and no-take zones.. and day and night...each of first two catagories would be broken up into number of sheep head(single, few, many and abundant), male and female, and sizes...the second catagories would be broken up the same as the first but would also include fish behaviors like resting, active, and feeding...does this sound reasonable or should we explain ourselves better?

[**Laura/SSEeducation** - 50 - 15:51:14]
RE: [**matt/laura/katie**] **For our data sheet..we would like the deep sea divers to have four catagories to choose from...take and no-take zones.. and day and night...each of first two catagories would be broken up into number of sheep head(single, few, many and abundant), male and female, and sizes...the second catagories would be broken up the same as the first but would also include fish behaviors like resting, active, and feeding...does this sound reasonable or should we explain ourselves better?**
Sounds like some good ideas. We are hoping to do both day and night dives and also dives inside and outside a reserve. When doing these missions, you always need ot have a good contingency plan in case of weather, etc. I would say that the sheephead numbers, size and and behaviours would be the high priority information to collect. I would also add depth information of where they are seen to the data sheet.

[**Shannon** - 51 - 15:51:26]
Julie... How does that affect those of us on land???

[**Julie/CINMSeducation** - 53 - 15:52:18]
RE: [**Shannon**] **Julie... How does that affect those of us on land???**
what is that? Are you referring to the wordy reply to the TOWYO and ADCP question?

[**Julie/CINMSeducation** - 54 - 15:54:37]
RE: [**Wendy**] **Thank You Julie**
Wendy, I should also add that they tie this information into plankton recruitment. Plankton recruitment is seasonal and is dependent on upwelling events (cold nutrient rich water rising to the surface)

[**Laura/SSEeducation** - 55 - 15:57:28]
Thanks for your interest in this chat and SSE. Based on your input to this chat, we will develop a data sheet and email it to you by the end of the week. If you are working on your own data sheets for extra

credit, we want to make sure that information gets incorporated in to the data sheet that we create, so please email that information to us by tomorrow.

[**Wendy** - 56 - 15:57:40]
Well, I have to go now thanks for youre help on The CINMS research questions.I really Appreaciate it

[**Julie/CINMSeducation** - 58 - 16:00:19]
Well Shannon, The information collected is important for us to gauge living resources in the Santa Barbara channel including rockfish, marine mammals, squid etc.

[**Shannon** - 60 - 16:01:18]
Sorry, I have to get going. Have to catch a ride home... good seeing all the information here. Thanks for your help, although I couldn't participate as much as I would have liked.

[**matt/laura/katie** - 61 - 16:13:36]
we need to go..thanks for the information and help..we will be sending you a rough draft data sheet tommorow in the morning..we can then make any suggested changes and send it back to you by three...please send responses to mr. marshall's email adress at ventura high school (mmarshall@venturahs.vtusd.k12.ca.us)

SUSTAINABLE SEAS EXPEDITIONS
VIDEO GALLERY

SITE INDEX

This page provides video and multimedia products produced during the Sustainable Seas Expeditions. These include special videos and video footage from live broadcasts. Some of these products are specifically planned; others are spontaneous offerings from mission participants. All products are offered in RealVideo and RealAudio format. Read about how to obtain this software by **clicking here**.

Sustainable Seas Expeditions

This video provides an overview of the five-year Sustainable Seas Expeditions. In it you will learn about our ocean resources; for example, the ocean covers three-quarters of the Earth and developed its current ecological balance over millions of years. You will also learn what the Sustainable Seas Expeditions hope to achieve through exploration and education. Produced by the National Geographic Society. (8.5 minutes)

The McARTHUR

Take an informal tour of the NOAA ship McARTHUR given by ship's captain Bill Sites. The tour walks you through the 175-foot oceanographic and fisheries research vessel, touching on many of its capabilities. The McARTHUR has a crew of 22 and can carry an additional 13 scientists. Take an inside look at the bridge, learn how the vessel is maneuvered, and see the navigational equipment. (8 minutes)

Interactive Tour of the Monterey Bay National Marine Sanctuary

This interactive tour of the Monterey Bay National Marine Sanctuary provides information on the sanctuary canyon, kelp forests, and a map and directions to the sanctuary. An extensive photo gallery offers images of invertebrates, fish, birds, mammals, and seaweeds that may be found in the sanctuary. Discover one or more of this site's hidden jewels: overflights of the sanctuary, a 360 degree view from the Monterey Bay Aquarium, and a virtual submersible dive into sanctuary waters. Produced by the National Geographic Society. (unlimited)

1998 Year of the Ocean Student Summit

The 1998 Year of the Ocean Student Summit with Dr. Sylvia Earle consisted of a group of 40 high school and middle school students who met on May 18, 1998. The summit was designed to help the students foster a questioning attitude and voice their concerns about the oceans and marine resources. As future scientists, leaders, and citizens, the students' concerns must be faced by the decision-makers of today. (16 minutes)

Monterey Bay Webcast

This May 18, 1999 webcast at the Monterey Bay National Marine Sanctuary discusses the Sustainable Seas Expeditions, the DeepWorker, and prickly shark ecology. Research Coordinator Andrew DeVogelaere provides a brief introduction, while shark experts Rick Starr and Gregg Cailliet discuss the secret lives of the prickly shark. (53 minutes)

Video	Audio Only
Fast connection (56k and above)	Fast connection (56k and above)
Slow connection (< 56k)	Slow connection (< 56k)

Channel Islands Webcast

This May 27, 1999 webcast at the Channel Islands National Marine Sanctuary discusses the Sustainable Seas Expeditions and the annual Great American Fish Count. Watch Laura Francis and Ed Cassano go underwater to conduct fish counts and learn about the interesting species they encounter. (46.5 minutes)

Video

Fast connection (56k and above)

Slow connection (< 56k)

1999 Education Highlights

1999 proved to have many exciting education events. This video highlights these events for April thru July of last year. See a sampling of what students were exposed to during these special events.

Video

Watch the video (28.8 k, 56k and faster connections)

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January 12, 2000
Student Scientists Join Hawai`i SSE

On Wednesday, January 12, approximately 140 students had the opportunity to participate in topside research. Students from O`ahu, Kaua`i, and the Big Island were flown into Maui to participate with Maui students. The students were tasked with collecting data on whale sightings and water quality within sanctuary waters. The data they collected will be included with data gathered during DeepWorker missions.

*The entries below are from students who write for **GAMEKIDS**, an online a gathering place for kids of all ages to learn and exchange non-computer games and activities. Read on as these student editors report on their day at sea.*

Students at the water quality station collect a water sample to measure its pH and temperature.

Kimberly B., Senior
Baldwin High School, Maui

Three different boats, donated by Trilogy, Pacific Whale Foundation, and Club Lanai, carried students to gather critical information on the sustainability and health of the ocean.

While at sea, each boat had six different experiment stations, so that each boat could perform more than one successful experiment. The six stations were: whale spotters and fluke identification, plankton tows, water quality, visibility, navigation, and hydrophones.

Plankton tows helped to identify which areas had the most plankton. Plankton, as tiny as they are, make up the base of the food chain and are eaten by sea animals big and small, ending with the largest whales. The areas where plankton life is most abundant are considered to be "the pastures of the seas." The students collected plankton by

dropping a cup in a net into the ocean. This experiment was successful. Because phytoplankton live in ocean water only as deep as the sunlight can reach, shallow depths sustain the most plankton life. The students towed the net that contained the cup of seawater back onto the deck to be analyzed under a magnifying glass. It was then that the availability of plankton life in that area was determined. Data were recorded onto their observation logs. Their sample of sea water was poured into a bag labeled by station, boat, depth etc. Information such as location, depth, temperature, and density of plankton over the large area covered by the three boats will help increase our knowledge of the local humpback whale habitat. The data from each station, from each boat will be analyzed, and the information used to determine the sustainability and health of our living seas.

Students examine a water sample for the presence of plankton.

Gabriella W., Freshman
King Kekaulike High School, Maui

"A spout at 2 o'clock or a breach at 9 o'clock!" was all we heard all day. We saw over twenty whales near and far. But by far the most exciting was when a whale calf came and swam right next to our boat. It was underwater and only a turquoise color but our boat crew filled with excitement. From this experience we were able to learn that calves are very curious and like to look at the boats. Calves can only hold their breath for seven minutes and so we were expecting this calf to come up at any moment. We were also able to use the hydrophone to see if the whale was still close. From our continuous watching, we were able to observe that no two females travel together except for the baby girl and mother. We also learned that mothers and babies usually travel with a male escort.

Erin H., Freshman
King Kekaulike High School, Maui

At one experiment station, we looked at ocean visibility. First we dropped a black and white-colored, round disc called a Secchi disk into the water. The disc had weights attached to the bottom to keep the disc underwater. It was held up by a rope marked with blue lines in one meter increments. We dropped the disc as far down in the water as possible. The marked lines told us how far the disc had gone down underwater while still in our sight. The water off of Lahaina, Maui is very clear so the disc went down deep until we weren't able to see it anymore. This experiment is one that could definitely have different answers. When done at different times it would produce different results. Also, if we conducted this experiment in other places in the world we might not be able to see the disc so far down due to pollution or sunlight and other natural causes. This could be a sign that Hawaii has pretty clear, clean waters.

Brittany M., Freshman
King Kekaulike High School, Maui

Students and teachers watch for more whale spouts and breaches.

We went along for awhile looking for whales. Then they began to appear in all directions. We had a great experience when a baby calf appeared right next to our boat. We put an underwater microphone called a hydrophone into the water. The hydrophone detects sounds and songs that the humpback whales and other marine life make. The hydrophone can pick up sounds that come from up to two to three miles away. Since there were whales all around us, the we could not tell exactly which direction the sound was coming from or if it was even coming from the same pod (group of whales). My job was to listen for patterns in the sounds. I found a pattern made by a whale. It was two high sounds followed by three deep, low sounds. We had a great day with the whales and heard all kinds of sounds with the hydrophone.

Chasity B., Freshman
Baldwin High School, Maui

Today, it was neat to see how satellites can pinpoint exactly where we are. We used a global positioning system (GPS) that relies on satellites to determine our latitude and longitude.

At the first stop, our location was north 20 degrees, 51.831 minutes and west 156 degrees, 59.043 minutes. As we approached our next stop, we were north 20 degrees, 50.9 minutes and west 156 degrees and 43.3 minutes. At our third stop, we were north 20 degrees, 51.7 minutes and west 156 degrees, 43.7 minutes.

(top) RETURN

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EXPEDITION UPDATE

January 10 - 25, 2000

The Hawaiian Islands Humpback Whale National Marine Sanctuary recognizes the rich markings of the Hawaiian language and has made every effort to include them here. However, certain computer incompatibilities have prevented all grammatical markings from appearing. The sanctuary will continue to remain culturally sensitive to the language and include these markings whenever possible.

The Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) Sustainable Seas Expedition (SSE) is designed to increase public awareness of the Hawai`i sanctuary, educate the public about humpback whales and their habitat, and document the habitat's characteristics. The first leg (Jan. 10-14) will focus on practicing shipboard procedures. The second leg (Jan. 15-19) will focus on conducting reconnaissance tasks within the sanctuary. Several public and student educational events will occur between Jan. 20-25.

The mission will use two ships: the NOAA ship Ka'imimoana; and the American Islander owned by the American Marine Corporation (**American Divers**). Each ship will be equipped with a fully functional submersible tracking and navigation system.

Jan 10-11 Aloha and welcome to the HIHWNMS. Last night the SSE team traveled from Honolulu to Maui aboard the Ka'imimoana. This morning we woke to find ourselves with Lana`i on one

LOG

January 10 Welcome from Hawai`i

January 12 Student Scientists

January 13 Student Visits

January 14 Atlantis Adventures

January 15 Maui Open House

January 16 Coral Research

January 17 Feeding Ecology

January 18 Research Activities

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side, Maui the other, Moloka`i behind us, and the sun rising over Haleakala.... absolutely beautiful. Jan 10 and 11 will be devoted to checkout dives for the scientists. **Read the welcome** from the state of Hawai`i.

The NOAA Ship Ka`imimoana off Maui at sunset on Jan. 11.

Jan 12

The Trilogy V carries high school students as they conduct whale research.

One hundred and forty students, from high schools on O`ahu, Kaua`i, Maui and the Big Island, boarded three whale watch cruise boats (generously donated by Trilogy, Club Lana`i, and the Pacific Whale Foundation) to participate in whale counts, record whale behaviors, take fluke identification pictures and analyze whale songs through the use of hydrophones. Scientists' checkout dives continue on the Ka`imimoana and American Islander. **Read their mission log**.

Jan 13 We woke up this morning to the most beautiful sunrise over Haleakala (House of the Sun) mountain. While three dives were conducted off the American Islander, the Ka`imimoana was host to 15 high school students who observed the first recovery of the DeepWorker. **Read**

High school students aboard NOAA Ship Ka`imimoana.

January 19 Commander Wright

January 22 Waikïkï Aquarium

January 23 Family Ocean Fair

January 26 Mahalo

about it.

(top)

Jan 14 Another successful morning with the Ka`imimoana media day. Reporters interviewed Sylvia Earle, NOAA's Sally Yozell, sanctuary manager Allen Tom, and other project team members to gain insight about the goals and objectives of SSE in Hawai`i. Highlights include a DeepWorker launch and recovery demonstration, and a radio interview hosted by Sanctuary Advisory Council member Charlie Maxwell with the SSE team. Conditions provided a pleasant opportunity for students to participate in an Atlantis Adventures submarine rendezvous with the DeepWorker. **Read a first-hand report of the Atlantis adventure.**

Jan 15 Strong winds kept the Ka`imimoana and American Islander working off west Maui, just offshore from Olowalu. Sylvia Earle and Univ. of Hawai`i Oceanographer Rick Grigg completed two successful dives in the morning. Two more dives were completed in the afternoon by sanctuary research coordinator, Steve Gittings and Grigg. Back on shore, approximately 700 visitors and local residents attended "E Komo Mai" at the Sanctuary's Headquarters in Kihei, Maui. Be sure to **read a complete report on the Open House.**

Jan 16

Many coral communities are found within sanctuary waters

We completed four extensive dives in the Lahaina Roads area off west Maui today. Lahaina Roads is a shallow depression approx. 2 miles west of Lahaina. The area is characterized by 3 distinct communities: a black coral forest -- harvested to minimum size years ago -- but currently

flourishing along steep walls, halimeda meadows, and bryozoan fields lining the bottom. **Read the misson log**.

Jan 17 The winds and bottom currents picked up today forcing us to reschedule the morning dives. We repositioned ourselves in the lee of Lana`i where Sylvis Earle took the submersible to approx. 150 feet in the vicinity of Palaoa Point. Two night dives by Sylvia Earle and Steve Gittings were also completed, bringing the total number of successful dives for the Hawai`i mission to twenty. **Do whales eat in Hawai`i? Read the mission log.**

Jan 18 We completed four dives off Lana`i at a site we affectionately call "The Wall." The Wall is by far the most dramatic site vsited during the expeditions. This rugged, unstable, vertical wall is over 100 feet tall with small caves, overhangs, pinnacles, crevices and loose rocks that appear ready to tumble at the slighest touch. Sanctuary program science coordinator, Steve Gittings, sums up the Hawai`i SSE research activities in **today's mission log.**

Steve Gittings reviews the video footage from his dive.

(top)

Jan 19

Sylvia Earle and Kip Evans broke an expedition record today, taking DeepWorkers to 1,300 feet. Along the way they spotted a six-foot long

The NOAA Ship Ka`imimoana heads off in the setting sun.

octopus. These two early morning dives wrapped up the at-sea portion of the Hawai`i mission. A **concluding log entry** was written by Ka`imimoana Commander Tim Wright.

Jan 22 The Waikïkï Aquarium co-hosted a SSE celebration in Honolulu. Read about it in **today's mission log**.

Jan 23 The National Marine Sanctuary Family Ocean Fair was held at the King Kamehameha's Beach Hotel in Kailua-Kona, Hawai`i. Jean Souza, Family Ocean Fair Coordinator, shares her thoughts in **today's log**.

Many children enjoyed the Family Ocean Fair.

Jan 25 The final education event of the expedition was held today. View an archive of the **Web broadcast**.

Jan 26 As SSE Hawai`i comes to a close, Claire Cappelle, mission coordinator, shares her thoughts about its many successes, and extends her thanks to all those who made this dream into such an amazing reality in **today's log**.

-Claire Cappelle, Expedition Log Editor

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Interview

Interview with Allen Tom, Manager
Hawaiian Islands Humpback Whale National Marine Sanctuary
December 1999

If you would like to email Allen Tom a question, please click here.

What does the Sustainable Seas Expedition mean to the sanctuary?

Allen Tom, manager of the sanctuary, greets guests at the inauguration ceremony. Special guest, Sylvia Earle, stands to Allen's right.

This is an exciting time, not only for the National Marine Sanctuary Program, but for anyone who loves, or even has a vague interest in, the ocean. In Hawai`i, our ocean -- and I use the word "our " with the greatest respect -- is vital to our everyday lives. Perhaps nowhere on Earth, more so than in island communities, do we have such a linkage with the waters that surround our world. The ocean is part of our heritage, our livelihood and most certainly, our future. Almost everything we do in Hawai`i today revolves around a healthy marine ecosystem -- from tourism to commerical uses, from research to education. Yet how much do we really know about what goes on in this mysterious ecosystem? New islands are being created just off the coast of the Big Island, and previously unknown marine animals, such as the megamouth shark

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caught off of the North Shore of Hawai`i, still wait to be discovered.

The National Geographic Society's Sustainable Seas Expedition, led by the unsinkable Dr. Sylvia Earle, will help focus the world's attention and interest on my home's unique marine ecosystems. Hopefully, it will serve to highlight some of the fascinating marine research that is already under way here. And, like all good research projects, it will not only generate more questions, but is likely to inspire a few young local students to become marine biologists or even a sanctuary manager. Bringing the SSE to Hawai`i is part of what the national marine sanctuary is all about -- facilitating resources from the mainland and elsewhere, and for a two - or three - week window, -- having the spotlight shine on Hawai`i.

Because the oceans are so vast, we have limited our scope of work to the waters just off of Maui, an area renowned for the highest concentration of humpback whales in the state. This is not to say that other areas around Hawai`i are not worthy of exploration. Indeed, Dr. Earle intends to come back to Hawai`i with her deep divers to visit a number of different places, all within the boundaries of the Hawaiian Islands Humpback Whale National Marine Sanctuary. These locations will include waters off of Hawai`i, Maui County, O`ahu and Kaua`i.

So, to return to the question: "What does the SSE mean to Hawai`i?" it certainly means potentially new research findings, new answers to age-old questions about the ocean, new questions that we never thought of asking, and new interest and enthusiasm for our marine world. In all, the possibilities are endless!

(top)

What does your job as manager of the Hawai`i Sanctuary involve?

My job as a marine sanctuary manager is to keep everything running on time, within budget and without getting too many people upset. This includes managing three sanctuary offices: one on Kaua`i, one on O`ahu, and the headquarters operation on Maui. It includes overseeing seven full and part-time employees, and answering dozens of daily inquiries about humpback whales. And if I'm lucky, I get to visit with some of the whale researchers in Hawai`i and learn about their latest findings.

How does one become a marine sanctuary manager?

I never set out to become a sanctuary manager, it just happened. Initially, I served as the on-site liaison for the sanctuary while it

went through its designation process. I was the contact person when the sanctuary went through its public hearing phase on whether there should even be a National Marine Sanctuary in Hawai`i. I can tell you that those were some of the most exciting, controversial and nerve-wracking years of my life! Later, when the sanctuary was finally approved by Governor Benjamin J. Cayetano and Dr. James Baker of NOAA, I was selected as its first manager.

My goal for the job is simple. The sanctuary needs to be a true partner in protection with all state, federal and community groups concerned about the humpback whale and its Hawaiian marine habitat. The people of Hawai`i should consider themselves very fortunate to have a national marine sanctuary on their front porch; there are only 12 of them throughout the entire United States and its territories.

(top)

One of manager Allen Tom's favorite activities is working with sanctuary volunteers. The volunteer corps at the sanctuary is rich, and enables the office to carry out many tasks it otherwise couldn't conduct.

What is so special about this sanctuary?

Being the only national marine sanctuary that is dedicated specifically to the protection of the humpback whale and its marine habitat, ours is a task that we at the Hawaiian Islands Humpback Whale National Marine Sanctuary program do not take lightly. There are so many questions about these magnificent animals that we still have yet to answer. Along with these new discoveries will come more questions. Some of the basic questions are just now beginning to be answered, such as, how many humpbacks are in Hawai`i at any one time? (The answer is as many as 6,000). Is the population recovering? (We believe there may be as much as 7% population growth each year.) What is the calf mortality rate, or in other words, are the calves making it back to Hawai`i year after year? How does acoustic testing affect an animal that uses sounds and songs in its mating riturals? What is the connection between native Hawaiian cultural beliefs and humpback whales? The list goes on and on.

The sanctuary itself is roughly 1,400 square nautical miles, which includes about 80% state waters. Regulations prohibit anyone from approaching a humpback whale within 100 yards, and the penalties within the sanctuary are much higher if you are caught in violation of these rules. Some of the major gathering grounds for humpback whales are found within the sanctuary boundaries. These areas include Penguin Banks off of Moloka`i, the area between Lahaina and Maalaea Bay off Maui, the Kohala coastline off of Kona, and the northern coast of Kaua`i.

Like our sister sanctuary in American Samoa, we produce a number of bilingual educational materials (in our case, in both English and Hawaiian). You can view some of these items by clicking here.

What is the desired outcome of the SSE ?

I know that we are going to have a great expedition. Maybe the weather will not cooperate, we might not see any whales up close, or maybe the submersibles won't even get deployed. However, we have already attracted attention to the plight of our marine environment, and received a number of sponsorships from a variety of groups, including Trilogy Excursions, the Pacific Whale Foundation, Atlantis Submarines, the Waikiki Aquarium, the King Kamehameha Hotel, and Kidscience Television. These groups will either be hosting an open house event or providing a free student whale watch during the SSE. The interest has generated news articles and new books from the National Geographic Society about the National Marine Sanctuary Program. Local students and teachers have attended special training sessions on SSE. Interest and excitement about the SSE is growing. On a selfish note, I would like everyone, worldwide, to see how special, beautiful and unique Hawai`i is. The islands are more than a vacation destination. We have some of the most unique environmental ecosystems in the world, and I want others to become as excited about our marine environment as I am. The SSE can open up new worlds for students and others, regardless of where they live.

(top) **RETURN**

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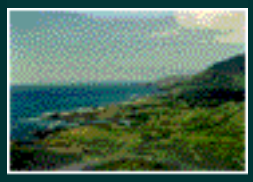
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The Natural Setting of the Humpback Whales

David Tarnas
Principle Consultant, Marine and Coastal Solutions, Inc.
Former State Representative and Chair of the House Committee on Ocean Recreation and Marine Resources, State of Hawaii

David Tarnas

The warm, sun-splashed waters of the Hawaiian Islands are the annual destination for many creatures seeking to escape the cold winter weather in the northern latitudes. Among them, the humpback whales' annual migration is one of the most impressive. These majestic sea creatures make their long voyage south to the Hawaiian Islands from the rich feeding grounds of Alaskan waters. These gentle giants arrive after the long trek to spend several months in the shallow island waters.

The first to arrive are usually the young single males, who sometimes travel alone or in small groups. The mothers, yearlings and bulls show up soon after. Sometimes, the first sightings of the humpbacks are off Kaua`i on the northwestern end of the main Hawaiian Islands chain. In other years, the first sightings are in the waters around Maui or off Kohala on Hawai`i Island. The whales are found in Hawaiian waters throughout the winter-spring season, with peak abundance occurring approximately between mid-February and mid-March.

When they are here in the islands, the whales travel at a much slower pace, keeping a more sedentary lifestyle in the shallow waters around the islands. While the whales do not appear to feed here, they meet to breed, give birth to the season's new calves, and nurse the young until they are strong enough to make the long

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trip back north.

The Humpback Whales in Hawai`i

Take a deep breath. Think of the sea.
Take a deep breath. Dive deep.

Watch the living colors of the coral reef swim and swirl.
Yellow, green, and red - a rainbow of fish and corals,
Teeming with life at the edge of the blue depths.

Listen to the whirl and wash of the water,
And the crackles and rattles of the shore.

The humpback whale sings long and deep with
Low bellows and high trills in a tapestry of sound.

Swim back to shore with strong steady strokes
Walk out of the sea on a fine white sand beach.

Gentle warm breezes heavy with
The smell of the sea.

We are surrounded by Nature, blessed by the sea and island life.

This is Hawai`i.
Aloha.

The whales swim alone or in groups in coastal waters and shallow offshore banks with their telltale spouts spraying into the air. As the pods of humpbacks cruise along the Kohala coast of Hawaii Island, they can be seen from shore. Their spouts and fin profiles indicate the number and size of the whales in a pod. Sometimes, the pod stops cruising and congregate in one area as a group, then several whales will swim around underwater. Sometimes the whales will swim quickly to the surface and heave their heavy bodies out of the ocean water in a spectacular display.

(top)

When a whale pushes itself high enough for its eye to break the sea surface, it's called "spy-hopping." From above the sea surface, they can see much farther. There are even times when the whale will slap its fins on the sea surface, splashing waves. They will slap their tails, making a big wave and a blast of sound. The grand performance is when a whale breaches, or pushes its body almost fully out of the water, before it is pulled down by gravity and comes crashing to the sea in a thunderous splash and spray of water.

Underwater, the whales move at a slow, ponderous pace -- as graceful giants in their Hawaiian ocean realm. The fluid movements of the whales' massive bodies remind one of a slow-motion ballet.

They are so huge, yet only a few strokes of their gargantuan tails move them along quite efficiently. The fins work like wings, and the humpbacks are very deft at turning and swimming with great precision and strength.

To look directly into the eye of a humpback whale is a strong realization that this is a creature that is very aware of itself. Surely, Hawai`i must be very special to this creature that returns year after year. On the Kawaihae coast of Hawai`i Island, an ancient and powerful temple was built on the Hill of the Whale, known as the *"Puu Kohola."* The *kohola* is a very potent *aumakua,* or guardian spirit.

The waters off the Ka Iwi coast on the east side of Oahu are part of the Hawaiian Islands Humpback Whale National Marine Sanctuary. This area is one of the prime whale watching spots on O`ahu.

The warm and shallow waters of the Hawaiian Islands provide important habitat for the humpback whales. Most of the whales spend their time in the shallow waters less than 40 fathoms (240 feet) deep. Cow-calf pairs are usually found in even shallower waters along the coastline, often separate from other whale groups. These coastal waters also are home to coral reefs and rocky-bottom ecosystems. Only as they swim from island to island are the whales seen in the deeper interisland channels. Most whales are found in areas with expansive banks of flat, sandy bottoms, such as Penguin Banks; the underwater plateau formed by the four islands of Maui, Moloka`i, Lana`i and Kaho`olawe; some areas off Kaua`i; and some areas off the northern Kona and Kohala coast of Hawai`i Island. All of these areas are included in the sanctuary.

When the whales arrive, the Hawaiian waters are once again filled with the rich melodies and overtones of the humpbacks' songs that create a tapestry of sound traveling for miles underwater. The singers seem to prefer the flat, sandy bottoms for enhancing sound transmission. While whales usually sing alone, sometimes group singing does occur.

The Hawaiian Islands Humpback Whale National Marine Sanctuary was created to protect the humpback whale and its habitat within the sanctuary. The habitat is basically the marine environment of

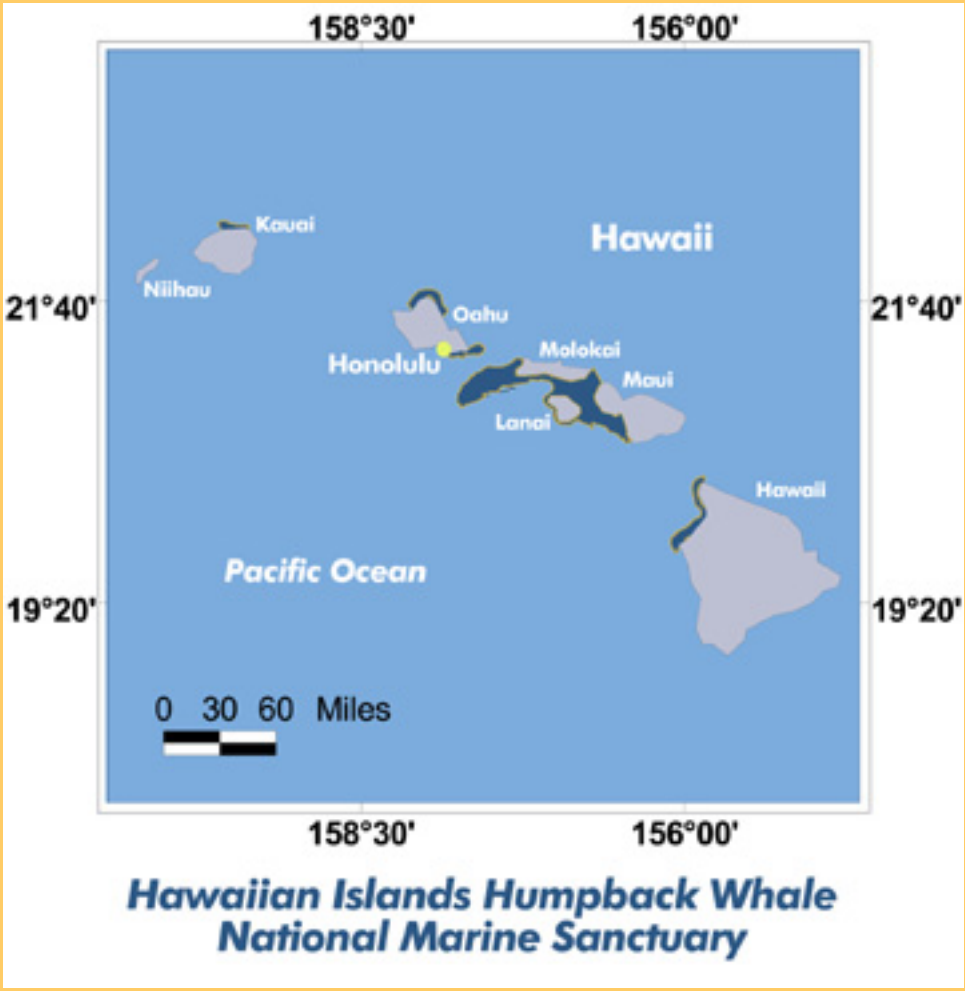
the waters around the coasts and offshore banks. This includes the area from the high water mark to the 100-fathom (600 feet) depth around the islands of Maui, Moloka`i, and Lana`i; the Penguin Banks; the Pailolo Channel; the northwestern part of Hawai`i Island; and portions of the coastal waters off Oahu and Kaua`i.

Hawai`i is a lovely chain of islands rising from the middle of Earth's greatest ocean. The Hawaiian Islands Humpback Whale National Marine Sanctuary has helped sustain this place for the visiting humpback whales who have returned year after year. We are doing our part to sustain the humpback's habitat so that the species will continue to thrive and rebuild its population to healthy levels.

(top) **RETURN**

Maps

The Sanctuary



Congress, in consultation with the State of Hawaii, designated the Hawaiian Islands Humpback Whale National Marine Sanctuary on November 4, 1992. The Hawaiian Islands National Marine Sanctuary Act identified the following purposes for the Sanctuary: to protect humpback whales and their habitat within the Sanctuary; to educate and interpret for the public the relationship of humpback whales and the Hawaiian Islands marine environment; to manage

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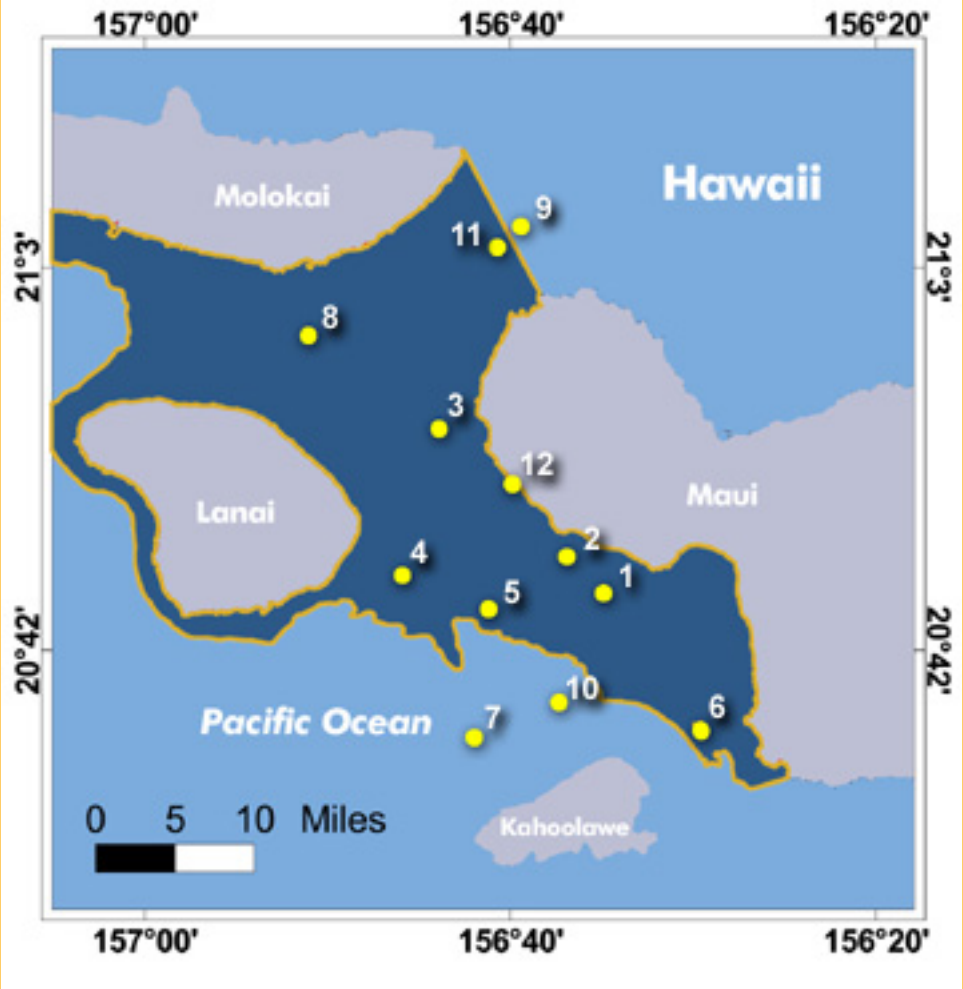
human uses of the Sanctuary consistent with the Hawaiian Islands National Marine Sanctuary Act and the National Marine Sanctuary Act; and to provide for the identification of marine resources and ecosystems of national significance for possible inclusion in the Sanctuary.

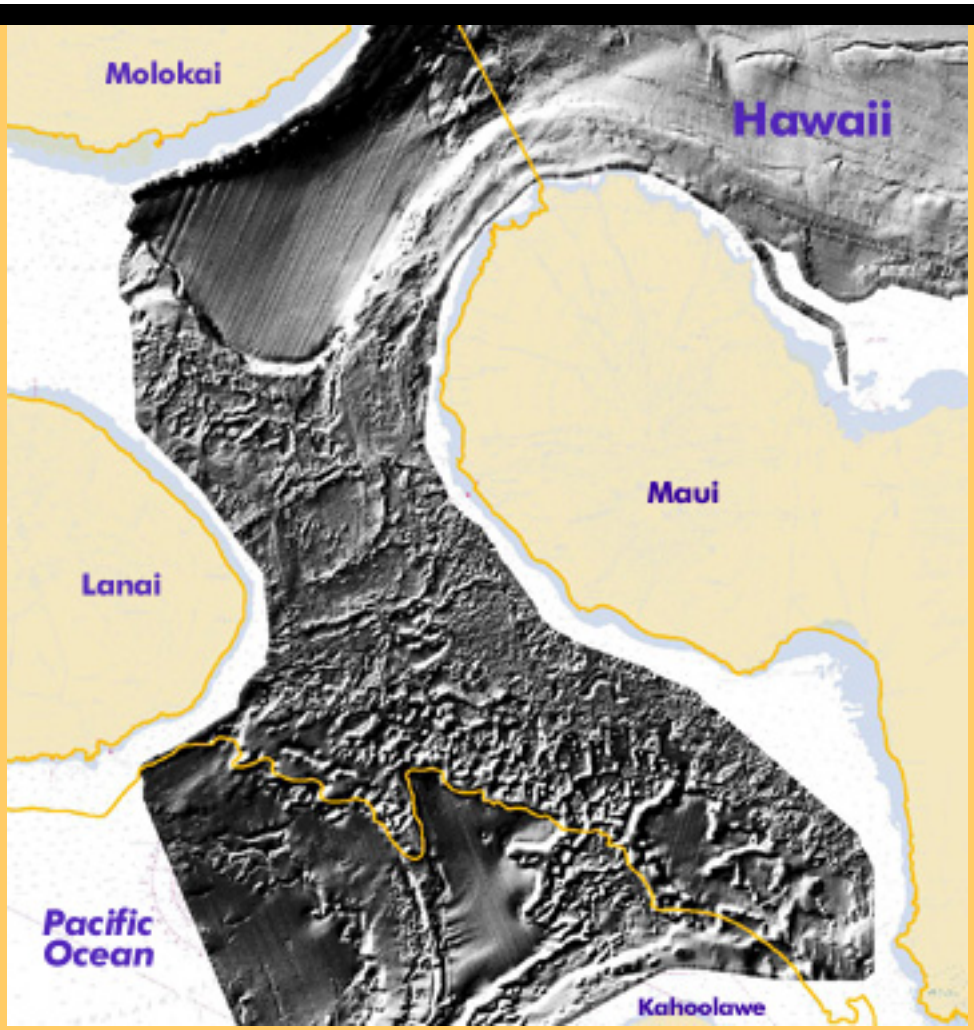
Today the waters around the main Hawaiian Islands of Kaua`i, O`ahu, Hawai`i, Maui, Moloka`i, Lana`i, and Kaho`olawe constitute one of the world's most important North Pacific humpback whale (*Megaptera novaeangliae*) habitats and the only place in the U.S. where humpbacks reproduce. Scientists estimate that two-thirds of the entire North Pacific humpback whale population migrate to Hawaiian waters for breeding, calving and nursing activities.

(top)

The Mission



The numbers above represent potential dive locations for the Sustainable Seas team. Sea state, technical challenges, and project priorities will determine if and when these target sites are visited. The expedition team will be conducting site characterizations at most locations. Several bottom features are worth noting: 6 - Molokini crater, 7 - North-South ridge, 8 - Rocky headlands, 10 - suspected fossil reefs, and 11 - Pinnacle 88. The Ka'imimoana will rendezvous with the Atlantis submarine at target site 12.



A closer look at the contours of the ocean floor surrounding Hawaii reveals a sharp drop-off very near the shore, not surprising for these volcanic islands in the middle of the Pacific. The sanctuary boundary, indicated by the yellow line, extends to a depth of 600 feet. (The bottom features were generated by simulating sunlight from the northwest at an azimuth of 45 degrees.)

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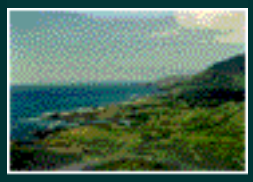
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Whale Research in Hawai`i: An Historical Overview

Joe Mobley, PhD., Professor of Psychology
University of Hawai`i - West O`ahu

Dr. Joe Mobley

This year's arrival of the Sustainable Seas Expedition in the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) marks more than 20 years of research on the humpback whales of Hawai`i. I thought it would be useful to go back in time and look at some of the people and the methods we have used over the years.

Each year around December-January, thousands of humpback whales and dozens of whale researchers return to the major Hawaiian Islands to carry out their business. For the humpbacks, this means calving and mating, and for the researchers, it means watching humpbacks do what they do. Personally, I think the researchers are nearly as interesting as the humpbacks.

One of the interesting things about the whale research field is its high retention rate; that is, most of the scientists who were working 20 years ago during my first field season are still around. The allure of the field is quite strong for anyone who appreciates science and nature. Our research permits, issued by federal and state governments, allow us to approach the whales more closely than the 100-yd limit imposed by law. As a result, we often find ourselves in the midst of these awesome animals, which remain nearly as mysterious as they were two decades ago.

I have been researching humpback whales in the waters of what are now the Hawaiian Islands Humpback Whale National Marine

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Sanctuary since 1978, when I arrived as a graduate student at the University of Hawai`i-Manoa. Whale research was quite a new enterprise at that time.

A humpback whale hurling its gargantuan body into the air exhibits a spectacular behavior known as breaching.

The Kewalo Basin Marine Mammal Laboratory (KBMML) of the University of Hawai`i, under the direction of Dr. Louis Herman, has been a major presence in humpback research since its first field season in 1976. Since that time, the lab has made major contributions to our understanding of humpback whale behavior, and has launched the careers of a host of whale scientists. One of those young scientists was Scott Baker, now a Professor of Biology at the University of Auckland in New Zealand. During those early years, Scott was one of the first to outline the patterns of aggressive behavior of humpbacks, previously characterized as "gentle giants." Scott has gone on to become a principal contributor in the application of genetics to our understanding of whale behavior and distribution throughout the world.

(top)

Around that same time, a young researcher named Debra Glockner (now Debra Ferrari) was starting her own research program, focusing on cows and calves and their behavior. I remember attending a marine mammal conference where she showed her underwater slides to her colleagues for the first time. People were stunned at the clarity and detail of her images, and all the more amazed by the fact that this petite woman could approach these giants with such confidence and obtain such spectacular results. She and her husband, Mark Ferrari, are still carrying on the research she started 24 years ago. To track individual whales, they rely primarily on photographs of the black-and-white ventral surfaces of their flukes (or "fluke ID" shots), as well as underwater video and still photos.

Also during the winter of 1978, two young scientists, Peter Tyack and Jim Darling, were commencing their graduate studies of humpbacks in the waters off west Maui. Peter Tyack was focusing on "singers," typically lone male humpbacks who produce the long,

complex "songs" for which the humpbacks are famous. We still are not totally clear on the function of whale's song, but Peter's work was an important beginning. Peter, now Chief Scientist at the Woods Hole Oceanographic Institution, remains interested in the acoustic behavior of whales and is a major figure in the field of marine mammal bioacoustics. Jim Darling, still an active contributor to the field, was concentrating on the relatively new technique of identifying individual humpback whales by photographing the unique black-and-white colorations on the ventral surface of their "flukes" or tails. This technique remains a staple feature of most programs of humpback research.

A "fluke ID shot" of a humpback whale. Researchers identify individual whales by the distinctive black-and-white markings on the ventral surface of their tails.

Obtaining fluke identification photographs, as we call them, allows us to track individuals as they move from pod to pod within a given season, or as they move from their summer feeding grounds in Alaskan waters to the wintering grounds of Hawai`i and elsewhere. This often requires us to approach well within the 100-yd limit to gain the detailed images required for identification. Often, tourists watching from commercial whale watching boats view such approaches as needless harassment, but this technique is a far cry better than the traditional techniques for tracking animals, which often require anesthetization, capture and tagging. Since nature was obliging enough to provide each humpback with unique coloration patterns, any harassment involved in identifying them is relatively minor and of short duration.

Fluke photographs can also tell us something about population size. The rate at which individuals are resighted through the years can be applied to "mark and recapture" models developed for estimating animal populations. John Calambokidis of Cascadia Research in Olympia, Washington, recently pooled hundreds of identification photos obtained from whale researchers working throughout the North Pacific. His results produced an estimate of around 15,000 humpback whales in the North Pacific, which suggests that the population has nearly fully recovered from the decimation of 20th-century whaling.

(top)

Aerial surveys of the Hawaiian humpback population were first performed by Dr. Louis Herman of KBMML in 1976. When I used the same aerial survey method in 1990, I was able to compare our data with those of the earlier series and infer that the population was increasing at that time. More recent surveys (1993-98), using modern distance-sampling techniques, have further supported these findings, suggesting that the population is increasing at a rate of 7% per year.

Another important technique from the "early years" of whale research is shore-station observation, which we still use today. Watching whales from elevated shore-stations allows us to observe their natural, undisturbed behavior. Additionally, through the use of surveyor instruments called theodolites, we can plot the movements of boats and whales and derive relatively precise speeds and directions of travel. Using these methods, we have been able to quantify changes in the whales' behaviors in response to such stimuli as boats and underwater sounds. Thus, we are better prepared to make informed decisions about what kinds of things disturb the whales, and which whale behaviors are particularly sensitive indicators of disturbance.

Female humpbacks are very nurturing mothers. They stay in close contact with their young (calf in foreground) while on the breeding grounds.

Now, more than 20 years later, our research programs still rely on the tried-and-true methods of past years. Nevertheless, we have much to gain by exploring new ways of answering questions. The recent establishment of the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) has helped us immensely by attracting new resources such as those of the Sustainable Seas Expeditions (SSE). The SSE, with its submersible DeepWorker and well equipped support vessel, represent the potential for new approaches to better understanding this enigmatic species. SSE research in Hawai`i during the 2000 field season will focus on better defining the acoustic characteristics of the humpbacks' habitat. The DeepWorker and its support vessel will perform "CDT" casts designed to obtain information on current, depth and temperature. These data will be incorporated into existing GIS data bases for the Hawaiian Islands so that the acoustic properties of the sanctuary waters can be characterized

more precisely.

Additionally, two leaders in the bioacoustics field, Dr. Whitlow Au of the Hawai`i Institute of Marine Biology and Dr. Adam Frankel of Cornell's Bioacoustics Research Program, will use the DeepWorker to address different questions. Dr. Au and Kelly Bird, a graduate student at the University of Hawai`i, will attach a high-resolution fish finder to the submersible to observe the mesopelagic boundary communities of fish, squid and shrimp during their evening and nighttime migrations. Dr. Frankel also plans to attach a towed acoustic array to the sub to investigate vocalizations by cow/calf pods and groups of whales that are active on the surface. The towed array can identify the direction of the vocalization sources, even when the pods are not visible underwater.

Thanks to the recent explosion in technological advances, we have new tools at our disposal to help answer some of the more enduring questions about this mysterious species. Programs such as the Sustainable Seas Expedition can offer us a glimpse of the exciting possibilities for the future of whale research.

Author Dr. Joe Mobley received his Ph.D. in Comparative Psychology (the study of animal behavior) from the University of Hawai`i at Manoa. He is currently a Professor of Psychology at the University of Hawai`i-West O`ahu.

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Education during the Expeditions

Patty Miller
Education Chair, Sanctuary Advisory Council
Teleschool Teacher, KidScience, HI Dept. of Education

The Sustainable Seas Expedition, through its use of submersibles, underwater research and exploration, offers incredible opportunities for a variety of exciting educational activities. The Hawaiian Islands Humpback Whale National Marine Sanctuary has made the commitment to making education a high priority during the Hawaiian expeditions as students of all ages throughout the State of Hawaii will have the opportunity to participate in a variety of activities.

Colorful informational signs at the Hawaiian Islands Humpback Whale National Marine Sanctuary office in Kihei, Maui provide facts about the humpback whale and its marine habitat.

We are very lucky to have a sanctuary that focuses on a very visible and "touchy-feely" animal such as the humpback whale. You don't have to be an oceanographer or scuba diver to see our humpback whales. During the winter months the whales can easily be seen from shore or boats and each whale

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spout or breach brings forth excited "oohs and aahs." The Sustainable Seas Expedition will not only be

Marine critters run wild at the sanctuary's dedication celebration in Kihei, Maui.

looking at the spouting and breaching whales at the water's surface, but will document, we hope, whale behaviors from below as well. Whether the whales will be seen from the DeepWorker submersible is yet to be seen, nevertheless, we will be able to document and share images of the humpback whales' environment. What is it about the warm waters of Hawaii that attracts the whales? The more we know about the whales and the environment they return to year after year, the better we can protect them.

The DeepWorker submersible will be used to conduct a variety of research projects. Our goal as educators is to have students understand the research that is being conducted and the information

that is collected. What better way for students to understand this process than to take part in the research themselves? To facilitate this, selected students and teachers will be taking to the waters of the Hawaii Sanctuary to participate in live, hands-on research activities. For three days, about four hundred students will participate in the Sanctuary's "Students and Teachers at Sea" program.

Students created a life size model of a humpback whale out of garbage bags.

Students in classrooms

throughout the State of Hawaii will be able to follow the SSE researchers and the "Students at Sea" activities via special television broadcasts. KidScience, a State of Hawaii Department of Education distance learning program, will broadcast a series of programs featuring the Sustainable Seas Expedition in Hawaii. Students in the classroom will learn about research by participating in monitoring activities and fish counts using video segments. SSE researchers will be available to interact with students via the telephone and the Internet. In preparation for these activities, students are encouraged to check out expeditions in other sanctuaries and learn about the types of research that were conducted. Classes are also being encouraged to get involved in research projects of their own.

The "Whale of Fortune" game, a popular activity created by sanctuary volunteers, sparks interest and tests players' knowledge about the humpback whale and its marine habitat.

If you were in charge of an SSE research project, what would you ask? We hope the expedition will excite and stimulate more students and teachers to get involved like this group of students from Kaua`i. Education is creating an awareness, and awareness is one of the first steps to understanding.

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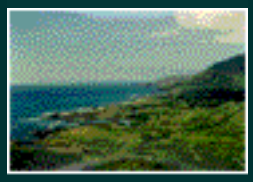
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The Biology of the Humpback Whale

Hannah Bernard, Executive Director
Hawaii Wildlife Fund

The Hawaiian Islands, the most remote high islands on earth, located in the middle of the world's largest ocean, have at their heart the only National Marine Sanctuary dedicated to whales and their habitat. The annual migration of the humpback whales, from their summer home in icy Alaskan waters to their Hawaiian winter destination, is a miraculous feat. They can cover nearly 3,000 miles of open ocean in less than two months' time, but how they find their way remains a mystery. The reason why they come here, however, is more easily understood.

Hannah Bernard and Jean-Michel Cousteau enjoy a laugh at the WhaleFest Beach Reef Clean-up, a sanctuary outreach event.

Like all whales, humpbacks are mammals, and belong to the baleen whale suborder, *mysticeti*. They graze on zooplankton and small fishes in temperate and subpolar waters. Nearly all of the baleen whales migrate some distance to warmer tropical waters to breed and give birth. The humpback whale population that comes to Hawai`i each winter is part of a much larger group that lives in the North Pacific Ocean, with feeding aggregations distributed in the Gulf of Alaska, southeast Alaska, and central California. Many members of these feeding groups migrate southward to the tropical waters off Japan and the Ryukyu Islands, as well as to Hawai`i, Mexico and Central America in roughly parallel tracks, with very little exchange between the breeding grounds.

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Humpback whales are very protective of their calves and prefer the shallow areas around the islands of Maui, Moloka`i and Lana`i, possibly due to calmer water conditions.

The Hawaiian Islands Humpback Whale National Marine Sanctuary has been established in the heart of the largest breeding grounds for the humpback whale. It is estimated that approximately 2,000 to 5,000 individuals come here each year, a significant portion of the total North Pacific population of 6,000 to 10,000 whales.

Humpback whales are not the largest whales in the world, but they are certainly the most watched. They are easily seen in sanctuary waters because of their large size and distinctive physical features, their energetic surface behaviors, and their close proximity to shore.

(top)

Humpback whales are easy to identify in sanctuary waters. In comparison to other whales, they are actually medium-sized, with females tending to be larger than males, averaging 45 feet in body length and weighing approximately 40 to 45 tons. The calves are typically 14 feet at birth, and may weigh as much as 2 tons! Mature humpbacks are dark gray to black on their backs and sides, with mostly dark undersides, although some individuals have splotches of white. Humpback whales have the longest pectoral flipper of all the whales--about one third the length of the body--which can be mottled white on the upper and lower surface.

The undersides of their tail flukes are as distinctive as our fingerprints, and range from all black to all white, with a whole gamut of splotching and scarring in between. The trailing edges of the flukes have a slight "S" curve and many knobby scallops and average 15 feet in width. When humpbacks dive, they often show their flukes, which researchers

photograph and use to identify individuals as they come and go within the Hawaiian Islands and elsewhere.

Humpback whales are identified by the unique markings on their flukes (tails).

Humpback whales are classified in the balaenopterid family, which also includes the world's largest whale--the great blue whale--and the smallest baleen whale, the minke. A family trait is an expandable throat with pleats that allows these whales to engulf huge quantities of prey and water, more than 500 gallons per gulp. The early Norwegian whalers called them "rorqual" or red whales because these pleats appear pink when fully stretched by a mouthful of prey. The whales strain this writhing mass of food by pushing the water out through the baleen (the keratin structures that grow from their top jaws instead of teeth), using their one-ton tongues like a plunger. Once the food is separated from the seawater, the whales swallow it and the process begins again. A remarkable humpback trait is its cooperative feeding strategy, during which several individuals "herd" the fish in a "bubble net" that the whales create by swimming in ever smaller concentric circles.

Humpback whales can generally be seen in Hawaiian waters between December and April. It is believed that while the whales are in Hawaii they do not engage in feeding activities, rather they concentrate on mating, calving and rearing their young.

The humpbacks rarely feed, however, during their stay in Hawaiian waters. Some observers have reported seeing them feed on schools of small fish, but like all baleen whales, humpbacks have adapted to fasting during their migration and breeding seasons, while living off their fat reserves. Undoubtedly, they would eat while they were here if food was plentiful, but tropical waters are typically nutrient-poor and don't support the shoals of fish and krill that humpbacks feed on during the summer months. When males engage in competitive behaviors on the breeding grounds, they sometimes fill their mouths with water to posture; that is to make themselves look bigger. Some people may mistake this behavior for feeding activity.

(top)

Another distinguishing feature of all humpback whales is their bumpy rostrum, or top jaw, which is dotted with fleshy knobs called tubercles. The early whalers also noticed these knobs and called them "stove bolts." No other whales have them, and the fact that they house a strand of hair and many nerve endings leads scientists to speculate that they may serve some sensory function. The final feature that easily distinguishes humpbacks from other whales, and for which they have received their common name, is the way they curve their back and tailstock region when preparing to dive.

Humpback whales are also easy to see in Hawaiian waters because they exhibit many dramatic behaviors. On their breeding grounds, the males compete for access to receptive females, slamming each other with their powerful tail flukes, lunging at and chasing each other, and producing unique and mysterious songs. The females and young are also active, slapping the surface of the water with their long pectoral fins and tails, and hurling their gargantuan bodies into the air in spectacular breaches. Female humpbacks are also very nurturing mothers. They stay in close contact with their young while on the breeding grounds, suckle their calves for up to a year, and defend and protect them from predators and rowdy suitors.

The 11 1/2-month gestation period of the humpback whale ensures that females impregnated in a given winter will give birth the following winter in the warm, sheltered breeding grounds. Calves grow quickly, sustained by their mother's fat-rich milk, and usually double in size during their first year. After feeding all summer in the cooler, nutrient-rich waters off the Gulf of Alaska, a newly weaned calf may follow its mother back to the breeding grounds the following winter. The calves also seem to learn the feeding areas their mother's prefer. By the time they reach young adulthood, between the ages of four and six, some whales are ready to breed themselves, and the cycle continues.

Two humpback whales *(Megaptera novaengliae)* surfacing directly beneath a boat. The State of Hawaii's official marine mammal, the humpback whale, is protected by three federal laws: the Marine Mammal Protection Act, the Endangered Species Act, and the National Marine Sanctuaries Act.

Hawai`i is truly a unique place. The islands are like emerald specks in the center of a vast ocean of indigo blue, populated with rare plants, unique animals and warm people who always offer a friendly "aloha." We are lucky to visit the whales in their nursery, in such a beautiful setting. The steep volcanic terrain makes it easy for us to observe our enormous winter residents and their young. Because the humpback calves are born here, they are truly a "child of the land", or "kama`aina." And thanks to the many tour boats that share the whales' winter home, we are often lucky enough to have a fairly close encounter in the heart of the Humpback Whale National Marine Sanctuary.

For more information on the Hawaii Wildlife Fund, click here.

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Hawai`i Culture

A Traditional Hawaiian Chant

Recited by Kahu (Rev.) Charles Kauluwehi Maxwell Sr. (a.k.a. "Uncle Charlie")

Kahu (Rev.) Charles Kauluwehi Maxwell Sr. (a.k.a. "Uncle Charlie")

Click here to listen to a recording of a traditional Hawaiian chant.

Translation:

Give to me all your knowledge from above,

All those intricacies of the songs,

Invoke these things upon me,

Invoke these things upon me.

Click here for more information about Uncle Charlie and Hawaiian storytelling.

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A Cultural Perspective of Whales and the Native People of Hawai`i

Joylynn Oliveira, Native Hawaiian Cultural Educator
Hawaiian Islands Humpback Whale National Marine Sanctuary

The First Voyagers

Amongst her many talents, Joylynn is the Native Hawaiian Cultural Educator at the sanctuary office. She also spends time educating the public about the many natural wonders that Hawai`i has to offer.

Traveling by canoe across a vast unknown body of water, Polynesian voyagers had set out on a journey that would change history forever. Arriving sometime between 500 and 750 A.D., the first voyaging canoe came ashore in Hawai`i. These seafarers had navigated their way across the deep blue Pacific sea with the aid of the natural environment, including ocean currents, stars, clouds, and the moon.

For many years, the legacy of these voyagers had established a culture that was isolated and unique (being the most isolated chain of islands in the world, the Hawaiian archipelago is secluded from the nearest continental landmass by approximately 2,500 miles). During this time, the inhabitants of the Hawaiian Islands had a self-sustained life-style. Depending only on immediate resources, the ancient Hawaiian people lived in unity and harmony with nature, believing that if they cared for the land and the sea, the land and sea would, in turn, care for them.

New Arrivals

This harmonious way of life was suddenly altered when British explorer Captain James Cook arrived in the islands in 1778. Cook and his crew introduced the native Hawaiians to western society. A new way of life was imprinted in the minds of the native people and westerners alike. Along with clothing, books and guns, the new arrivals also brought disease. The natives had lived a secluded life for hundreds of years and had no immunity toward the common cold, smallpox and other common ailments of the Old World. Consequently, the Hawaiian population drastically diminished in just a few years.

The hokulea, an ancient Polynesian voyaging vessel, is most likely the type of craft that the first voyagers used to discover the Hawaiian Islands.

As westerners began to spill into the islands and explore, many resources sparked their interest, among them the supply of sandalwood. Sandalwood had a strong natural fragrance and became a major export. Eventually, the natural forests were depleted and the wood became scarce.

Living in peace and harmony with nature, Hawaiians believed in a strong relationship between the plants and animals on the land and in the sea. This belief extended to include the notion of land and sea counterparts. It was thought that each counterpart complemented the other, creating a bond between them. The Kumulipo, the Hawaiian creation chant, states, "Hanau ka palaoa noho i kai. . . Kia`i `ia e ka `aoa," which translates, "The whale is born into the sea . . . Protected by the sandalwood." This truth is mirrored in the life of the whale, which was in sync with the life of its guardian, the sandalwood. It is interesting to note that in modern times, the whales of Hawai`i have also suffered great losses and have become endangered, just as the sandalwood did more than a century ago. (The Kohola and the Kolea [Whale and the Plover] folktale below also illustrates the belief in a strong relationship between plants and animals on land and in the sea.)

(top)

The Kohola and Lei Niho Palaoa

Whales, like every other creation of nature, were respected by the Hawaiian people. It was believed that deities would take the form of animals and plants, and, therefore, deserved respect. The whale, also known as the kohola, was considered to be a family deity or `aumakua. Hawaiians believed that when a powerful ancestor died, he or she took the animal form of an `aumakua and ever after guided and protected the family.

The kohola was also believed to be a manifestation of kanaloa, one of the four major demigods of Hawaiian folklore. Kanaloa was the god of the sea, and is said to be the god responsible for helping the Polynesians find Hawai`i. Some people say that the early Polynesian voyagers followed the path of the whale, which eventually led to the Hawaiian islands. Kanaloa was also the ancient name of the island of

Kaho`olawe, which appears to have the profile of a whale.

The whale was first identified as the palaoa in the Hawaiian language. Palaoa originally referred to whales in general, but later came to specifically identify both the toothed sperm whale and whale ivory. Today, the word kohola is commonly used to refer to whales, and especially the humpback whale.

Throughout recorded history, several species of whales had passed through the islands, including both baleen and toothed whales. The toothed whale, or palaoa, developed an important and significant role in Hawaiian culture. The Hawaiian proverb, "`O luna, `o lalo, `o uka, `o kai, `o ka palaoa pae -- no ke ali`i ia" translates to "Above, below, the upland, the lowland, the whale that washes ashore--all belong to the chief." This proverb refers to the authority of the royal class. On rare occasions, the carcass of a toothed whale would wash ashore, and immediately became the possession of the chief.

The ivory of the palaoa was removed and made into a niho palaoa, a whale-tooth pendant. The ivory was carved into the suggestive shape of a tongue, which may have signified someone who spoke with authority. The niho palaoa was then strung through strands of braided human hair from an ancestor, and the entire piece was known as a whale-tooth necklace, or lei niho palaoa.

The lei niho palaoa was only worn by the ali`i, or the high ruling chief, and was the second most treasured artifact. The feather cloak, also worn by the ali`i, was the most highly prized possession of all. The lei niho palaoa represented strength and power. It is said that the mana, or spirit of the gods, would be passed on to the wearer of the lei niho palaoa, as would the mana from the ancestor whose hair was used, the carver who made the piece, and all those who wore it beforehand.

(top)

Mana and Place Names

The mana of the whale was also evident in place names throughout Hawai`i. Many areas, especially along the coastlines of the islands, had names that referred to whales. For example, Laeonakohola (Cape of the Whales) is a cape located on the western coast of the island of Kaho`olawe, which overlooks an area where humpback whales are

commonly seen. Hunananiho (Tooth Concealment) is an area located on the island of Hawai`i in the Hamakua district. It is said that at this site, the mother of the Hawaiian chief named `Umi hid a lei niho palaoa, which was given to him later in his lifetime. `Umi then became a very prominent figure in Hawaiian history.

A famous national historic site located on the island of Hawai`i is known as Pu`ukohola Heiau. A heiau is a place designated for worshipping gods, and the name of this site translates to "Hill of the Whale." The origin of the name is uncertain, but whales may have been easily observed from the site, which played an important role in Hawaiian history. It is the hill where King Kamehameha built a temple to please his family war god in hopes of one day ruling all of the Hawaiian Islands.

The dazzling peaks off the island of Kaho`olawe overlooks one of the many areas where humpback whales are commonly seen.

In his quest, Kamehameha wanted to rule the island of Hawai`i, which, at the time, was ruled by his cousin Keoua Kuahu`ula. Kamehameha searched for spiritual guidance and sent his aunt to seek direction from the prophet Kapoukahi. Kapoukahi told her that Kamehameha would conquer all of the islands if he built his war god a large heiau atop Pu`ukohola.

After hearing this prophecy, Kamehameha constructed the large heiau and followed strict guidelines ensuring that his god would be pleased. In 1791, the heiau was complete. Kamehameha invited his cousin Keoua Kuahu`ula to the dedication ceremony, and a scuffle took place, during which Keoua and most of his companions were killed. The body of Keoua was offered as the principal sacrifice to Kamehameha's war god, Kuka`ilimoku.

With the death of his cousin, Kamehameha did indeed become sole ruler of the island of Hawai`i. Soon, the larger prophesy proved true, and by 1810, Kamehameha the Great had conquered all of the Hawaiian Islands, marking a turning point in the islands' history.

Kanaloa and the Kahuna

The history of Hawai`i was not written on paper. Rather, it was preserved orally and by petroglyphs, which are picture drawings similar to hieroglyphics. Many petroglyphs contain human images as well as animal figures, which may tell a story or provide a landmark. On the islands of Lana`i and Hawai`i, petroglyphs have been identified in shapes that suggest the figures of whales. The petroglyph on Lana`i, in particular, displays the image of a whale with a human being on top of it. This petroglyph may symbolize a legend, or mo`olelo, which tells of a boy who left the islands on the back of a whale.

One version of this mo`olelo is recorded in Hawaiian folklore and offers a link between the oral tradition and the petroglyph. It also provides another connection between the deity Kanaloa and his animal figure, the whale.

In old Hawai`i there once was a kahuna (priest) named Makua who wanted his son to become a kahuna even greater than himself. Makua prayed to his two gods, Kane and Kanaloa, asking them to teach his son how to become a great kahuna. The two gods appeared one day to Makua to tell him they heard his prayers and that they would eventually send a messenger to his son. Many years passed, but no messenger appeared.

One day, while Makua and his son were working, they heard a commotion on the beach. A whale had washed ashore. All the people from the village rushed to see the amazing sight, and played on the whale's back. Makua's son was anxious to join in the excitement, but Makua was hesitant. Finally, after several days, Makua allowed his son to approach the whale.

Makua's son climbed on the whale with the other boys. As he did, the whale suddenly awoke, and everyone except him fell off. The boy was carried away on the back of the whale to the land of his father's gods. Makua mourned for the loss of his son until one evening, when his gods came to him in a dream. The gods told him that the messenger had come for his son, and that he was being taught well in their world.

(top)

The Whale's Importance in Hawaiian Culture

This small excerpt of the history and culture of the Hawaiian Islands and its people offers a mere glimpse of the whole picture. Information about whales in the Hawaiian culture, although limited, indicates that the people of Hawai`i were always aware of the whales' presence. It is believed that the native Hawaiians neither hunted nor ate whales because the meat lacked taste. In fact, it was considered kapu, or taboo, for a commoner to possess any part of a whale.

Several views regarding the limited information about the cultural importance of whales in Hawai`i may offer insight as to why the kohola was not dominantly displayed in the culture. One view, offered by Louis Herman, Ph.D., Director of Kewalo Basin Marine Mammal Laboratory in Honolulu, Hawai`i, suggests that humpback whales were not present in Hawaiian waters before the arrival of Captain Cook. Herman theorized that humpback whales may have dispersed from other areas after 1778 due to increased pressures from whaling and other long-term changes

The native Hawaiians may have viewed the whale as a very sacred creature, an animal form of the god Kanaloa.

in the major water masses of the North Pacific.

A second view suggests that, in comparison to other animals, whales were not highly important or necessary to the native Hawaiians. Many animals, such as sharks, turtles and owls, were often depicted in Hawaiian folklore and were considered to be `aumakua. It is likely that the Hawaiians' self-subsistent life-style did not create a need for the large food supply that could be obtained from a whale.

A final view suggests that the Hawaiian culture may have viewed the whale as a very sacred creature, an animal form of the god Kanaloa. Knowledge of the whale and its connection to the culture may have been reserved for the high-ranking chiefs and their priests, and as the ancestors died, so did their special understanding.

The mystery of the importance of whales to the culture of the Hawaiian people, the seafarers of the Pacific, remains unsolved. Through cultural awareness and outreach programs in the community, the sanctuary will help to preserve the remaining knowledge and may even bring forth new and exciting information. Exploring the earth above, as well as the depths below, may give the people of Hawai`i a new perspective on how their ancestors lived, and may reveal additional secrets about their heritage.

Editor's Note: The Hawaiian text on this page does not include all grammatical markings of the Hawaiian language due to computer incompatibilities. Please note that the Hawaiian Islands Humpback Whale National Marine Sanctuary is aware of the lack of these markings and will continue to remain culturally sensitive to the language, including these markings when possible.

The Kohola and the Kolea

Click on the image below to view a coloring book version of this ancient Hawaiian folktale.

Retold by Allen Tom
Hawaiian Islands Humpback Whale
National Marine Sanctuary Program

National Marine Sanctuaries

A coloring book in English and Hawaiian

March 1997
Produced by the Hawaiian Islands Humpback Whale
National Marine Sanctuary

Adapted from an oral tradition of the Marshall Islands
(The Whale and the Sanderling)
by (copyrighted) Jane Downing, Ministry of Education, Marshall Islands

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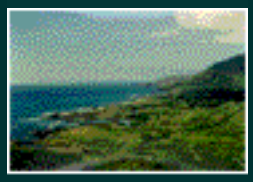
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Senator Akaka Welcomes the Sustainable Seas Expeditions

December 13, 1999

Senator Daniel Akaka

I welcome the Sustainable Seas Expedition to the Aloha State. Congratulations to the National Geographic, the Richard and Rhoda Goldman Fund and the National Oceanic and Atmospheric Administration on their mission to discover more about the Nation's 12 National Marine Sanctuaries from "below the surface." The Sustainable Seas Expedition is an important step in understanding the oceans that surround the Hawaiian islands. The dives in January 2000 will expand our knowledge about the diversity of life in the waters of the Hawaiian Islands Humpback Whale Sanctuary. I hope all of you in Hawaii can take advantage of the activities planned for the Sustainable Seas events such as Education Day on January 13th, the Sanctuary open house on Maui, and live video conferences in classrooms, to the open house at the Waikiki Aquarium.

The ocean is our final frontier. I have sailed to other islands using celestial navigation as our ancestors did to reach other islands. I have fished for Ahi and Mahimahi, and reef fish as well as bottom fish, including Weke, 'Ama'ama, 'Aweoweo, Opakapaka, Papio and Ulua. My favorite is the Kumu. My son has sailed on the traditional sailing canoe Hokule'a, following the migratory route of ancient Polynesian voyagers; and works to conserve turtles on the Kona

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coast. Islanders know from firsthand experience that the ocean is a living resource in which there are many unknowns. As an island state, we need to understand the oceans around us, from the smallest plankton to the largest marine mammals.

My work in Congress reflects my love for the ocean. In 1990, I introduced legislation to authorize a study on establishing a sanctuary for humpback whales that winter in the Hawaiian Islands. That lead to collaborations between NOAA and the State of Hawaii and to the final designation of the sanctuary in 1992.

Almost ten years after the initial study, many things have happened. The Hawaiian Humpback Whale Sanctuary has been in existence for seven years. I believe we have found a way to balance the needs of the diverse groups who want to use the ocean, while maintaining a safe area for whales to congregate. From the beginning, our sanctuary director Mr. Allen Tom knew that it was important to work with all user groups in the planning process. After the designation in 1992, the Director formed a commission to oversee how the Sanctuary is working, with a commitment to review the sanctuary and the state's role on a regular basis.


Photo: Office of Sen. Akaka

In addition to the open ocean environment of the whales, we need to understand the extent and health of our coral reef systems. Reefs are biological keystones. They play a vital role in maintaining the structural integrity of our islands. I hope the Sustainable Seas Expedition can promote better understanding of our reef areas, too. Coral reefs generate billions of dollars in tourism and are critical to the biological diversity of the greater Pacific Ocean. Coral reefs are treasure chests for biotechnology products based on naturally occurring substances.

(top)

According to NOAA, almost 85 per cent of all coral reef

Senator Daniel Akaka releases a green sea turtle raised in captivity at the Mauna Lani Bay Hotel on the Big Island of Hawai`i. The sea turtle, a threatened and protected species is being released into the Hawaiian Islands Humpback Whale National Marine Sanctuary - which border's the hotel coastline. Senator Akaka was instrumental in the Sanctuary's creation in Congress. The habitat of the sanctuary off of the Kona coastline on the Big island includes a mixture of sand and gravel substrate mixed with a coral reef habitat - a perfect place for adult sea turtles to be found.

areas under U.S. jurisdiction are in the Northwestern and main Hawaiian Islands. In the Northwest Hawaiian Islands, the acreage of reef is greater by far than the actual land mass above sea level. Major reefs surround Oahu, Moloka'i, Kaua'i and Maui. The Hawai`i State Department of Land and Natural Resources (DLNR) has published a compelling "State of the Reefs" report. The report identifies the extent and type of reefs, and the local, state and federal groups that are working to understand the reef areas surrounding Hawaii. The report also identifies the growing problems that face reef areas from natural causes and from greater human use and extraction. We need to find the keys for living together -- humans and reefs areas -- sustainably. (For more information about the Hawaii DLNR Division of Aquatic Resources, click here.)

Because of the uncertainty facing coral reefs and the opportunity to do something about it, I have introduced legislation to expand the ability of the government to fund community-based coral conservation projects and research. In addition, I am supporting coral reef legislation introduced by Senator Inouye and myself. Both of these bills promote research, monitoring, community involvement and educational outreach so we humans can come to a better working relationship with reef ecosystems. The bills bring people and communities together to participate in, and learn more about, the conservation of ocean resources --coral reefs and the many species that depend on reef ecosystems. By making ordinary people responsible for reef conservation we can alter the types of human activity and behavior that are responsible for the adverse impacts on coral reefs that we glimpse today.

There is much more to discover about the final frontier of the ocean. We are learning more about the birth of our volcanic Hawaiian islands and the movement of the Pacific plate by studying the processes forming Loihi, an active sub-sea volcano off the coast of the Big Island. We are learning more about the air-sea interactions in the tropical Pacific that drive global climate. And we are perfecting our ability to raise fish and shellfish in both recirculating systems on land and in offshore cages. With the advantage of submersible technology taking divers to depths of 2,000 feet, the Sustainable Seas Expedition will introduce us to the natural history and wonder of Hawai'i's marine sanctuary as we have never seen it before. I look forward to the on-line, real-time

experiences from the Expedition in January.

For Senator Akaka 's official Web site, please click here.

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Experiencing the Sanctuary

Susan Scott , Marine Science Writer & OceanWatch columnist,
Hawai`i Star-Bulletin

Susan Scott

Several years ago, a few friends and I were sailing between Maui and Lana`i when suddenly, the wind died. The surface of the water grew glassy and the boat slowed to a halt. It was such a glorious morning, no one wanted to start the noisy engine. Instead, we pulled down the sails and let the boat drift. Lying back in the cockpit, I proceeded to enjoy a rare, peaceful moment floating on Hawai`i's vast blue ocean.

While enjoying the moment, my mind drifted to another time when my boat was so becalmed in the Pacific. I remember being thrilled at the sight of thousands of Portuguese man-of-wars floating on the surface of the water like tiny blue balloons, their no-nonsense tentacles dangling beneath. This sight was unusual because during normal tradewind conditions, the rollicking waves of the Pacific Ocean obscure the blue floats of these drifting creatures. Usually, I don't see a Portuguese man-of-war until I swim into one and feel the painful sting of its long, fish-catching tentacles. It was an extraordinary moment seeing these creatures innocently bobbing along in their natural offshore habitat.

Back to my calm sailing day off Maui, where, unlike at home, sitting in silence was an acceptable pastime. My friends and I watched in amazement as a great frigate bird swooped down near the boat and neatly plucked a fish from the water's surface. The big black bird was careful to keep its wings dry because, unlike other seabirds, the feathers of this species can soak up water. Once that happens, the bird can't take off -- a death sentence for a frigate bird at sea.

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An immature frigate bird trying to land on our sailboat mast.

Wet wings, however, are not necessarily so lethal on land. Once, while working at an atoll in the Hawaiian Islands National Wildlife Refuge, I came upon a frigate bird that had accidentally dipped its wings in a large rain puddle. Standing in water that covered its legs, the bird was bedraggled and struggling, apparently confused as to how to cope with such an unusual body of water. I hurried to inform the refuge manager, who returned to the puddle, picked up the bird and placed it high on a nearby beach. Immediately, the creature spread its wings to dry in the hot sun. When we returned an hour later, the frigate bird was gone.

Frigate birds have a bad reputation for stealing fish from other birds, but the truth is, they catch most of their fish themselves. This is tricky business for birds with such fussy feathers, which is probably why they evolved their exceptional robbery tactics.

(top)

When in the thieving mood, frigate birds can outwit even the most cautious seabird. I once watched two frigate birds simultaneously dive toward a red-footed booby flying home to feed its chick. With split-second timing, the frigate birds each grabbed one of the booby's legs and flipped the unfortunate creature head-over-heels. In the process, the booby's hard-won fish popped from its beak and fell toward the sea. It didn't go far. One of the frigate birds caught the fish in midair and took off with its prize at top speed, its partner in crime flying in hot pursuit.

It's no coincidence that 18th century sailors named both Portuguese man-of-wars and frigate birds after war ships. These animals' tactics for survival can be as fast, sneaky and efficient as their naval namesakes.

As the hour wore on, we continued to laze on the deck

Portuguese man of war

of the boat in silence, no one wanting to break the spell of this unusual morning. Then, a loud call from someone on the aft deck burst the bubble of calm and brought us all to our feet. I arrived at the back of the boat just in time to observe one of the most astounding wildlife sights of my life: a full-grown humpback whale was swimming directly for the boat's stern. It looked like the whale would crash into the transom, but with just a few feet to go, the huge mammal abruptly dove underwater. With mouths agape, my friends and I hung over the aft rail and watched the whale's enormous flukes disappear beneath the boat.

What an extraordinary feeling to know that a 40-foot-long, 40-ton animal was swimming directly beneath our 37-foot boat. It was terrifying and delightful at the same time.

Dolphins riding the bow wave of our sailboat.

We rushed to the bow and peered over the pulpit, waiting breathlessly to see what would happen. As I stood there, I thought of the stories I had heard about whales' interactions with boats. There was Moby Dick that grumpy sperm whale. That tale, however, didn't bother me -- that whale had good reason to be annoyed with people and their boats.

But what about those modern tales of boats being holed and capsized by whales at sea? Did this really happen? Do whales really rise up under boats, tip them over, smash them up? Suddenly, I felt small and vulnerable. This ocean did not, I realized with pounding heart, belong to my species.

A strange sound came to my ears and I realized I was hearing the legendary song of the humpback whale. A moment later, our diving whale surfaced directly in front of the boat, its massive body just clearing the bow. The maneuver was so precise that there was no doubt the whale knew exactly what it was doing: swimming under an obstacle that had been floating in its path. And then, with a gargantuan breath that spewed pungent fish smells into the air, the whale was gone.

The hypnotic humming, however, still surrounded us. Soon, we were taking turns hanging off the boarding ladder with our ears to

the water, listening to the eerie, underwater songs of the magnificent humpback.

Today, whenever I hear about protecting whales or creating more marine sanctuaries, I remember that special day off Maui. It is experiences like these that make the subject of marine sanctuaries come alive.

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January 10, 2000
Hawai`i Welcomes the Expeditions

Timothy E. Johns, Chairperson
Hawai`i Department of Land and Natural Resources

William S. Devick, Administrator
Division of Aquatic Resources, Hawai`i Department of Land and Natural Resources

Jeffrey S. Walters, Sanctuary Co-Manager
Division of Aquatic Resources, Hawai`i Department of Land and Natural Resources

We wish to extend our warmest greetings and aloha to everyone following the Sustainable Seas Expeditions (SSE) in Hawai`i. While the researchers are completing their final pre-dive activities, we would like to highlight the many ways in which we feel this mission will assist in sustaining Hawai`i's seas.

Coral reefs like this one are abundant throughout Hawai`i. (Photo courtesy of Dave Gulko)

In essence, it's quite simple - Hawai`i's people and their marine environment are intimately interconnected, and any activity, such as SSE, that will help us better understand and manage our natural ocean world is beneficial. But to see just how important SSE in Hawai`i really is, let's take a closer look at Hawai`i's marine environment in general, and the Hawaiian Islands Humpback Whale National Marine Sanctuary in particular.

Hawai`i - The Oceanic Island State

The Hawaiian archipelago stretches 1,523 miles across the central Pacific Ocean.

Including all the islets in the northwestern part of the chain, there are approximately 130 islands in Hawai`i. Our newest island - Lo`ihi seamount - is now forming deep off the southwestern tip of the Big Island.

Hawai`i's islands are surrounded by over three million acres of coral reef. These reefs contribute millions of dollars to our local economy from reef-dependent tourism and fishing industries. Hawai`i's reefs are vast - they comprise more than 80% of the total coral reef area in all U.S. waters. Hawai`i's reefs are also biologically unique - over 25% of Hawai`i's reef animals are endemic, meaning they are found nowhere else on earth.

In Hawaiian waters deeper than about 100 meters, where most corals cannot receive enough sunlight to grow, expansive hard-bottom areas of the sea floor serve as habitat for commercially-important bottom fish such as ehu (red snapper, *Etelis carbunculus)* and onaga (long-tailed red snapper, *Etelis coruscans)*. There are also undersea cliffs, pinnacles, and vast sandy plains that serve as bottom fish feeding and nursery areas. Pelagic (open ocean) fish such as tunas and marlins, as well as a number of different dolphins and whales, inhabit the waters overlying these deep water areas.

SSE Habitat Characterization and Marine Resource Management in Hawai`i

Bottom fish, such as *Ehu* or red snapper, are among the many commercially important marine resources found within the sanctuary. (Image courtesy of Les Hata)

Because they lie far below the depth limits of most SCUBA divers, Hawai`i's deep water marine habitats are less understood than shallow coral reef and soft bottom areas. The information collected with the SSE mission's deep diving submarines promises to enhance our comprehension of Hawai`i's immense areas of deep water habitat. Underwater video footage will help us "ground truth" our sonar maps of the seafloor. Analysis of bottom samples and water samples collected by SSE should yield biological and chemical data that will help us better understand Hawai`i's marine resource ecology.

All of the above mentioned habitat characterization activities to be conducted by SSE promise to facilitate better management of a wide variety of Hawai`i's marine resources, including coral reefs, fish and marine mammals. Of course, humpback whales are among Hawai`i's most widely known and loved sea creatures, and the information collected by the SSE will be of particular usefulness in managing this special sanctuary established in Hawai`i for humpback whale protection.

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The Hawaiian Islands Humpback Whale National Marine Sanctuary

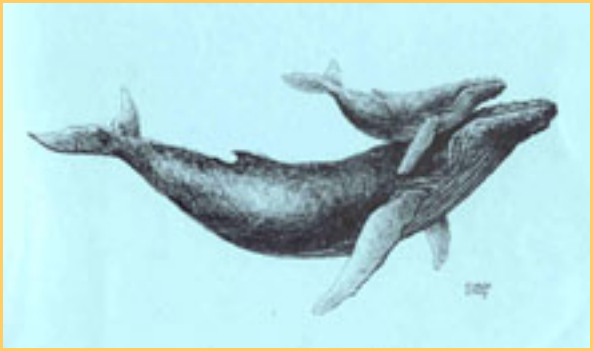
The waters around the Hawaiian Islands serve as the primary breeding and calving areas for about two thirds of the total North Pacific humpback whale population (5,000 - 7,000). Recognizing that managing humpback whale habitat in Hawai`i is essential to the survival of this endangered species, federal and state resource management agencies, as well as a number of other concerned organizations and individuals, worked together to establish Hawai`i's national marine sanctuary. The sanctuary was Congressionally designated by the Hawaiian Islands National Marine Sanctuary Act on November 4, 1992. The national marine sanctuary complements the state system of Marine Life Conservation Districts, Natural Area Reserves and Fishery Management Areas established to protect Hawai`i's unique marine ecosystems. The central purposes of the sanctuary as stated in the Act include:

1. protecting humpback whales and their habitat;

2. educating and interpreting for the public the relationship of humpback whales to the Hawaiian Islands marine environment;

3. managing human uses of the sanctuary consistent with the Act and the National Marine Sanctuaries Act, as amended; and,

4. providing for the identification of marine resources and ecosystems of national significance for possible inclusion in the sanctuary.



Most female humpback whales in the North Pacific give birth in Hawaiian waters. (Image courtesy of George Carey)

Much of the sanctuary is in nearshore areas where the state of Hawai`i has management jurisdiction over most marine resources. From the beginning, Hawai`i's Department of Land and Natural Resources, the State Office of Planning and other state agencies, have worked with the federal government's National Oceanic and Atmospheric Administration to manage the sanctuary in a unique partnership. This "co-management" relationship was formally established via a compact agreement signed by NOAA Under Secretary D. James Baker and Governor Benjamin J. Cayatano in 1998.

Collaborative Sanctuary Management Strengthened via SSE

Co-management of the sanctuary is manifest in a number of ways. As stipulated in the compact agreement, the state's sanctuary co-manager works as an equal partner in the oversight of sanctuary operations. On a daily basis, state and federal sanctuary staff work closely to development and implement a wide variety of research and education projects. The state also works closely with the NOAA's National Marine Fisheries Service in issuing permits to scientists who conduct ocean research related

to humpback whales.

Governor Benjamin J. Cayatano with SSE's Dr. Sylvia Earle and other friends of Hawai`i's marine environment -- "A Partnership for Protection."

There are a number of activities planned for Hawai`i's SSE mission that will help continue the tradition of collaboration between state and federal agencies in managing the sanctuary. As discussed above, SSE submarine pilots have plans to study deep areas of the seafloor that have been identified by state researchers as probable habitat for commercially-important bottom fish species.

In addition to coordination on scientific research activities, several SSE education and outreach activities have been developed in close collaboration with Hawai`i's Department of Education and other state agencies. As discussed in other pages on this Web site, these activities will involve hundreds of children and adults in a variety of informative activities ranging from open houses on three islands to whale watching trips and submarine dives for Hawai`i's school children. In the process of developing and implementing these collaborative SSE research and education projects, partnerships between federal and state sanctuary management staff and other agencies will be further strengthened, and co-management of the sanctuary should thereby be further improved.

Key Benefits of SSE in Hawai`i

We hope we have helped to elucidate the significance the State of Hawaii places on our marine environment, the Hawaiian Islands Humpback Whale National Marine Sanctuary, and the Hawai`i SSE mission. In summary, we believe that SSE in Hawai`i promises to produce the following important benefits:

1. new scientific information about Hawai`i's humpback whale habitat and other important marine resources;

2. public education and outreach activities concerning Hawai`i's National Marine Sanctuary and other marine areas; and,

3. multi-agency cooperation and collaboration to assist marine resource management in Hawai`i.

In closing, we wish to again welcome all those following the SSE mission in Hawai`i, whether from near or afar. Regardless of your level of participation, you are an important partner in our efforts to sustain Hawai`i's seas.

For more information about the Hawai`i Department of Land and Natural Resources,

*please visit their **web site**.*

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January 13, 2000
Students Participate in SSE Operations

Claire Cappelle, Mission Log Editor
Hawaiian Islands Humpback Whale National Marine Sanctuary

Many Participating High School Students

While the pilots were busy exploring the ocean floor, 15 high school students from O`ahu, Maui, Kaua`i and the Big Island explored life aboard the Ka`imimoana during a Sustainable Seas Expedition. Students were welcomed aboard by Commander Tim Wright and then given a tour of the boat. After watching the recovery of the DeepWorker, the students were assigned work tasks at specific work stations: Tracking and Navigation, Submersible Operations, Video Documentation and Editing and Pilot Post-Dive Form. In addition, the students were able to rotate through several other stations such as CTD deployment, SSE Operations and Planning and the Ship's Bridge. One requirement of the day was that the students at each of the four main stations write a one or two paragraph description about their station.

Join our students as they share what they learned today.

Tracking and Navigation
Student Author

Our group's job was to shadow Craig Russell who's job is Tracking and Data Manager. He taught us the basics about tracking and navigation of a submersible. There are two types of tracking used on the NOAA Ka`imimoana: acoustic and satellite. Tracking is very important for a number of reasons. It is used to track where the submersible goes, ensure the pilots safety, and to prevent losing the submersible, which costs lots of money. Tracking is also used to mark areas that are of interest to scientists, so that if they desire, they can return to that area and do further

research.

The Tracking and Navigation team takes a break before writing their mission log.

The Submersible Operations team poses with the DeepWorker.

Submersible Operations
Student Author

We visited the submersible after meeting Francesca Cava, a DeepWorker pilot, and learned about the specifics of submersible operations. Before a dive, the crew must go through a two page checklist to ensure that everything is functioning properly. That process takes somewhere around an hour. The list includes checking that no cables are in the way of the thrusters, that the tracking system is installed and working, and that all fastenings are tight and secure. The life support system of the submersible includes two oxygen tanks and a CO2 scrubbers that remove carbon dioxide from the cabin. There is also an air regulator in case of an emergency. Gages can be checked for cabin pressure, etc. Underwater maneuvering is determined by vertical and horizontal thrusters that are controlled by pedals in the cabin. Weight (buoyancy) can be controlled by air or liquid (soft and hard ballast).

Video Documentation and Editing
Kala, Student Author

Our group project was to work with National Geographic photographer, Kip Evans, to create a short video describing our experience aboard the NOAA research ship, Ka'imimoana. Kip gave us a crash course on video photography, using his really expensive video camera to get some cool shots of the submersible vessel, DeepWorker 2000. We also videotaped interviews with several crew members: Steve,

DeepWorker's engineer; Dana Wilkes, the Ka'imimoana operations officer; and Ramos, who demonstrated how the A-frame structure at the ship's stern is used to haul DeepWorker on board. Learning how to edit our video on Kip's computer, we made a title shot and added underwater footage from the Hawaiian Islands Humpback Whale National Marine Sanctuary.

The Video Documenting group looks on as Kip Evans, National Geography Society's photographer, explains the finer points of video editing.

The second phase of my Students-at-Sea experience was the opportunity to go on an Atlantis submarine dive off the Kona coast the following day. We descended to 104 feet while counting fish species. The data we collected will supplement the data collected by the NOAA scientists on Maui. Participating in the Sustainable Seas Expedition was a fantastic experience and I hope Sustainable Seas will return to Hawai`i in the future.

David F., Student Author

Our mission while on board the reaserch vessel Ka`imimoana, was to shadow Kip Evans in a production of a short five minute video of what the students were learning while on-board the research vessel. In doing so we walked around vessel interviewing crew members, scientist and even the submersible pilot. After gathering all the desired footage, we went back inside the ship and began editing the video. Kip Evans did a great job of explaining and showing us how a documentary video of the dives are put together. He also taught us his techniques and opinions on how to make good footage. Our group would like to thank Mr. Evans for taking the time to show us what he does at work.

Pilot Post-Dive Form
Several Student Authors

All the Maui, Kaua`i, and Hawai`i students met at the Lahaina Civic Center where we had an orientation describing what the day would be like. After we finished at the Civic Center we went to the Lahaina harbor and rode the Man-o-War to the NOAA ship Kai'imimoana. On the ship, we visited different stations where we saw the different research information and techniques that were used to acquire it. We saw the submersible retrieved for the first time on this Expedition. We talked to a lot of the crew members and they explained their jobs on

Claire Johnson and students pause for a photo aboard the Ka'imimoana.

the research vessels.

This we a good experience and it definitely impacted our studies on marine biology and how it affects us. Our group's mission was to focus on collecting the field data for the first submersible recovery on the NOAA ship Ka'imimoana. We talked to John McDonough and Claire Johnson about the weather condition, overall mission and the mission goals. We filled out the field post-dive debrief form with the assistance of Francesca Cava who piloted the DeepWorker submersible on this particular day. She said that the site was a really good training area for pilot proficiency, but there was low fish diversity and no invertebrates. John said that all of this data was being collected as a general reconnaissance mission for future reference when reviewing our past missions.

(top) **RETURN**

January 14, 2000
Atlantis Adventures

Patty Miller, KidScience
Hawai`i Department of Education

Claire Johnson
Sustainable Seas Expeditions

Many student poets

Patty writes:

Students on-board the submarine Atlantis participate in monitoring research, 110 feet beneath the water's surface.

At noon today 48 students boarded an Atlantis submarine to begin their research mission. They had been tasked to do fish counts and participate in a monitoring exercise. The kids are gazing out of their portholes in awe as we descend to about 110 feet. Fish are swarming in front of the portholes, the kids are madly trying to record numbers and species. All of a sudden, two dim lights appear off in the distance...is this a huge fish with glowing eyes and do we really want to meet up with it? As the lights got closer, it began to take the shape of an alien spaceship. It was an eerie feeling, even to me, who knew that it was the DeepWorkers. Sylvia Earle and Steve Gittings, each in there own submersible, had come to meet the kids in the Atlantis submarine. Talk about excitement. Sylvia is demonstrating the antics of the DeepWorker, a 360-degree spin, cruising past the portholes to give the kids a closer look, and then waving at us with the manipulator arm. Steve Gittings in the other submersible is holding up a sign, asking to borrow some Grey Poupon from our submarine. It was a great opportunity for the kids see the DeepWorkers in motion.

The DeepWorkers departed and the Atlantis Sub continued on to a couple of different reefs where the kids began their research. First a fish count. They learned very quickly how difficult this was, if only those fish would stay in one spot. The kids were able to identify and list many different species they found on the reef. The eels sticking their heads out of the corals were very popular with the kids. As we approached the second reef, the kids prepared to do a monitoring project. Each had picked the species they wanted to monitor, some went for schools of fish, some eels

Aliens Underwater!?! No, it's Dr. Sylvia Earle in DeepWorker approaching students in the submarine Atlantis.

or sea urchins, and others tried to list all the different types of corals. All the data they collected will be compiled into a final report and shared with the scientists. It was a really incredible day. We are very grateful to Atlantis Submarines for giving us this opportunity.

Dr. Steve Gittings cruises by the submarine Atlantis demonstrating DeepWorker's maneuvering capabilities.

Claire writes:

We all know that the world's oceans cover over 70% of the earth's surface. Now how do you inspire the youth of today to learn more about this fragile ecosystem? One way is to send students and teachers out to sea to participate in a project like the Sustainable Seas Expeditions. You allow them the opportunity to conduct oceanographic research, such as, measuring water quality and recording marine mammal sightings; taking them aboard a research vessel like the NOAA ship, Ka'imimoana, and allowing them to shadow scientists, educators, dive technicians, data collectors and the ship's crew as they conduct a normal day of operations; and getting them into the watery depths to observe first-hand what this unique environment contains. All of this is exactly what we did with the Sustainable Seas Expeditions Hawaiian Style over the past three days.

Approximately 400 students and teachers from various schools all over the Hawaiian Islands participated in the Students and Teachers-at-Sea Program with . Today dual Atlantis missions were taking place off of the coast of Kona on the Big Island and Lahaina, Maui. An ambitious mission such as this takes precise planning, lots of hard work and dedication, and often causes logistical nightmares which require resolution. These education and outreach days were made possible by visionaries like Patty Miller of KidScience, along with Hawaiian Island Humpback Whale National Marine Sanctuary and SSE staff, as well as donated whale watching vessels and free Atlantis submarine trips.

Students carefully monitor and record the number and species of fish found around the coral reef system.

The coral reefs in Hawai`i abound with life. These surgeonfish swarmed around the portholes of the Atlantis submarine as it made its way along the reef off of Kaiua Bay.

Today, I was fortunate enough to be the SSE representative assisting with the Kona Atlantis submarine dives with 84 students and teachers from Hawaii Preparatory Academy, Kohala High School, Kealakehe Elementary, as well as, home schooled children. In Kona, we sat a few feet from the gentle ocean swells in a protected area provided graciously by the King Kamehameha Beach Hotel. After an hour and a half orientation about the National Marine Sanctuary Program, SSE and the Hawai`i Sanctuary, and a detailed lecture about the local marine life by Pete Hendricks of the Department of Land and Natural Resources, students were well equipped with the basic knowledge they would need to conduct research aboard the Atlantis submarine. Two of the main objectives for the students were to conduct marine life or fish counts using REEF (Reef Environmental Education Foundation) protocols, as well as participate in 25 meter monitoring activities. These goals and objectives were right in line with what was happening with Dr. Sylvia Earle and Laura Francis in the two DeepWorker 2000 submersibles and the Maui Atlantis submarine off of Lahaina.

After a long day of research, the submarine Atlantis surfaces in the calm azure waters of Kailua Bay.

A quick lunch and bathroom break and off the kids went to board the Atlantis submarine. The excitement was glowing on their faces as the students armed with fish count slates and scientific folders climbed down into the bowels of the 48-passenger submarine. Our dive site for today is commonly known as Thurston's, right off of Kailua Bay in Kona and consists of a healthy coral reef that extends down to about 85 feet with great abundance and diversity of marine life. Perfect for our fish count activities! Hatch is closed, students are briefed, down we go. Yellow-striped goatfish, long-nosed butterflyfish, and yellow tang are easily recognized and recorded in abundance on data sheets. Later in the dive, we begin our 25 meter transect and monitoring activity. This is repeated twice in the same location for each submarine dive. Touch down on the sandy bottom at our maximum depth of 104 feet, a slow spin and the

port side gets the excellent view of this incredible reef brimming with life.

At this point the students and teachers aboard the sub are asked to write down some of their thoughts about the ocean and why a humpback whale would choose this area to breed their young.

I'm a whale so gentle, graceful as can be.
Swimming here in the deep blue sea.
My home is full of sand and decorated with a wonderful coral reef.
My neighbors, the fish, are as cool as can be and they have their own personality.
Hawaii is the place to be for warmth, freedom and to just be happy.
I have no harm.
I'm so safe in my part time home, where I can raise my child and watch him grow.

-Allen, student

If I were a whale, I surely would not be caught lurking at the bottom of the sea!
Instead, I would be swimming all around.
I would go every place possible, and would hope to not be found!
I would live life in the ocean as much as I could, and
treat all the other fishes as I should.
I would love the life I live and live the life I love,
and swim and jump to meet the sunsets rising up above!

-Jamelyn, student

Deep down in the ocean blue, you might hear an awkward moo.
This would be the Humuhumunukunukuapua'a, which is one of the many fish I saw.
Through the coral you might see a yellow tang.
They are swift and move as fast as a bang.
The peacock grouper is quite cute.
Like the forceps fish, which is a beaute.
The submarine experience was really fun, even though the colors change out of the sun.

-Laura, student

The balance of the ocean,
is like a fraction.
If it is unbalanced,

the humans or sea animals
and sometimes even both,
will be in a tragic state.
The ocean is like a precious vase,
if it is broken,
the results are tragic.
If we do not conserve, our ocean now,
What will be left of it,
if we continue to use it
as a dumpster?
It will be like sludge,
empty and lifeless.
If the fraction is unbalanced,
like 8/6,
it will breakdown,
and collapse.
We will soon lose
our wonderful ocean life
forever.
We must conserve now,
and save our precious resources.
Before they are gone.

- Ashley C., student
Seabury Hall High School, Maui

(top) RETURN

January 15, 2000
Maui Open House

Allen Tom, Manager
Hawaiian Islands Humpback Whale National Marine Sanctuary

E KOMO MAI (Welcome)

Keiki Hala Hula: Young keiki (children) perform the hula for visitors to the sanctuary E Komo Mai Event.

The Hawaiian Islands Humpback Whale National Marine Sanctuary welcomes the public to our headquarters office located at 726 South Kihei Road, Kihei, Maui, Hawaii. Today, an open house was held at the Sanctuary headquarters. Events included a variety of activities from the local community, including Keiki Halau Hula (children's hula) performances, demonstrations of canoe paddling from the Kihei Canoe Club, a performance by the musical group Vaihi and a special performance by Ohi'a Productions of their original children's musical entitled "Beneath the Ocean Blue." In between all these special events, visitors strolled around the property, met the sanctuary volunteers and learned about NOAA's and National Geographic's Sustainable Seas Expedition underway in sanctuary waters off Lahaina.

The Oahu musical group, Vaihi, performs Hawaiian and local music to a packed audience in Kihei.

Our office and surrounding property has a colorful history, historical past and bright future as a learning center about the humpback whales, the sanctuary program and the local marine environment.

In 1994, I moved into what was once an old atmospheric station -- owned and operated by the federal government. At that time, the neglected station was closed off from the public by metal fences, iron wood trees and a large gate at the front of the access road. Today, the office is now the headquarters of the National

Marine Sanctuary program in Hawai`i, as well as a learning and visitor center.

My first goal was to make the property much more user friendly. Although the buildings had been continually occupied since their creation in the late 1940s, they had since fallen into a state of neglect and disrepair. I wanted to open up the buildings to the public to provide a place where people could stop in and learn about our program, and how we were working with others to protect the humpback whale and its habitat.

Many people visit the Kihei Sanctuary to learn more about the local marine life and hope to catch a view offshore of breaching humpback whales that frequent the area.

Less than one week to the day after I moved into the office, several people from the surrounding community showed up on my doorstep with offers to help -- everything from painting, to weeding, to office work. The result was the formation of the sanctuary volunteer program -- with many of the original members still helping out today. You can see some of their names and faces on our volunteer board in the front office. The volunteers worked diligently to transform the buildings into the visitor center I had envisioned. Today, more than 60 volunteers spend more than 10,000 hours a year improving our headquarters, answering questions about the site and the whales, as well as providing other useful information.

Sanctuary volunteers teach children and adults how to make flowers and hats out of Lauhala leaves.

An added jewel to our sanctuary site is a three-acre historic Native Hawaiian fishpond fronting the property. History tells us that this fishpond was once used by King Kamehameha the Great for his own personal use. It was a place where fish such as moi and mullet were once raised. Later, an old residence known as the Koa House stood near the fishpond in the Kalepolepo Beach Park area. The fishpond, with its rockwall still visible to the naked eye at low tide, is one of the last remaining fishponds on the south side of Maui. A group of dedicated volunteers have formed the non-profit organization (AOAO O NA LOKO I'A) to renovate and restore the fishpond so that it can become a teaching tool for those of us who want to learn about, and preserve, a portion of our colorful, historical past. Additionally, the Kihei Canoe Club and the Maui Community Workday Program have supplied the sanctuary grounds with native Hawaiian plants that range from seaside naupaka to noni to a small koa tree.

If you missed our open house today, please visit us, weekdays from 9:00 am to 3:00

pm and remember -- E Komo Mai -- you are always welcome.

(top) RETURN

January 16, 2000
Investigating Coral Health, Habitats, and Ancient Climates

Dr. Richard (Ricky) Grigg, Professor
Department of Oceanography, University of Hawai'i

Being selected as the University of Hawai`i representative as a pilot to conduct research in the DeepWorker submersibles in the Hawai`i Sustainable Seas Expedition, has been a privilege and an honor. Working with Chief Scientist, Sylvia Earle, has also been a superlative experience.

Dr. Richard "Ricky" Grigg, from the University of Hawai`i, will be investigating the coral reefs off Maui.

My mission objectives included several multidisciplinary tasks; first to assess the health and status of the black coral bed off Lahaina, Maui and to determine the lower depth limits of the population. Second, I hoped to identify several ancient drowned reefs that grew at a time of earlier and lower sea level - about 10,000 years ago. The purpose of this was to collect baseline data on the drowned reefs in order to write future research proposals to drill down into these structures. The information retrieved from the drill cores would represent a historical archive of climate and sea level history for the Hawaiian Islands. My third objective was to characterize bottom fish habitat throughout the deep channels between Maui, Lana`i and Ka`hoolawe.

Thus far in the mission, I have been fortunate to make significant progress in accomplishing all three of these objectives. First, I have been able to establish the lower depth limit of black coral, mean 325 feet. I have also obtained age structure data on the population. Harvested areas are healthy and in an advanced stage of recovery. The harvesting rate in the past appears to be sustainable. I have also made one reconnaissance dive with Sylvia Earle on a drowned fossil reef pinnacle in the `Au`au Channel. Other scientists in the program including Steve Gittings and Kip Evans have also helped in documenting all of the above.

Coral Reefs found in the underwater Molokini Crater off the shores of Maui.

Perhaps the most challenging and gratifying experience has been learning to be a pilot. The DeepWorker submersibles are ultra high-tech machines of great capability but they do require a high level of skill for operation. To spend over 10 hours in the process of making 8 dives in the twilight zone in the deep blue azure waters of Maui has made one of my lifetime dreams come true. I look forward to making even more dives in the future.

(top) RETURN

January 17, 2000
Do Whales Eat at Night ?

Kelly Benoit Bird, Graduate Student
Hawai`i Institute of Marine Biology

My research focuses on the feeding ecology of marine mammals. This means I study what marine mammals eat, and why they choose those foods over other foods. In Hawai`i there is a community of fish, shrimp and squid that migrate towards the surface at night but are found very deep during the day. This mesopelagic (midwater) boundary (island associated) community is an important food resource for spinner and spotted dolphins, as well as bottomfish and gamefish such as tuna and marlin, but likely only during the night.

Whitlow Au and Kelly Benoit Bird collect date into the wee hours of the morning. The organisms that they are studying migrate to the surface at night but are found very deep during the day. Therefore, they begin their scientific research after sunset.

I have been studying this boundary community around the islands of O`ahu and Hawai`i using acoustics. I'm using a fishfinder that has been modified to read directly into a computer. I deploy this device off the Ka`imimoana during nights when no other operations are going on. With this system, I can 'see' the small fish, shrimp and squid that are migrating nearer to the surface in dense layers. I also deploy this fishfinder on the submersible, pointing it in the same direction as the camera. I'm trying to collect simultaneous video and acoustic information so I can get a better idea of what the fishfinder is trying to tell me.

It has always been believed that humpback whales do not feed while they are in Hawai`i, where they breed. No one has ever observed a humpback whale feeding here. Then again, no one has ever seen them mating either, and we know that must be happening. Foraging theorists have modeled the feeding of humpback whales and have determined that the density of food in Hawai`i is so low that it would cost the whale more energy to chase the food than the food actually contains. Basically, that means there is no point to feeding. This model holds true during the day. My research

Whitlow Au deploying the towfish into the waters off Lana`i midnight Sunday night.

however, is finding incredibly rich and dense food resources during the night around the other islands. We are trying to determine if the amount and density of food present in areas where whales are could possibly be high enough to provide an exploitable resource for these animals. Perhaps, we will be able to point whale researchers in the direction of studying whale behavior at night, and comparing and contrasting that information with their daytime behavior.

(top) RETURN

January 18, 2000
A Long Journey With a Purpose

Steve Gittings, Science Coordinator
NOAA National Marine Sanctuary Program

Hawai`i is a one-of-a-kind place. Separated by thousands of miles of ocean from other large land masses, many of its land and sea creatures are found nowhere else. More than 20 percent of its ocean residents are endemic to these islands.

But even as isolation and time have given rise to many new species on this island chain, there are animals that treat an annual trip to Hawai`i as a simple fact of life. Humpback whales arrive every winter from the cold waters of the north Pacific to the Hawaiian Islands and depend on the islands to meet their needs to reproduce and raise their young. Their many songs and behaviors have been the subject of study for quite a few researchers over the years, and some professional photographers have built careers in partnership with these magnificent creatures. The culture of the islands themselves has always embraced the humpbacks. It teases the imagination to wonder why there are so many whales in the waters off the island of Kaho`olawe, whose profile could easily be mistaken for a giant humpback, and whose earlier Hawaiian name paid homage to Kanaloa, god of the oceans.

Humpback whales are regularly sighted in the waters off the island of Kaho`olawe.

The Sustainable Seas Expeditions arrived to the waters of the Hawaiian Islands Humpback Whale National Marine Sanctuary with a simple purpose -- to better understand what makes these legendary waters tick. We firmly believe that it is only with understanding that we humans can hope to avoid the unnecessary destruction of the natural world that we depend on for everything from life to lawnmowers. One objective was to find out what lives in the waters and on the seabed in areas where humpbacks roam. We also hoped to get "baseline data" from sites that might later be revisited to look at long-term changes in the health of the region. We would also

make opportunities available for local scientists and educators to see their world from a different perspective, perhaps even first hand through the plexiglass dome of a submersible. In the end, one of our greatest hopes was that we might work with these people to identify areas of research that need to be pursued to take our understanding to an even higher level, and with luck, help make it happen.

Ready, Aim, Survey!

The weapons in our scientific arsenal included two DeepWorker submersibles owned and operated by a tremendous group of people from American Marine Corporation; a remotely-operated underwater vehicle (ROV) owned by SSE, and the impressive oceanographic assets and crew of the NOAA Ship Ka'imimoana. We used the subs and ROV to dive to and film locations that seemed to be particularly well suited to varying types of biological communities. The sites were chosen after careful analysis of high resolution maps produced by the U.S. Geological Survey. The maps accurately depict features as small as two or three meters in size. We also consulted local experts such as Dr. Rick Grigg, Dr. Whitlow Au, and Ms. Kelly Benoit Bird, from the Univesity of Hawai`i, who participated on the cruise and were thrilled to see areas they knew so well in such detail, geologist Dr. Chip Fletcher, and officials from the State Dept. of Land and Natural Resources. Between us, we identified many "target" locations. Many we were able to visit, but some were a bit too rough to provide the measure of safety needed when putting humans into the sea!

Dr Steve Gittings, Science Coordinator for the National Marine Sanctuary Program, annotates footage from his dives in the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Mission to Explore and Discover

The USGS maps also offered a unique opportunity to speculate about the history of sea level and its relationship to current bottom features. A land bridge existed several thousand years ago between Maui and Lana`i, and being exposed to erosion, it became a complex topography probably consisting of plains, fresh and salt water lakes and sink holes. With sea level rise, the land bridge flooded, and limestone secreting animals and plants grew throughout the area, in some places forming reefs, further complicating the bottom formations. With sea level rising faster than the upward growth of the reefs during the last several thousand years, the reefs, which require light to grow, died off. Today, substrates below 100 feet or so do not appear to harbor many living remnants of these "drowned reefs", but other animals and plants have taken up residence on the bottom. The result is the rugged submarine terrain we see today, and the subject of the submersible surveys that brought us to Hawai`i.

(top)

We conducted single or paired sub dives at each of the targets visited. Lasting from one to five hours, at least one pilot collected video and narrated the dive to describe all the features and characteristics of the dive sites. The other sub collected video or samples for specific purposes. For example, small clips of precious black coral branches will be used by Ms. Amy Baco at the University of Hawai`i to assess the genetic relationships between the colonies throughout the Hawaiian Islands.

One of Dr. Grigg's interests is understanding how black coral populations respond to harvesting. It is important to know whether source populations are available to supply larvae to repopulate areas suitable for black coral growth but depleted by coral harvesting. During the course or our mission, we did not find large stands of black coral in water deeper than areas normally targeted by harvesters or even in any large abundance beyond known coral beds. Though much more survey work should be done to confirm these findings, any repopulation of black coral beds is likely to require reproduction by remaining colonies, so sufficient healthy colonies must be left intact to act as parents for future populations.

The biological communities we observed in the upper four hundred feet of the study area were dominated by either limestone forming crusts of algae, upright branching algae called Halimeda, which grows in vast meadows and forms much of the sand on the bottom, or branching colonies of microscopic animals called bryozoans. Corals, which formed the reefs on which all the others now grow, does not dominate in deep water, but certain types still occur. Some, including black corals, are prized by collectors and are used for jewelry and other ornamental items. In soft bottom habitats between 650 and over 1000 feet, tremendous numbers of sea urchins and tubed anemones dominated. During night dives, millions of amphipods and other small creatures turned the water to a thick soup when they emerged from the bottom, attracted to the lights of the subs. The richness of this place becomes clearly evident at night!

They Love the Night Life

A breaching humpback is a common sight in the sanctuary during the day. SSE scientists are also investigating their habitat at night.

After the daytime dives were completed, Dr. Au and Ms. Benoit Bird worked during the evenings to study the migration of animals that live during the day in deep water. They are working to understand the abundance and distribution of animals that move up every night into the water column from deeper layers of the ocean. Called "mesopelagic" organisms, they participate in a nightly ritual called vertical migration. They swim upwards and toward shore, meeting in large, dense aggregations where they likely feed and possibly reproduce. It is also suspected that these layers provide feeding opportunities for larger animals, including many fish, dolphins and perhaps even humpbacks. Using a towed sonar system, Dr. Au and Ms. Benoit Bird measure this process. Data streams

into their computers every second for hours, and is processed to produce graphs of the depth and thickness of the mesopelagic layer over time. Studying this elusive process is essential to a more complete understanding of how Hawaiian waters support the many species of animals found here.

And in the end...

What are the impressions we are going home with? And what needs to be done to better understand Hawaiian waters and the life they sustain?

The variety of places and things to study in this part of the world is staggering. The geology alone, and the history of life associated with it, is ripe for scientific harvest. The technology available today, including high resolution mapping tools, submersibles, ROVs, advanced diving techniques, and a medley of electronic sensors high above and below the ocean surface, offers opportunities for research that are only limited by the imagination. Studies on geologic history to understand the past and predict the future of climate change could be done with more investigations of drowned reefs throughout the islands. Studies on whale distribution using satellite tracking devices, combined with investigations on vertical migration of mesopelagic animals, might help us understand day-night patterns of movement and possible feeding by these leviathans. Studies on fish and coral distribution, reproduction and larval dispersal will be necessary to ensure the long-term survival of these, and other harvested animal and plant species. And long-term monitoring stations that track things like changes in water quality in certain places and the fate of introduced species to the islands should be established.

The most enduring impression I personally took from these islands relates to the natural forces that create and reclaim them. Nature is clearly in charge of this place. We saw it in the weather and seas that forced changes in plans, in currents that ended sub dives, in the majestic walls above and below the surface along the south coast of Lana'i, and in the breaches of whales. I feel honored that nature saw fit to give up at least a few of its secrets.

Aloha.

(top) **RETURN**

January 19, 2000
Commander Wright Bids SSE Farewell

Tim Wright, Commander -- NOAA Ship
KA`IMIMOANA
Office of NOAA Corps Operations

Commander Tim Wright graciously welcomed the SSE team aboard his vessel and gave us a home away from home for ten days, while we explored sanctuary waters of four island regions: Maui, Moloka`i, Lana`i and Kaho`olawe.

The KA'IMIMOANA *(The Ocean Seeker)* has safely and successfully completed the first Sustainable Seas Expedition cruise of the year 2000. It has been a very satisfying and interesting experience for all the officers and crew. After several days of preparation and training, KA'IMIMOANA recovered and deployed the one-person submarines DeepWorker 8 and DeepWorker 9 with assistance from American Deepwater Engineering.

The area of study, NOAA's Hawaiian Islands Humpback Whale National Marine Sanctuary off Maui and Lana`i, offered spectacular scenery and ocean life above and below the water. The mountains and rainbows of Maui were a magnificent background to the whales and dolphins around the ship. We look forward to viewing the video and samples collected by the submarines and scientists.

This expedition was an outstanding example of cooperation and partnership between a government agency (NOAA), private enterprise (American Marine Corporation), the National Geographic Society and academia (University of Hawai`i). Led by Dr. Sylvia Earle, National Geographic Society Explorer-in-Residence and former Chief Scientist of NOAA, important advances were made in exploring and understanding one of our nation's great treasures -- the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Among the most rewarding aspects of the cruise were visits by high school students from all around the Hawaiian Islands to KA'IMIMOANA.

The Ka`imimoana travels into the sunset as it heads back to Honolulu. The at-sea portion of the Hawai`i Sustainable Seas Expedition wrapped up today with two final spectacular dives to 1,300 feet.

Their enthusiasm and interest during the workshops, conducted by shipboard scientists, was gratifying and rewarding for both the students and instructors.

KA'IMIMOANA, her officers and crew, look forward to future cooperation and participation in this type of project. Hawai`i has an extremely valuable resource in its national marine sanctuary. The diversity of life on earth and the importance of our stewardship for future generations to enjoy this diversity can only be appreciated and enhanced by projects such as this. We are proud to be a part of the Sustainable Seas team

(top) **RETURN**

January 22, 2000
Sustainable Seas Celebration and Open House at the Waikïkï Aquarium

Naomi McIntosh, O`ahu Sanctuary Liason
Hawaiian Islands Humpback Whale National Marine Sanctuary

On January 22, NOAA's Hawaiian Islands Humpback Whale National Marine Sanctuary, in collaboration with the Waikïkï Aquarium, hosted a one-day special event for families to celebrate the Sustainable Seas Expeditions in Hawai`i.

Children had fun pole "fishing" at the Dept. of Land and Natural Resources, Div. of Aquatic Resources booth. This hands-on activity developed by the Hawai`i Aquatics Resources Education Project, teaches children about the importance of minimum catch sizes to sustain Hawai`i's fisheries.

Under a clear Hawaiian sky, the first after almost a week of rain, families who ventured to the Waikïkï Aquarium were treated to a variety of festive activities that helped mark the successful completion of the SSE mission in the Hawai`i Sanctuary.

Guest speakers, Dr. Bruce Carlson, Director of the Waikïkï Aquarium, U.S. Senator Daniel K. Akaka, Allen Tom, Sanctuary Manager, and Dr. Sylvia Earle helped to relay the excitement generated by the Expeditions and its discovery mission to document the deep ocean resources of our country's 12 National Marine Sanctuaries. Senator Akaka aroused further excitement in the crowd when he proclaimed his desire to make this new century the "Millennium of the Ocean!"

The highlight of the day was the theatrical performance by **`Öhi`a Productions**, entitled "Beneath the Ocean Blue." Using creative costumes and songs, the talented troop of energetic actors and singers explained the importance of keeping a healthy marine ecosystem in balance. The play designed for kids, had every child and adult in the audience captivated. Dr. Sylvia Earle was so impressed with the performance that

she took a moment away from her enthusiastic crowd of fans awaiting her much anticipated book signing to meet the performers.

Allen Tom, Hawai`i Sanctuary Manager, Senator Daniel K. Akaka, Dr. Sylvia Earle and Bruce Carlson, Director of the Waikïkï Aquarium, welcome visitors to the Sustainable Seas Celebration and open house.

Senator Akaka couldn't help but lean in to get a closer look at the DeepWorker model. The model will be housed at the Waikïkï

The Waikïkï Aquarium is hosting a model of the DeepWorker submersible and SSE informational panels as a special month long exhibit from January 14 through February 6, 2000. A special treat for the open house was the opportunity for Aquarium visitors to meet the SSE DeepWorker pilots who were on hand to answer questions about the deep ocean and the experience of diving in a one-manned submersible.

Representatives from various organizations including Atlantis Adventures, the State of Hawai`i Department of Land and Natural Resources, Kewalo Basin Marine Mammal Laboratory, Department of Education's KidScience, the National Marine Fisheries Service Honolulu Laboratory, the State of Hawai`i Coastal Zone Management Program, the Hanauma Bay Education Program, the Sustainable Seas Expedition, the Hawai`i Undersea Research Laboratory, the Waikïkï Aquarium and the Hawaiian Islands Humpback Whale National Marine Sanctuary Program offered a variety of great activities to help children and adults discover things they can do to help care for Hawaii's ocean.

The SSE Celebration and Open House was a huge success and a demonstration of the community's support for promoting ocean awareness and environmental education.

Keiki (children) model their squid masks that they decorated at the Hawaiian Islands Humpback Whale National Marine Sanctuary's booth.

(top) RETURN

January 23, 2000
National Marine Sanctuary Family Ocean Fair

Jean Souza, Family Ocean Fair Coordinator and Kaua`i Sanctuary Liaison
Hawaiian Islands Humpback Whale National Marine Sanctuary

WKAILUA-KONA, ISLAND OF HAWAI`I--The National Marine Sanctuary Family Ocean Fair was held today at King Kamehameha's Kona Beach Hotel. The enthusiasm and community spirit evidenced in the sign-up of 22 booths was again reflected in the attendance by 450 eager residents and visitors. This well-attended event featured a fun-filled day of learning and inspiration as fair-goers were treated to special activities at each booth, and as a trio of prominent speakers addressed the theme of "Exploring Our Heritage in Oceans and Space."

The Sanctuary's whale-of-fortune game was a popular test of whale knowledge that netted winners a humpback whale poster. A keiki (child) is assisted by the Sanctuary's Native Hawaiian Cultural Educator, Joylynn Oliveira.

All-day activities centering around the theme of ocean and space exploration included a whale-of-fortune game, face-painting, ocean magnet making, mock rocket launches, science experiments, starlab planetarium programs, fishing games, paper fish weaving, turtle construction, and demonstrations of ocean safety. There was also a lot to learn about Hawaiian monk seal and dolphin research activities, fisheries management on the Island, student ocean projects, and Hawaiian traditions. All activities were free to the public, thanks to the generous and creative contributions of booth participants.

Kumu (teacher) Keoni Jennings performed an oli, (a traditional chant) to open the formal part of the program. Hawaiian Islands Humpback Whale National Marine Sanctuary Manager, Allen Tom, served as master of ceremonies, and introduced sanctuary co-manager Dr. Jeff Walters of the Hawai`i Department of Land and Natural Resources, and event co-sponsors King Kamehameha's Kona Beach Hotel and Atlantis Adventures. The contributions of Big Island residents, including those that serve on the Sanctuary Advisory Council, were acknowledged.

Fair goers were treated to body paintings of marine animals as King Kamehameha's Kona Beach Hotel employees and their families donate their time and talents at the face painting booth.

A boy encourages his space rocket to takeoff at the Onizuka Space Center booth.

A standing-room-only crowd of over 225 listened to Dr. Sylvia Earle, NASA Astronaut Joan Higginbotham, and underwater photographer and whale researcher Flip Nicklin. Dr. Earle also participated in a book signing with Borders Books Café and Music.

The Family Ocean Fair was the last of a series of community events held around the state sponsored by the Sanctuary in conjunction with the Sustainable Seas Expedition's visit to Hawai`i.

The Sanctuary would like to thank the booth participants for making this a successful community event. They were: Hawai`i Department of Land and Natural Resources, Division of Aquatic Resources; Natural Energy Laboratory of Hawai`i Authority; University of Hawai`i Sea Grant Program; National Marine Fisheries Service; Sustainable Seas Expedition, National Geographic Society; U.S. Coast Guard Reserve and Auxiliary; Hawai`i Department of Education and KidScience; Atlantis Adventures; Kona Underwater Photographic Society, Kona Sailing Club; Kula Nai`a; Ellison S. Onizuka Space Center; Future Flight Hawai`i; Gemini Observatory; Hawai`i YMCA Aquatics Program; County of Hawai`i Aquatics Program; families and employees of the King Kamehameha's Kona Beach Hotel; Kumu Keoni Jennings; Na Pua Noeau; Susan Lehrner's home school students; and the Hawaiian Islands Humpback Whale National Marine Sanctuary.

(top) RETURN

January 26, 2000
Sustainable Seas Expedition -- Hawaiian Style

Claire Cappelle, Mission Coordinator
Hawaiian Islands Humpback Whale National Marine Sanctuary

Aloha

The Hawai`i Sanctuary sends a warm mahalo to all who helped make the Hawai`i SSE mission a success.

For months we had heard about the successes and the frustrations with the Sustainable Seas Expeditions (SSE). In all honesty, it was with some trepidation that we began planning for the arrival of SSE to the Hawaiian Islands Humpback Whale National Marine Sanctuary. As we began planning for the mission we focused on our strengths -- education and outreach. However as we tapped into the experience and wisdom of the nine previous sanctuaries that hosted SSE and local scientists, we began to pull together a research component that surpassed all our expectations. By January, we had a clear picture of not only what SSE accomplished in previous sites but more importantly what it could be for us. In essence, Sustainable Seas Expedition -- Hawaiian Style.

SSE's arrival presented a unique opportunity for our children to be exposed to innovative marine technology and deep water scientific exploration, the likes of which had never before been available at this magnitude. Approximately 435 students participated in some type of hands-on marine research activities through the efforts of SSE. Students on the mainland and American Samoa were also able to follow the Hawai`i mission through our Web site and local and national broadcasts of KidScience, Hawai`i's Department of Education's interactive distance learning program. In addition, over 1000 tourists and residents joined the sanctuary staff and members of the SSE team at celebrations on O`ahu, Maui and the Big Island.

Local scientists provided invaluable information on local weather conditions, bottom

terrain, species identification and overall habitat characterization complimenting the SSE research team. Overall, twenty-seven dives, including four night dives, were completed during our 10-day mission. The deepest dive for any SSE mission was obtained off Palaoa (sperm whale) Point, Lana`i where the DeepWorker dove to 1299 feet. A rare pelagic octopod, *Haliphron atlanticus,* was observed and captured on film by Dr. Sylvia Earle. The Lahaina Roads area, a "drowned reef" featuring black coral colonies along the walls of this former freshwater lake and Halimeda and Rhodolith communities on the bottom floor was surveyed. In addition, a tow-fish supporting a small fish finder sonar transducer was deployed. This device conducted acoustic measurements of organisms in the mesopelagic zone during the night hours. Habitat characterization dives were launched in the four island region of Moloka`i, Maui, Kaho`olawe and Lana`i. SCUBA operations were also conducted to obtain underwater footage of the DeepWorker's rendezvous with Atlantis Adventures' submarine and to develop educational videotape on conducting underwater transects.

In retrospect, the underlying impetus for the success of the Hawai`i SSE expedition lies in Aloha. Not "ALOOOHA" spoken with indifference, but aloha spoken from the heart. Aloha that spurred the donation of boats, submersibles, education materials, camera crews, staff time, in-kind services and hours of tireless work. Aloha made possible by the generosity of the private marine sector, the federal government, the State of Hawai`i and non-profit organizations who join forces with the Sanctuary.

The Sanctuary would like to extend a sincere *mahalo nui loa* (overwhelming gratitude) to those who contributed to the success of the Hawai'i Expedition:

- Each and every student that participated in SSE - your enthusiasm made us remember why we journeyed into the marine field oh so many years ago;
- The teachers who endured short deadlines, frustrating flight schedules and long bus rides;
- Our partners who came to the table bearing gifts and donations following in the true tradition of aloha;
- Our volunteers who worked endless hours with dedication and vigor; and
- The SSE team in Washington D.C. and those who left their families and homes to spend two weeks with us as we embraced Sustainable Seas -- Hawaiian Style.

A hui hou (until we meet again)

(top) **RETURN**

January 25, 2000

1:00 pm to 2:00 pm Eastern Time (10:00 - 11:00 am Pacific time)
Sustainable Seas Expeditions - Hawaiian Style

Introduction

KidScience joins National Geographic and NOAA's Hawaiian Islands Humpback Whale National Marine Sanctuary on a special underwater exploration. In January 2000, the "Sustainable Seas Expeditions" will be coming to Hawaii to to explore the marine sanctuary and conduct research using a one-person submersible called "DeepWorker". Research projects will examine whale behaviors, the environment the whales inhabit and the ocean floor within the sanctuary boundaries. Students from all over the state will be participating in data collection activities similar to those of the research scientists. One question all will be trying to answer is, "Why do the whales come to these particular waters each year?"

One student activity will be participating in some Atlantis Submarine dives, (pretending that they are inside a whale not a sub), to look carefully at the whale's environment from a whale's point of view. Another project will involve students doing whale counts, whale behavior observations and water chemistry studies on-board whale-watching vessels off the island of Maui. Join us for the "live" KidScience broadcast, "Sustainable Seas Expeditions - Hawaiian Style", January 25, 2000, 1:00-2:00 p.m. EST, to see what the researchers, "DeepWorker", and the students have learned.

KidScience is an interactive distance learning program for students in grades 4-8. It is co-produced by the Hawaii Department of Education and KHET, Hawaii Public Television and has been producing distance learning series for eight years. KidScience programs are delivered via satellite to PBS stations, cable consortiums, school districts and individual schools. During the 1999 school year, programming was broadcast in 24 states with an estimated audience of one million students. Programs are broadcast live, but receiving sites use both live and taped versions of the broadcasts. Three different sites are connected for live telephone interaction during each of the programs. All participants can interact via the Internet before, during or after the live programs. The "ask an expert" section is a popular part of the web site

(http://kumu.mhpcc.edu/kids2/). KidScience programs range from a three to ten part series; length is dependent on content. Each Program within the Series is 60 minutes long.

Helpful tips for participating in the chats -- includes a description of registration, participation, and observation.

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About the Video Broadcast

All broadcasts require the use of RealPlayer. If you do not have RealPlayer installed please click **here** to find out how to obtain it. Otherwise click **here** to view the broadcast.

For those of you with a satellite the coordinates were:
Telstar 5 K25
Frequency vertical down 12144
Event time: 1:00 pm - 2:00 pm Eastern time
Test time: 12:45 pm - 1:00 pm Eastern time

Web Chat Transcript

Claire Cappelle-SSEChatHost- Welcome and please state your name and where you are from when asking a question. If you are able to view the live KidScience broadcast about the Hawaiian Islands Humpback Whale National Marine Sanctuary SSE mission, I hope you enjoy it!

Q1: Peter- What are the SSE observations of the coral reefs? What condition are they in?

A1: Claire Cappelle - Peter this is a great question that I will be saving for the live broadcast. I anticipate that Dr. Sylvia Earle or Dr. Steve Gittings of the Sustainable Seas Expeditions will most likely have a chance to go into more detail about the condition of the coral reefs where they were diving in the DeepWorker 2000 submersible during the mission.

Q2: Becky- Have you identified the "unidentified" octopus???

A2: Claire Cappelle - The last I heard on Sunday at the Kona Family Ocean Fair was that we still had researchers and specialists reviewing the video footage and pictures of the octopus taken by Dr. Sylvia Earle at approximately 1,300 feet off of Maui and Lanai. I will forward this question on to the live broadcast as well to see if they have any updated information.

Becky, I just heard from Dr. Sylvia Earle and she said that octopus expert, Dr. Dick Young from the University of Hawaii Manoa was able to positively identify this species, which was first found in the cold waters off of Norway. More information about the specific species will be available on our web site in the near future.

Q3: Bruce/Gray's Reef - As a Deep Worker pilot my self, I am wondering what was learned by taking the DeepWorker to greater depths?

A3: Claire Cappelle - Bruce, many things were learned by taking the DeepWorker 2000 to greater depths. Dr. Earle and National Geographic Society's Expedition photographer, Kip Evans both went to depths of 1,300 feet during the Hawaiian Islands Humpback Whale National Marine Sanctuary SSE mission. Sylvia happened upon a potential new species of octopus at this depth and obtained about one hour of video footage that is currently being reviewed by specialists. Site characterization and a better understanding of the habitat that the whales live in here are some of the things that they learned from studying the specific target sites.

Q4: Rhea/CCHSinGeorgia - How do we become part of the students at sea project?

A4: Claire Cappelle - We have a great new program called Students-at-Sea with the Sustainable Seas Expeditions. In the next few years the Expeditions will most likely be back at the Gray's Reef National Marine Sanctuary off of Savannah, Georgia and that would be a great opportunity for students like yourself to get involved.

Q5: Puni- What were the similarities and differences between the Hawaiian Islands SSE mission and other sanctuaries for example Grays Reef?

A5: Dr. Sylvia Earle - Throughout all of the sanctuaries that SSE has visited, we have tried to assess the various nature of each place. This coming year, we are developing an instrumentation package that will be left at each Sanctuary site and the basic theme is to find out what each Sanctuary is about and to help establish monitoring stations in these special areas.

Q6: Jason/CCHSinGeorgia - How often are new species of aquatic animals found?

A6: Claire Cappelle - Less than 5% of the world's oceans have been explored, often time many new species are found during exploration of the ocean depths.

Q7: Jason/CCHSinGeorgia - How large was the octopus on the footage?

A7: Claire Cappelle - I believe that the octopus that was captured on film by Dr. Earle was approximately 6-8 feet long. It was identified as a female that was holding on to an egg sack within her tentacles.

Q8: Jason/CCHSinGeorgia - Why is exploration so restricted? (5%)

A8: Claire Cappelle - Exploration into the ocean is not restricted per se, however it is limited due to many different factors. As technology advances with remotely operated vehicles (ROVs) and manned submersibles, more of the ocean depths will be explored in the future. In its deepest depths, the ocean is approximately 7 miles deep. Only two people in history have ever been to this depth, can you imagine? As Sylvia likes to say, the greatest era of exploration into the oceans have just begun.

Q9: Mellie- The fish in this clip look like Blue Striped Grunts. I know these fish are in FKNMS. Are they introduced fish to Hawaii?

A9: Claire Cappelle - The yellow fish you saw on the videotape are called blue-striped snapper and are an introduced species that are thriving in Hawaii as Dr. Steve Gittings mentioned.

Q10: Rhea/CCHSinGeorgia - If some of the whales and other sea life are endangered why do people continue to pollute the ocean?

A10: Claire Cappelle - Great question, Rhea! Even though people know that there are many types of endangered whales and sea life out there, however it is difficult for most people to understand the connection they have with the world's oceans. Even if you live in a land-locked area in the continental United States, your behavior affects the ocean. What fertilizer you use on your lawn, whether or not you recycle, etc. are all ways that one's actions affect the marine environment no matter where you live. Watersheds from all areas end up in the ocean and the world's oceans know no boundaries. It is our hope that with the Sustainable Seas Expeditions, we will not only be conducting research in these special areas that have been designated as National Marine Sanctuaries, but that we will help educate the public how to be more environmentally responsible.

Q11: Jenny/CCHSinGeorgia - Did you observe whales feeding at night? What was learned about the depth of feedings?

A11: Claire Cappelle - We did not have the opportunity to observe humpback whales feeding at night during the Sustainable Seas Expeditions. However a local researcher in Hawaii, Whitlow Au, and his assistant joined the Expeditions and was conducting night observations in testing the density of plankton (krill, copedpods, etc.) and found in the area that would attract resident humpbacks.

Q12: Virginia- Have you heard of the Oceania Project and does the Sustainable Seas project work together with that and other research projects?

A12: Steve Gittings - I don't know personally about the Oceania Project, but SSE works regularly with scientists and educators from other projects. At some of the marine sanctuaries, scientists working on projects funded by money and other support unrelated to SSE use the subs and ship time provided by SSE to enhance their research. We also work with government agencies like the US Geological Survey to conduct research together by combining the efforts of experts from NOAA, USGS, and National Geographic.

Becky and Bruce/GraysReef - Howdy folks, Laura, Patty, Steve, Sylvia et al... what a wonderful broadcast! I loved the aquarium used to demonstrate the DeepWorker, maybe we can do the same for our upcoming Savannah Ocean Festival, April 22. Patty, you were such a wonderful moderator. Hello to Andrea from Gray's Reef as well.

Andrea/NASA Chat Host - Hello - to Gray's Reef as well - 'see you online!'

Mellie- Thank you, Thank you, Thank you. Sylvia and Steve. This has been the best hour of the day.

Claire Cappelle - Thank you all for your wonderfully inquisitive questions. Shortly I will conclude the chat. You will be able to find an archived version of this chat in the future at www.sustainableseas.noaa.gov. Thanks again for your participation.

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Informal Educational Activities

The primary goal of the SSE's informal educational efforts is to mount an intensive public education campaign that inspires both local and national constituents to learn about the value and importance of the national marine sanctuaries and their role in marine conservation. The National Geographic Society and NOAA are working together to present the SSE's ocean conservation message and mission findings through a variety of public outlets including books, magazines, videos, television shows, open houses, fairs, traveling exhibits, staff presentations, press events, and the Web. Some examples of informal educational products that have been completed to date are an **SSE educational highlights video**, National Geographic TV "Sea Stories" and "Explorer" programs, and three books authored by Dr. Sylvia Earle and published by the National Geographic Society: the children's book *Hello Fish!; Dive;* and *Wild Ocean: America's Parks Under the Sea.*

Sanctuary staff members played a lead role in the development and planning of informal education events and programs including open houses, fairs, staff visits to aquariums and schools, and traveling exhibits. During 1999 and 2000, each of the sanctuaries hosted an open house aboard a NOAA ship or onshore at a sanctuary office or local marine center.

Visitors who boarded the NOAA ships had the opportunity to view the *DeepWorker* submersibles first hand. Onshore open house participants got a close-up look at the traveling *DeepWorker* exhibit (a life-sized model of the real submersible). Either way, visitors gained an appreciation of how this technology is being used to explore the depths of our national marine sanctuaries.

Read about open houses in the **June 30 mission log** from the

SSE Education Program

Teacher Materials

Teacher Opportunities

Student Opportunities

The *DeepWorker* traveling exhibit at the Channel Islands SSE open house.

Olympic Coast National Marine Sanctuary and the **August 1, 1999** mission log from Grays Reef National Marine Sanctuary.

Other examples of informal education associated with the Sustainable Seas Expeditions and the national marine sanctuaries include:

A **Live Interactive Tour** of the Monterey Bay National Marine Sanctuary, produced by the National Geographic Society.

Frontiers of the Sea from Radio Expeditions, a partnership between National Public Radio and the National Geographic Society.

Read an **excerpt on ocean conservation** from the inspirational book, Wild Oceans, by Dr. Sylvia Earle.

Media representatives are invited to attend SSE public events. For information contact the **SSE Education Team**.

Informal Education

1999 Education Archive

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SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

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June 30, 1999

Brady Phillips, Public Affairs Coordinator
National Marine Sanctuaries Program

Location: Port Angeles Open House
Time: 9:00 a.m - 12:00 p.m.

Early morning clouds and rain gave way to breaks of sunshine as the Sustainable Seas Expeditions open house began at the Port Angeles City Pier. A front page article entitled "Subs Open to Public" appeared in the Peninsula Daily News with a photo of Bob Steelquist, sanctuary education coordinator, standing next to the two DeepWorker submersibles. The article helped attract upwards of a thousand people to the City Pier from 9:00 a.m. to 12:00 p.m.

Dr. Sylvia Earle greets visitors at the SSE Open House on the Port Angeles City Pier.

This enthusiastic turnout from young to old was labeled a huge success by sanctuary staff, who are dedicated to bringing such opportunities to local Olympic Peninsula communities. Wide-eyed and curious children were abundant as parents and grandparents brought their kids to view the subs and visit the Arthur D. Fiero Marine Life Center. Even several day care centers, summer schools, and boys and girls clubs brought their students down to participate in the open house events. The event was not limited to children -- many adults and especially retirees ventured down to the pier to satisfy their curiosity and find out what these "funny looking subs were all about."

Visitors were able to view the two DeepWorker 2000 submarines used in the mission and talk with the mission pilots and SSE Director and National Geographic Explorer-in-Residence Dr. Sylvia Earle. The Navy ship YTT Discovery Bay, which supported the Olympic Coast Sustainable Seas Expeditions, was also open for tours.

Other open house activities were located in the Arthur D. Feiro Marine Life Center on the City Pier. The SSE display panels with a model of DeepWorker have been on display at the center since Saturday. Visitors could also view actual underwater footage taken from DeepWorker in the Olympic Coast Sanctuary and observe some of the same marine life in the adjacent aquariums and touch-tanks. Children were given

Children observe some of the organisms found in the sanctuary at the Arthur D. Feiro Marine Life Center.

the opportunity to artistically interpret what they would see underwater if they were a SSE sub pilot. There were some very creative kids with vivid imaginations.

Dr. Sylvia Earle was on-hand to welcome visitors, answer questions, and sign some of her new books. Several student summit "alumni" also showed up to check in with Sylvia and learn about this year's SSE mission.

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EXPEDITION UPDATE

June 16 - 30, 1999

Time to get used to some changes, as we say goodbye to the McARTHUR, and to balmy Southern California weather, and move on up the coast to Washington state. This mission will operate from US Navy Ship YTT-11 Discovery Bay which is designed for submersible launch and recovery operations. We're hopeful that this will make us better able to handle the challenges of DeepWorker operations on the open ocean, but we still have to worry about unpredictable weather and hazardous conditions. This mission will run from June 16 to June 30, with a live web chat, courtesy of NASA, on July 1 at 10:00 a.m. PDT.

Gale Mead, Expedition Log Editor

June 17

Olympic Coast National Marine Sanctuary's Sustainable Seas Expedition got under way at the Seattle Aquarium on June 8th with the arrival of the two new DeepWorker subs, capable of diving up to 2000 feet. Olympic Coast pilots trained for 6 days at the Seattle Aquarium, viewed by hundreds of aquarium visitors. Dr. Sylvia Earle's lectures, and other public events, were met enthusiastically by crowds at the aquarium.

Today, June 17th, final preparations are being made for our 19:00 departure. As the Nuytco crew continues working on the subs from the Discovery Bay's fantail, pilots and members of the scientific party are settling into their state rooms and preparing for the cruise.

LOG

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Summary of Investigations

Tonight we will leave the sheltered water of Puget Sound, headed for Olympic Coast. Daybreak over the rugged Olympic mountains will find the Sustainable Seas Expeditions off Cape Alava, preparing for our first dives.

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

(top)

June 18

An electrical short circuit on the ship's crane delayed departure from Seattle for 19 hours. After replacing the parts, Discovery Bay's group cast off from the Seattle Aquarium and headed the ship north, through Puget Sound, toward the Pacific.

Weather conditions have changed in the last 24 hours. A weak low pressure system has moved into the Olympic Coast, bringing mild winds and four to six foot seas. Navy meteorologist, Chief Mike Nelson, is forecasting a high pressure system moving in tomorrow, which will increase winds and seas.

Dive supervisor, Larry Shumaker, will spend the first hours on the coast testing launch and recovery of the subs using the ship's main crane. These over-the-side launches will be more difficult than the stern operations used by the NOAA ship McARTHUR on previous Sustainable Seas missions.

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

(top)

June 21

We've finally completed our first dive in Olympic Coast sanctuary waters! Monday morning, the sanctuary's research coordinator, Ed Bowlby, dove the DeepWorker by the Chibahdehl Rocks (near Neah Bay off Cape Flattery) to depths of 60 to 120 feet. He reported good light penetration, and plenty of sea stars, sea cucumbers, and fish. As long as the weather cooperates with us, we should be able to get a lot more good dives in during the next few days.

Gale Mead, Expedition Log Editor

June 24

Today's mission activities saw some successes, and some frustrations. Attempts to do some benthic sampling during the night didn't yield as much as we'd hoped, but we got some work done with the ROV, and Bob Steelquist was able to complete a good dive to 150 feet. And we got a very welcome break from the rain and drizzle, with blue skies, and some warm, wonderful sunshine.

Gale Mead, Expedition Log Editor

June 25

The team is still experiencing mechanical difficulties, read all about it in the June 25 mission log.

(top)

June 26 - 27

This weekend has been a great success, given that we're still operating under the limitations imposed by the ship's failed Z-Drive. All of our scientists had opportunities to dive within sanctuary waters, several of them to depths between 200 and 300 feet. And we were able to

find some good biologically diverse dive sites for them. Ed Bowlby was able to extend transects started by scuba divers, into deeper water, while Mary Sue, Tom, Annette, and Bob got some great observations of rocky habitat, with rockfish, lingcod, and assorted other critters.

Gale Mead, Expedition Log Editor

June 28

Our last day of dive ops was a big success. Mary Sue Brancato completed a transect that lasted over two hours, and Bob Steelquist had a good deep dive with lots of interaction with the resident critters.

Gale Mead, Expedition Log Editor

June 29

We got an early start this morning, heading back to Port Angeles. There was a flurry of activity to get all our gear packed up and offloaded, as well as preparations for tomorrow's open house on board the ship. Now, the Olympic Coast folks will get busy putting together all the images and data they gathered during their mission, while the rest of the SSE team gears up for the next mission, in Stellwagen Bank National Marine Sanctuary.

Gale Mead, Expedition Log Editor

(top)

Interview

Interview with Carol Bernthal, Manager
Olympic Coast National Marine Sanctuary

What makes the Olympic Coast National Marine Sanctuary unique?

Click here for audio response. (RealAudio), for help see About this Site


Carol Bernthal

The Olympic Coast National Marine Sanctuary is unique in a number of ways. Located on the northwestern tip of Washington's Olympic Peninsula, it's about as far west as you can get in the lower 48 states. This remote, wild seascape has shaped the people that live here. A predominantly rural, coastal community adjoins the sanctuary boundaries and local economies are closely tied with natural resource industries such as fishing, shellfish, and timber. Many families that homesteaded here more than a century ago still live in the community. They survived by learning to use the local resources, and the economic well-being of the people is still closely linked with the sea and land.

Our neighbors also include four Native American tribes with a rich history, lending a culturally distinct flavor to the Olympic Coast. The sea is a predominant theme in Native American art, music, food, and traditions that are still widely practiced. A connection with the ocean is reflected in many of Indian names for local places, such as the melodic word kalaloch, which, according to some, means "a good place to land" or "lots of clams"!

We are also fortunate to share boundaries with the Olympic National Park and the Washington Maritime Wildlife Refuge system managed by the U.S. Fish and Wildlife Service. Together, these protected areas range from the glaciers of Mt. Olympus to the

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dramatic coastline and the deep-water canyons. This provides us with a unique opportunity to witness an entire ecosystem, a rare event in an increasingly fragmented world.

What do you hope to accomplish with the Sustainable Seas Expeditions to the Olympic Coast?

Click here for audio response.

We have three primary objectives for the Sustainable Seas Expeditions at the Olympic Coast. The first objective is to collect information to better characterize sanctuary resources and habitats. Simply put, we need to know what's out there. Specific projects will include characterizing, for the first time, the deep-water sea-floor benthic communities; surveying the abundance and diversity of fish populations in areas with variable levels of fish trawling activities; examining cold-water seeps (offshore areas where cooler water "seeps" from the sea floor); and conducting the first visual transect from nearshore habitats out to the continental shelf. We also hope to explore some of the deep-water canyons off the coast.

Eroded headlands like Point of Arches attest to forces of the sea as it constantly assaults the shore. It is an irony of the rocky inter tidal zone that this constant disturbance creates amazing diversity in inter tidal communities.

Our second objective is to bring this information "home" to the average citizen, to encourage a marine conservation ethic. This will be done through video and photography of a world unknown to most people, and we plan to convey those images through our education and outreach programs. For most people, the sea is a vast and untouchable unknown, unless they happen to be an experienced diver.

Finally, we will test the effectiveness of using submersibles for inventorying sanctuary resources. In other words, what can a submersible do that other research tools, such as sidescan sonar or remote cameras, can't? We have a great need to figure out the best and most cost-effective means of gathering the information that will help us be responsible managers of the marine environment.

(top)

How will the Sustainable Seas Expeditions help you better manage the resources of the Olympic Coast?

Click here for audio response.

It will provide information on the health and abundance of marine resources, a "report card," of sorts, on the marine world. In many cases, it will be the first direct observations of these places. This information will let us know how well we are doing as marine stewards. It also acts as a baseline of the natural world, which is inherently changing and dynamic.

For example, one of major management issues in the Pacific Northwest is declining fish populations. Several species of rockfish like bocaccio and Pacific cod, are of particular concern, as these populations are now found at levels lower than 10 percent of their historic abundance. One of the alternatives being discussed by scientists is the use of marine reserves to protect these species. By observing the differences in sea-floor characteristics and fish populations in both heavily and lightly trawled areas, we can gain insight into how best to designate and locate such reserves to be truly effective.

What types of educational projects are planned?

Click here for audio response.

One of our projects associated with the Sustainable Seas Expeditions is a teacher training workshop on August 8 to 13. Fifteen high school teachers from around the country will attend the workshop. The five-day workshop will place a strong emphasis on field investigations and student-driven research. The Olympic Coast Sanctuary will be used as a natural laboratory to integrate the teaching of natural science and geography. Teachers who participate in the workshop will develop lessons relating to the Sustainable Seas Expeditions and National Marine Sanctuaries, and will give presentations at local, regional and national education conferences. Our hope is that their students will be inspired to

become the marine scientists of the future.

(top)

What are some of the challenges you face in managing the Olympic Coast Sanctuary?

Click here for audio response.

The weather! The window of opportunity for conducting ocean based research is fairly narrow. The Olympic Coast is legendary for its horizontal rainstorms that dump up to 200 inches of rain a year, strong winds in winter, fog in summer and everything in between. I call it beauty with a vengeance, but if you are up to the challenge, it is well worth it.

Sand beaches are home to many types of burrowing organisms. At high tide many emerge to feed in the surging water. As the tide recedes, they withdraw into the sand, protected from drying and predation.

Another major challenge, especially for gaining public awareness of the sanctuary, is access. There are few roads along the coast, with the exception of a few access points, such as at Kalaloch, LaPush, Taholah and Cape Flattery. This makes it especially challenging to enforce regulations in the sanctuary. You really have to have a boat or hiking boots to get "into" the sanctuary. Fortunately, we have a small research vessel, the R/V Tatoosh, that allows us to do nearshore research. The Sustainable Seas Expeditions will expand our range by providing access to offshore areas, and a rare opportunity to drive a one-person submersible. The public education and awareness components of the expeditions will really help us in this realm.

One solution to these challenges has been to focus on building effective partnerships with our neighbors and sharing limited resources, much in the tradition of homesteaders who used "barn-raising" parties to quickly construct shelters using the collective energy of the community. It also forces us to be more creative in

designing programs. Often, our approach is to inspire and empower others in the community to share the workload.

(top)

What are some of the obstacles you face in trying to protect the marine environment?

Click here for audio response.

I think one of the largest challenges we face today is recognizing the interconnectedness of the natural world. There are huge-scale processes effecting marine health. Ocean currents are driven by global climatic regimes; sediment deposition patterns from the Columbia River influence coastal erosion patterns; the list goes on and on. It makes me realize we cannot manage in isolation. What we really need is a change in the way we think and live.

In contrast to many other sites within the National Marine Sanctuaries system, our population base is actually stable or shrinking, and is in transition economically. The term "sustainability" may be a buzzword for many people, but out on the Peninsula, it means the difference between remaining in your community or migrating to a distant city with more opportunities. Tribal communities have been hit especially hard by recent declines in fishing. For the sanctuary, one of the biggest challenges is to find the balance between using resources and protecting the marine environment.

(top)

If you had to envision the Olympic Coast in 50 years, what do you see and how does the sanctuary make a difference in that picture?

Click here for audio response.

I see two distinct paths. The positive one is that coastal communities have invested in sustainable economies that are linked to a healthy marine and terrestrial environment. Because of local,

regional and national support of the sanctuary, groundfish and salmon populations have stabilized and returned to levels that allow a sustainable harvest. Local communities have adopted sections of the coast, and school kids are intimately involved with monitoring. People respect and cherish their cultural identity, and the rift between white and native populations has begun to heal.

Alternatively, I see that we failed to recognize the link between our personal actions and the health of the environment, and as a result, marine mammals, seabirds, and fish populations have declined despite the designation of the sanctuary. Declining natural resources and increasing global populations have caused a collapse in the natural world, which is barely hanging on within protected areas.

The choice is ours. Either scenario is possible. Our staff is trying its hardest to make sure it is the first option. I think the Sustainable Seas Expeditions can help us to secure that positive future.

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Natural Setting

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Like its sister National Marine Sanctuaries, Olympic Coast National Marine Sanctuary represents one of our nation's marine treasures- a jewel with many facets: rugged cliffs, offshore islands, broad sandy beaches and shadowy forests at the ocean's edge. This rugged boundary between sea and land is formed and constantly being re-formed by the Pacific Ocean, which is both a dominating physical force and reservoir of living things, giving the coast its ecological, scenic, climatic and cultural identities.


Robert Steelquist

Situated within the temperate mid latitudes of the Northeast Pacific, the Sanctuary occupies confluences of land and water, of strait and open sea, of continental shelf and submarine canyon.

Humpback whales *(Megoptera novaeangliae)* visit the Sanctuary during spring and summer months, congregating to feed over the rich banks off Cape Flattery.

Its ecological richness owes much to the process of coastal upwelling. Summer wind, blowing primarily from the north, and southerly surface currents, force the uppermost layer of water near the shore away from the land. In its place colder, nutrient-laden water from the deep rises into the sunny shallows. As the deep water mixes at the surface, microscopic plankton thrive, feeding an entire chain of organisms from minute larvae of crab and barnacles all the way up to the largest organisms, including humpback whales. This seasonal pulse, driven by current and climate patterns and day length, translates into abundance in many species: short-

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lived phytoplankton whose whole lives span hours or days and birds, fishes and marine mammals, whose seasonal migrations bring them to the Olympic Coast to exploit the bounty. "Hotspots" of upwelling create local patches of particular richness, supporting breeding populations of seabirds like the common murre and concentrations of fish and their predators.

The rich nearshore environment includes extensive kelp beds, dominated by bull kelp. These forests of the sea harbor many life forms, as nurseries to many species of fish and invertebrates, as complex dwellings because of their complex structure and as forage areas for migratory fish, birds and marine mammals.

Bull kelp *(Nereocystis leutkeana)*forms a critical habitat in Olympic Coast National Marine Sanctuary. Its hollow stems grow quickly, afixed to rocks on the bottom.

(top)

On the shore, this productivity translates into intertidal communities of astonishing diversity and abundance. Headlands, islets and seastacks host invertebrate populations inaccessible to humans. Broad boulder-and cobble-filled tidal flats form complex tidepool systems, teeming with life. Olympic Coast contains one of the most diverse collections of marine algae species on Earth.

From the summit of Mt. Olympus (7,964 feet) to the deepest recess of the Quinault Canyon (4,404 feet deep at the sanctuary boundary) the Olympic Coast's geological legacy gives the place its qualities of drama and ruggedness.

Part of the North Pacific "Ring of Fire," the Olympic Coast landscape is the product of uplift and erosion. Beneath the Olympic Coast, one of the worlds smallest tectonic plates, the Juan de Fuca Plate slides under the advancing lip of the North American continent. This subduction drives the periodic volcanism of the Cascade Range, to the east, including the 1980 eruption of Mt. St. Helens. Basaltic seafloor produced about 50 million of years ago along the volcanic Juan de Fuca Ridge and the sediments of the ancient continental shelf have been scraped onto North America, forming the Olympic Mountains. Moving in fits and starts, this process has left evidence of severe earthquakes in the past, and promises another "big one" in the indefinite future. Tsunamis, earthquake and volcanic energy translated into wave energy in the ocean, remain a constant threat

on the Olympic Coast.

Ochre sea stars *(Pisaster ochraceus)*are voracious predators in the intertidal zone. Feeding on mussels and other mollusks, they limit the range of these species.

The jagged rocks that form the seastacks, islets and offshore islands are mostly remnants of seafloor formed in the last 25 million years. As sea level has risen and fallen over the eons, coastal plains and wave-cut terraces have formed, evident as uniformly flat tops on many of the islands and headlands along the coast. The coastline itself alternates between menacing headlands and quiet pocket beaches of course sand and cobble. That combination, unadorned with highways, condos, and commercial development because of its wilderness status in Olympic National Park, gives the coast its wild appearance.

The maritime climate reveals itself as powerful seasonal trends of wave, wind and precipitation. Winter storm systems, formed thousands of miles away at sea, gain momentum as they track toward the Olympic Coast. Between October and March, periodic storms pound the coast with lashing rain, hurricane-force winds and waves that have been recorded near 100 feet. For navigators of the present, as well as those of the past, the Olympic Coast can be a fearful place--a desperate combination of wrong place at the wrong time. Over 150 documented shipwrecks in and near the Sanctuary attest to the coast's dangerous weather conditions. Remnants of those mishaps endure only as scraps, continually being ground into smaller pieces and scattered.

(top)

All of these natural factors shape cultures of humans as well. The earliest inhabitants, ancestors of today's Makah, Quileute, Hoh and Quinault tribal members, looked to the sea for subsistence and wealth as much or more than they depended upon the land's resources. Hunters of seals and whales, gatherers of mussels and other shellfish and fishers of halibut, salmon and lingcod, they knew the currents, banks, and countless other features of the ocean environment intimately. Their villages

and seasonal camps were placed where marine resources could be exploited to advantage. The characters of song and story brought

voice to animal and spirit beings--embodiments of wildlife and forces they lived among and considered neighbors in the coastal environment.

Common murres *(Uria aalge)*nest in the densest colonies of all seabirds. Females lay one egg per season, holdin the large pointed egg between their legs. Egg losses are high because of predation and disturbance by eagles and gulls.

Even American settlers, importing their "civilization" on foot, by wagon, coastal steamer and later automobile, found the natural setting a powerful shaping and limiting force. Today, a century after the closing of the "frontier," communities of the coast claim only minor footholds on the landscape. Geography and isolation undermine the forces that would transform the Olympic Coast into the cultural and commercial landscape of so many other places.

The Sustainable Seas Expeditions will provide us with glimpses of the sanctuary's hidden face: the world under the horizon. Beneath that surface a broad continental shelf gradually slopes to the west, incised by ancient river valleys and blanketed by sediments flowing off the Olympic landscape. But just as the forces of nature shape the sanctuary and its resources, sea conditions and weather have a profound effect on the missions. Currents which can easily overwhelm the diminutive DeepWorker, swells that can disrupt launch and recovery operations and unpredictable weather can frustrate even the most carefully-planned operation.

Though a small consolation, the conditions that give Sustainable Seas project leaders, researchers and pilots the worst headaches are precisely those which make Olympic Coast National Marine Sanctuary the ecological and cultural treasure that it is--a jewel in a spectacular setting.

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The Sanctuary

Like its sister national marine sanctuaries, Olympic Coast National Marine Sanctuary represents one of our nation's marine treasures--a jewel with many facets: rugged cliffs, offshore islands, broad sandy beaches and shadowy forests at the ocean's edge. This rugged boundary between sea and land is formed and constantly being re-formed by the Pacific Ocean, which is both a dominating physical force and reservoir of living things, giving the coast its ecological,

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scenic, climatic and cultural identities. Situated within the temperate mid latitudes of the Northeast Pacific, the Sanctuary occupies confluences of land and water, of strait and open sea, of continental shelf and submarine canyon.

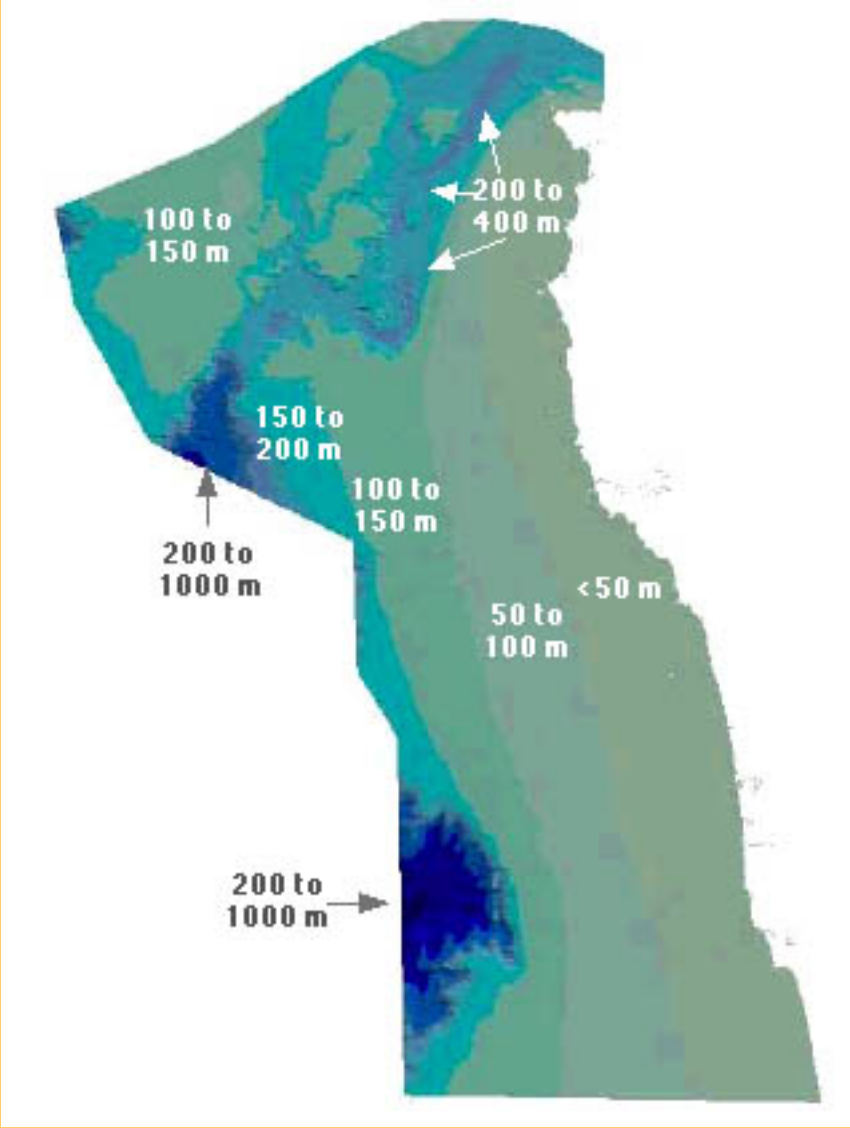
(top)

The Mission

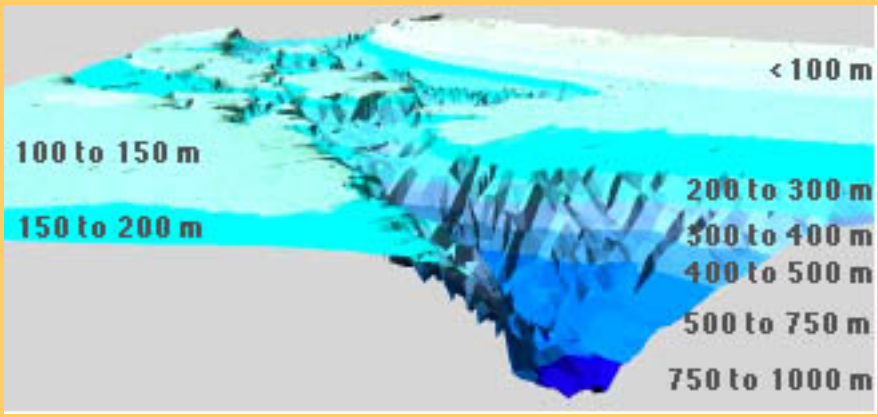
The Olympic Coast team has an ambitious dive schedule. The numbers indicate sites for: 1) an education project to study underwater marine habitats, 2) exploration transects within deep ocean canyons, 3) a research effort to study the effects of fish trawling, 4) a cross-shelf characterization of sea floor and benthic communities, 5) night operations and bottom sampling, and 6) an exploration of cold seep areas and other tectonic features.

(top)

The Sea Floor

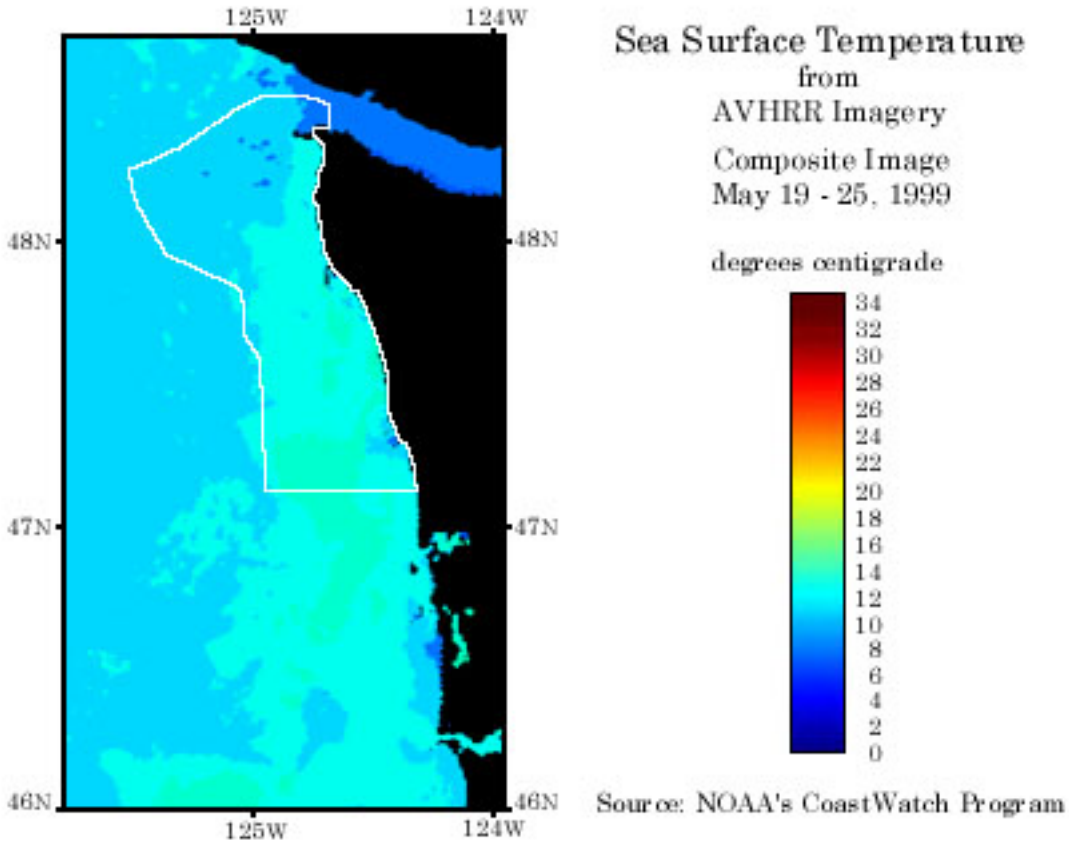


Two dimensional view of the sea floor of the Olympic Coast National Marine Sanctuary. The map has been cut to the actual boundary of the sanctuary. Unlike the California sanctuaries, the Olympic Coast sanctuary features a broader shelf area. The most distinguishing feature of the sea floor is the Juan de Fuca Canyon in the north. This is a very important lane for marine commerce into the Strait of Juan de Fuca.



Three dimensional views of the sea floor of the entire Olympic Coast National Marine Sanctuary (top) and the Juan de Fuca Canyon (bottom). An important research project of the expedition will be to assess sea floor disturbance from bottom trawling in the shelf area (<200 m). (Source: based on NOAA's hydrographic survey data collections)

Sea Surface Temperature

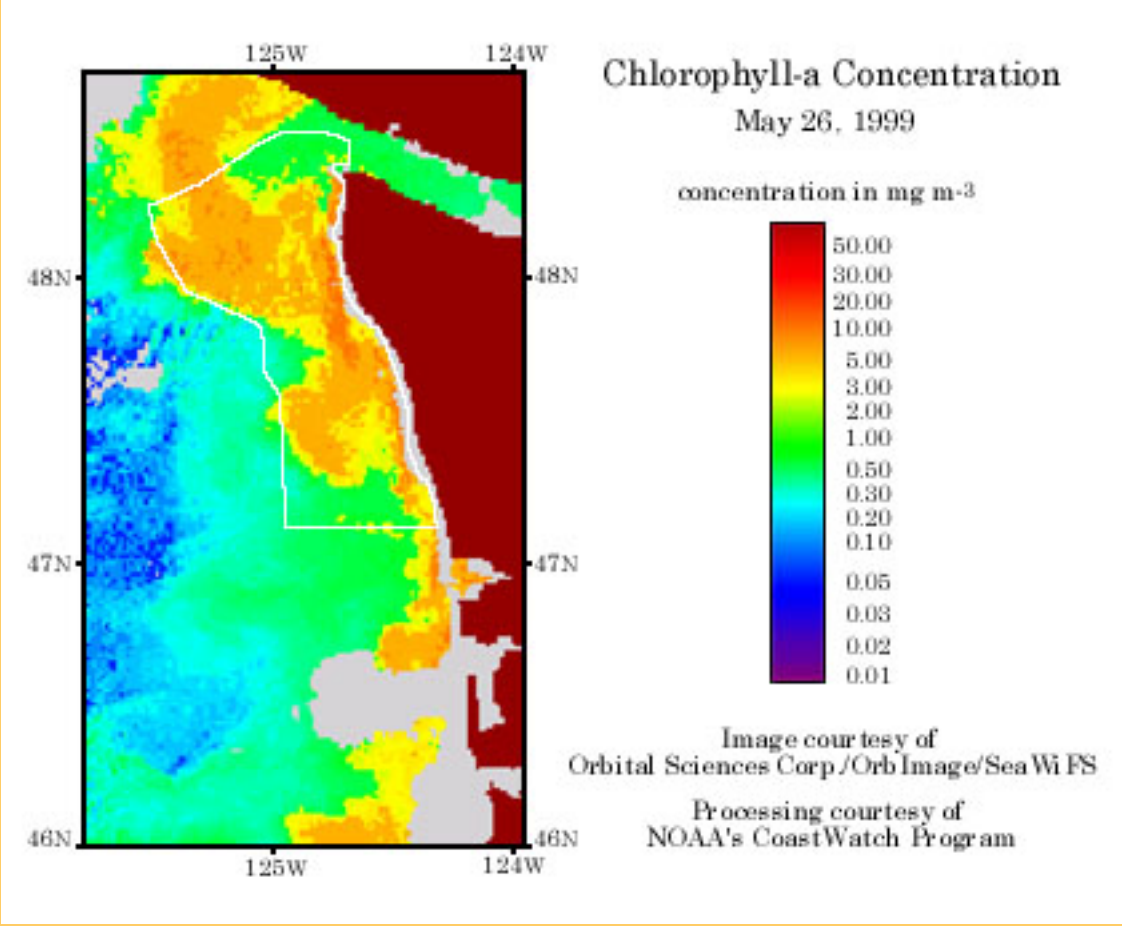


Cool sea surface temperatures (10 to 12 degrees centigrade) characterize the springtime ocean waters of Washington's Olympic Coast. Produced from the Advanced Very High Resolution Radiometer (AVHRR) on NOAA's polar orbiting spacecraft, the scene shows an incursion of slightly warmer waters (13-14 degrees centigrade) extending north in an increasingly narrow band along the shore. Clouds and land are shown in black.

The AVHRR sensor measures radiation reflected from the earth's surface. Data are transmitted from the sensor to ground receiving stations and processed using multi-channel atmospherically corrected algorithms. This particular scene is a seven-day composite image of data collected from May 19-25, 1999. Compositing helps remove clouds that keep radiation from reaching the sensor.

Resolution of AVHRR data is approximately one kilometer. This image represents a series of products being provided by NOAA's CoastWatch Program exclusively for the National Marine Sanctuaries and the Sustainable Seas Expeditions.

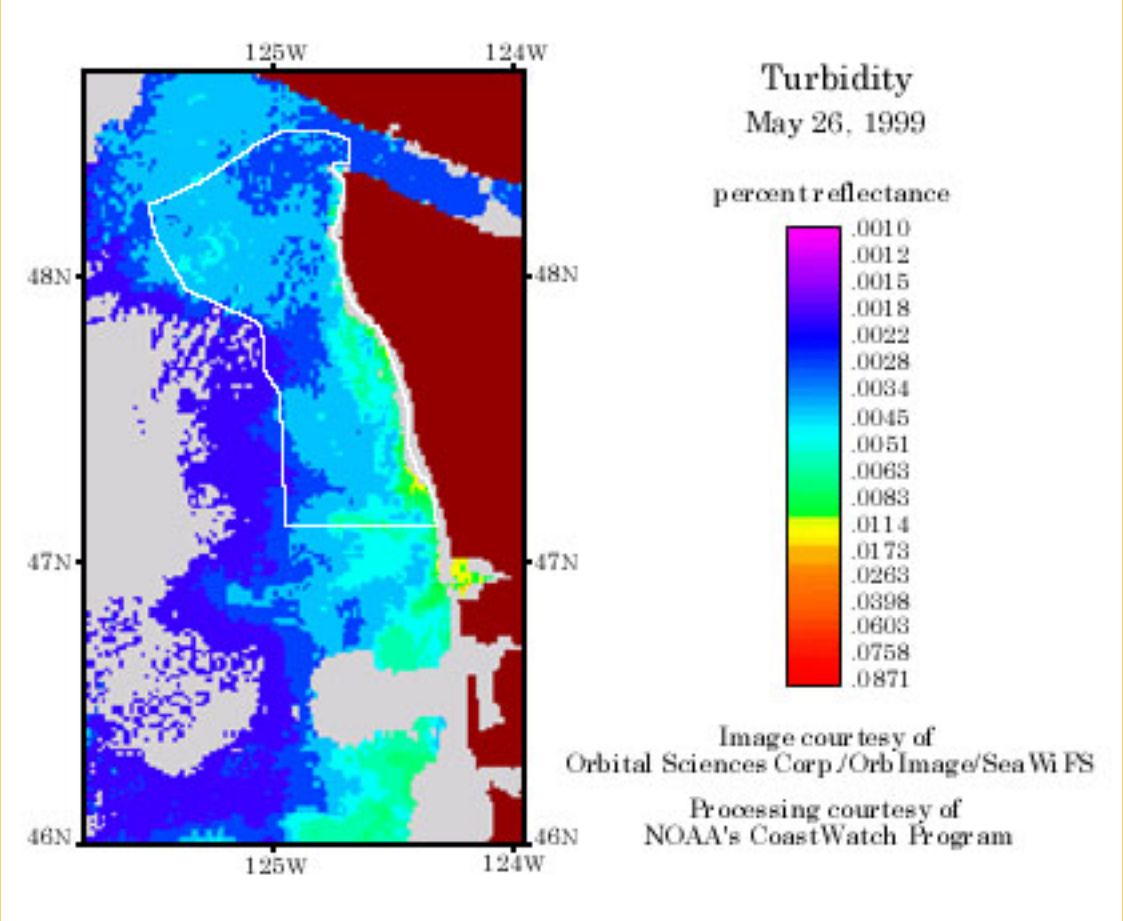
Chlorophyll-a Concentration



Primary productivity along the coast of Washington (as measured by chlorophyll-a) appears, in this partially cloud-covered image, to be concentrated in a relatively narrow band along the shore. A c-shaped feature also appears just west of the Strait of Juan de Fuca. Local upwelling of nutrient-rich marine waters is a probable contributing factor along with estuarine outflows of nutrients from Grays Harbor, Willapa Bay, and the Columbia River to the south. Local patterns of productivity at the sea surface are influenced by many physical factors including winds, currents, and temperature.

False color image provided courtesy of Orbital Sciences Corporation. Data originates from the SeaWiFS sensor (Sea-viewing Wide Field-of-view Sensor) aboard OSC's SeaStar satellite. The sensor measures radiance in specific bands of the visible light spectrum, and the data is used to calculate chlorophyll concentrations. The resolution of this image (minimum pixel size) is about 1 kilometer. The SeaStar satellite orbits about 440 miles above the earth's surface. Image processing provided by NOAA's CoastWatch Program, where a series of remote sensing products are being provided exclusively for the National Marine Sanctuaries and the Sustainable Seas Expeditions.

Turbidity



Turbidity in this illustration provides a measure of suspended particulate matter at the ocean's surface, primarily sediment. Sources include outflows from rivers and bays and resuspended material from the ocean bottom. Local patterns are influenced by winds, currents, and rainfall. Turbid waters appear to be concentrated in a relatively narrow band along the coast, particularly near the mouths of Grays Harbor, Willapa Bay, and the Columbia River.

False color image provided courtesy of Orbital Sciences Corporation. Data originates from the SeaWiFS sensor (Sea-viewing Wide Field-of-view Sensor) aboard OSC's SeaStar satellite.

The sensor measures radiance in specific bands of the visible light which is then corrected to a reflectance value for the water. In this image, reflectance in certain bands results from scattering of light by particles in the water which is generally described as "turbidity."

The resolution of this image (minimum pixel size) is about 1 kilometer. The SeaStar satellite orbits about 440 miles above the earth's surface. Image processing provided by NOAA's CoastWatch Program, where a series of remote sensing products are being provided exclusively for the National Marine Sanctuaries and the Sustainable Seas Expeditions.

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Science Questions and Investigations in the Sanctuary

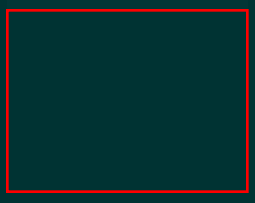
Ed Bowlby, Research Coordinator
Olympic Coast National Marine Sanctuary

Ed Bowlby

Research investigations using the Sustainable Seas Expedition (SSE) DeepWorker submersible will complement ongoing science projects the sanctuary has undertaken since 1995. From rocky tidepools to the depths of offshore submarine canyons, Olympic Coast National Marine Sanctuary encompasses an amazing diversity of marine resources and habitats. To try to understand the interrelationship of such a complex marine ecosystem and to address many resource driven questions, requires different types of research and monitoring efforts. And the complexity, size, and remoteness of the area has necessitated partnerships with many ongoing agency and university efforts, as well as multidisciplinary teamwork.

Intertidal investigations have involved biologists monitoring permanent transect sites or literally walking the entire wilderness coastline. These biologists focus on interrelationships of physical features and forces with macroinvertebrate and macroalgae communities, over space and time. In other words, we are attempting to understand long-term trends in plant and animal distribution and abundance and how these communities may change over time. We are also attempting to distinguish changes due to human impacts versus those occurring naturally.

Investigations that extend out from the shoreline attempt to answer



similar questions but require very different approaches. Scuba divers monitor subtidal communities by swimming transect lines or quadrants, similar to their intertidal counterparts, except fins replace feet. Or they may "capture" macroinvertebrate and macroalgae species via underwater photography, for later analysis in the lab. Other investigators use aircraft to conduct annual photographic surveys of surface canopy kelps, or a combination of aerial and shore-based observers to census the sea otter population, whose populations are intricately linked to the health of the kelp community. To help us track these and many other interrelated resources, the information is logged into a computer (Geographic Information System) for use by scientist or resource manager.

(top)

Other marine mammal populations are monitored by a variety of methods. Most pinnipeds (seals and sea lions) are censused from aircraft when they haul-out on islands, while the at-sea distribution and abundance of cetaceans (whales and dolphins), can only be monitored as surface observations from boat or airplane. Obvious questions include how many there are, where do they forage and on what, and how do they fit into the overall ecosystem.

Similarly, seabird investigations use different methodologies, depending on the species or question asked. Some seabirds are colony nesters on islands and annual overflight counts can be conducted for population trends. For others, and to address the question of at-sea distribution and abundance, biologists conduct visual transects, either from small boats or airplanes along nearshore waters, or from ships for offshore surveys.

Bottom samples from the Sanctuary help researchers map communities of bottom-dwelling organisms.

Understanding the lives of microscopic plants and animals requires completely different investigative tools. These can include net tows from vessels for plankton distribution and abundance studies, or the detective work on why certain plankton species harbor biotoxins that pass up the food chain, seasonally impacting fish and shellfish and even humans.

Plankton and nekton (free-swimming critters) live in a three dimensional

environment and depend on physical attributes of their aquatic realm. Typically, physical oceanographers have utilized ships to deploy instruments to sample water properties, such as the standard "CTD" (conductivity, temperature, depth) arrays that are lowered through the water column to measure temperature and salinity at varying depths and to collect water samples for other tests. Other remote sensing tools measure ocean currents while the ship is underway, using an instrument called an "ADCP" (acoustic Doppler current profiler). Ships also acoustically survey the seafloor to distinguish gross habitat features (e.g. mud bottom vs. rocky) with side-scan sonar or multi-beam surveys, to eventually correlate with associated biological communities. Even satellites get into oceanography by measuring sea surface temperatures and surface plankton blooms.

(top)

And now, with the SSE submersibles in OCNMS, we will take many of the same tools and questions from above, and with our own eyes, go to the sanctuary depths. One of the projects will conduct a video transect across the continental shelf, beginning where the scuba divers left off (60-80 ft. range) and extend an east-west survey line out to the shelf break (roughly 600 ft.). This is an initial attempt to gather baseline information on biodiversity and seafloor physical features. Some of this effort will also "ground-truth" the ship-board acoustic surveys, to determine if the remote habitat classification scheme is accurate, so it can be applied to larger areas.

Another SSE DeepWorker project seeks to learn more about fish behavior, and how it might affect estimations of fish populations, critical questions for fish management. And a nearby investigation will attempt to assess if there are differences in benthic communities between areas heavily versus lightly trawled, which will address the question of the impact of fishing gear on macroinvertebrates and seafloor habitat.

The DeepWorker will also investigate cold seep areas previously identified from

remote surveys, to examine both geological and biological features. These sites expel exotic fluids containing hydrogen sulfide and methane, and may reveal interesting biotic communities.

Fishing is an allowable use of sanctuary resources. As with other uses, however, the balance between protection and exploitation of marine resources requires solid science and appropriate concern for the future of vulnerable fish populations and habitat.

Deep submarine canyons cut into the Washington continental shelf and are thought to serve as pathways for the flow of colder, denser, nutrient-rich water during upwelling events. DeepWorker will explore and photo-document these unique habitats.

Knowledge and understanding gained during SSE and the other ongoing scientific investigations mentioned above will help resource managers to more effectively protect the resources in the Olympic coastal waters.

In my professional career, I've been fortunate to have been involved in a variety of projects that monitored marine life and ecosystems. Now, as a submersible pilot and investigator, I look forward to this new perspective, the opportunity to observe first-hand the deeper water undersea communities. And while conducting the "science" part of these investigations, the visual images that we broadcast may be as exciting and educational to those living in land-locked regions as it was to me growing up in Oklahoma. In fact, my childhood enthusiasm for marine biology, and my decision to follow it as a career, was inspired by stories and visual accounts from the Cousteau undersea adventures. So, besides collecting necessary data for science and resource management, I am hopeful that the images that come from our work here will inspire some young person to the fascinating aspects of these special undersea, sanctuary environments.

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Education at the Sanctuary

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Protecting marine ecosystems is one the most daunting tasks facing our society. What makes the job so difficult is that in order to protect, we must first understand. And while our knowledge of the oceans, their processes and inhabitants has come a long way, huge gaps remain.


Olympic Coast National Marine Sanctuary

As an educator, I see this as a particular challenge, because it means that in order to teach effectively, we first have to also learn. In effect, each of us -- scientist, educator or policymaker -- must become a student again. With the ocean itself as the teacher, we have to become curious, master the skills of observation necessary in this difficult environment and draw our conclusions from what we discover.

The Sanctuary serves as an important living classroom for students. Hands-on field investigation exposes young people to the rigors of science in the real world and builds on life experience in the out-of-doors.

The beauty of Sustainable Seas Expeditions is that with each participant acting as a student, our experiences become that much more valuable to other students, whether they are in grade schools, high schools, universities or other settings. For each researcher and pilot, Sustainable Seas rekindles the excitement of our first encounters with the strange and wondrous worlds within the ocean. And for our Expeditions to be fruitful, we must form our questions carefully, experiment with new tools and methods and be prepared for setbacks. As all students discover, learning can bring its own frustrations and false

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starts.

The Olympic Coast Sustainable Seas missions are all designed to take us to new environments and to find answers to very basic questions: What do these communities look like? Do human activities like fishing affect bottom habitats? How do fish behave around submersibles? Remotely operated vehicles? What lives in the submarine canyons?

The answers to these questions form the basis for research projects of the future. But they will also give us new knowledge to pass on to teachers, writers, reporters, visitors and students of all ages -- the people that are served by Olympic Coast National Marine Sanctuary's current education programs.

For teachers, workshops on intertidal monitoring and the natural history of marine animals and plants will be enriched by techniques for video monitoring that are developed during the Sustainable Seas Expeditions. Looking and asking questions -- the basic premise of the Sustainable Seas Expeditions -- will be developed into more formal methods of inquiry that teachers can use with their students in marine environments near their schools.

(top)

Sanctuary trained ranger-naturalists lead beach walks, tidepool explorations and other educational programs to heighten visitor's awareness of the marine environment

For writers, new information about Olympic Coast's submarine canyons, pictures taken from the submersibles and eyewitness accounts by SSE pilots will be available. For reporters, new perspectives on the link between science and resource protection will emerge. That, in turn, will help the public understand the choices we -- and they -- must make to protect marine resources.

Visitors to the Olympic Coast who travel great distances to experience, first hand, the uniqueness and importance of this place will return home with a better understanding of what lies beyond the breakers and under the flat horizon they see from the coast's scenic vistas.

And students -- from the youngest to the oldest -- will learn new chapters from the Olympic Coast textbook. They will see scientists in action, perhaps inspiring them on to higher educational or vocational goals. They will learn of innovation in research methods as SSE pioneers submersible technology and the use of the Internet as a communications and educational tool.

The Sustainable Seas Expeditions represent an opportunity to bring the marine education process into sharp focus. During the expeditions we renew the sense of excitement that accompanies discovery -- for novices and experts, young and old alike. Most importantly, Sustainable Seas reminds us that this new-found knowledge must lead to new commitments to the protection of the new marine environments we discover.

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Sanctuary Reflections

Dedication Address: Ronald H. Brown, Former Secretary of Commerce
U.S. Department of Commerce

Introduction by: Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

On Saturday, July, 16, 1994, Secretary of Commerce Ron Brown joined other dignitaries and scores of sanctuary supporters in formally dedicating the Olympic Coast National Marine Sanctuary. Sadly, Secretary Brown did not live to see Olympic Coast National Marine Sanctuary fulfill its promise. His life ended tragically in a plane crash in Croatia. Nevertheless, his words of optimism and commitment remain an inspiration and continue to guide Olympic Coast National Marine Sanctuary in its crucial mission. What follow are his comments, made at the time of the sanctuary's dedication.

Secretary Brown:

"The dedication of the first national marine sanctuary in the Pacific Northwest makes this a very special day for the citizens of Washington-and for all Americans.

Olympic Coast National Marine Sanctuary occupies one of the most productive regions of the planet-the North Pacific Temperate zone.

"Let me begin by congratulating each of you - leaders of the coastal Indian tribes, legislators, agency representatives, and residents - who worked so tirelessly to ensure that the bounty and beauty of these waters, this precious heritage, will be here for our children's children to enjoy.

"We are here today to demonstrate that, as President Clinton said,

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America can set an example for the world. We can achieve economic growth that continues through the lifetimes of our grandchildren because we respect the resources that make that growth possible.

"Because of the very special interrelationship we enjoy with the coast and waters that surround us - providing food, sport, income, and recreation - it behooves us to also recognize our obligation to protect and preserve the great resources the ocean represents - and to do so in the spirit of allies, not adversaries.

(top)


Olympic Coast National Marine Sanctuary

Broad rocky inter tidal zones and offshore islands create complex wildlife habitat-rich feeding zones for fish, and invertebrates as well as nest and perch habitats for watchful bald eagles and peregrine falcons.

"There is a Native American proverb that says 'The frog does not drink up the pond in which he lives.' The Clinton Administration is committed to what we call sustainable development. This is a policy of environmental stewardship that allows us to meet the needs of the present without sacrificing the needs of the future.

"President Clinton came into office with a vision of an America that is economically strong and environmentally sound; an America of jobs and opportunities; an America in which the public and private sectors can and do work together for the common good.

"The Olympic Coast is a magnet for visitors, educators, bird watchers, scientists, and fishermen - and women - all attracted by the scenic splendor, the rocky shores, and cobbled and sandy beaches. And importantly for those who call this state and region home, the pledge of protection and preservation that this sanctuary designation brings is the product of cooperative caring on the part of large numbers of people who share a concern about both today and tomorrow.

"Recognizing the need for this kind of delicate balance in our

national agenda, President Clinton has established three principles to guide our consideration of environmental issues:

"First, we believe a healthy economy and a healthy environment go hand in hand. Environmental problems result not from robust growth, but from reckless growth. We can stimulate the economy by making our people healthier, our communities more attractive, and our products and our services more environmentally conscious.

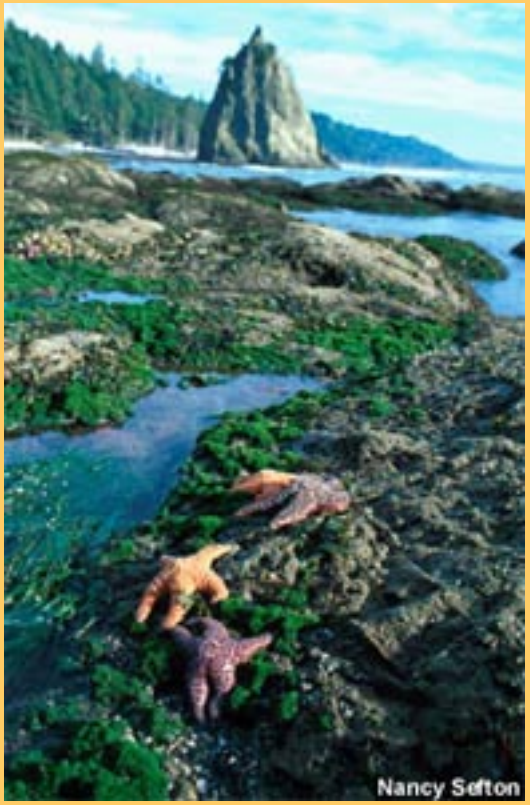
"Second, America must lead the way in promoting economic growth and environmental preservation at home and abroad. We live in an era of global economics, global environmentalism, global epidemics. More and more, our lives and our livelihoods depend upon people throughout the world being healthy and prosperous and respectful of the planet we all share. What is good for the world in this sense is very good for America.

"And third, we must move beyond the false choices and unnecessary antagonisms of the past. We all share a common interest in economic growth that preserves rather than pollutes our environment. With the kind of Yankee ingenuity and the pioneering spirit that carried early settlers across hard trails to the Pacific Northwest, we can have jobs and clean air to breathe, clear water to drink, and fertile fields and oceans.

"All of us grew up in an America that assumed tomorrow would be better than today. We took for granted the fact that our children's and our grandchildren's lives would be better than our own.

"But the world has changed, and the trials of the last two decades have taught us that we cannot take our standard of living for granted - economically or environmentally.

"We must continue to work together - inspired by the delight



The Olympic Coast's remoteness assures that inter tidal communities are spared the pressure of sheer numbers of people. In this wild environment, habitats remain intact and organisms interact through natural processes, including competition for space and predation.

in a child's eye when a harbor seal or gray whale is sighted, or the wrinkled grin of a fisherman when the catch is good. We must honor the tradition of this land as earliest caretakers who approached nature's gifts with appreciation and deep respect. And we must keep our promise to protect nature's legacy for future generations."

(top) **RETURN**

Olympic Coast's Legacy of Exploration

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Bruce Terrell, Cultural Historian
National Marine Sanctuary Program

What is now Olympic Coast National Marine Sanctuary has a long tradition of exploration. The northwest tip of the Olympic Peninsula has had an almost magnetic attraction for sailors and cartographers for almost 400 years.

Juan de Fuca was the name of a Greek ships' pilot who reported visiting what is now known as the the Strait of Juan de Fuca in the 1590s.

It was here, according to the itinerant Greek ship pilot named Juan de Fuca, that the Northwest Passage emptied into the Pacific Ocean. Juan de Fuca, also known as Apostolos Valarianos, claimed that he found a passage between the Atlantic and Pacific oceans in 1592. His visit was never confirmed although his name was preserved on later English maps. For 200 years after his account was published in 1596, Spain, England, France and Russia all sent explorers to confirm his report and lay claim to the region and its riches.

The earliest European explorations of the Pacific coast were conducted by the 16th century Spanish. These voyages were cloaked in secrecy. Documented Spanish exploration on the Northwest Coast began in earnest in the mid-1770s. The first known landing on the Washington coast was attributed to Bruno Heceta in 1775 at the mouth of the Hoh River. His crew were turned back by Indians and he returned to the south having missed

the entrance to the strait.

Sea otters *(Enhydra lutris)*were hunted to extinction in Washington in the early 1900s. Otters from Alaska were reintroduced in 1969 and 1970 and gradually have made a comeback. The current sea otter population numbers over 500 and otters have been seen in the Strait of Juan de Fuca and along the west coast of Vancouver Island.

During the next twenty years several European expeditions explored and mapped the Northwest Coast. Captain James Cook was already a noted Pacific explorer when he passed Cape Flattery on his way to Nootka in March 1787. It was on this voyage that Cook named Cape Flattery because it deceived (or "flattered") him into believing he might find Juan de Fuca's fabled strait to the east. The otter pelts the English obtained from the Indians were to be the key to opening the coast to European colonial ambitions. Cook's sailors sold the furs at great profit when they stopped in China after their Northwest Coast visit. Home in England, the sailors spread stories about the fantastic prices to be had for Northwest pelts in China.

Following the publication of Cook's reports in 1784, British ships began to travel to the Pacific Northwest to hunt the sea otters. Thanks to John Ledyard, one of Cook's Americanized crewmen, American traders began to learn about the potential wealth. New England ship owners, too, began to exploit the region's otters for their luxuriant fur.

(top)

As the British and Americans competed for economic supremacy in the Northwest fur trade, the Spanish were slowly eclipsed. Political events in Continental Europe combined to distract Spanish and English attention while the Americans seized the economic advantage. Spain's three-hundred year old New World empire had weakened while France's attempts at European empire building left the Pacific open to New England's seafaring Yankee traders.

In an attempt to curb their competitors' incursions into the region, the Spanish had attempted to establish outposts at strategic places. Their primary port was at Nootka Bay on Vancouver Island. They established several outposts about the region including on at Neah Bay to serve as a base for surveying the Strait of Juan de Fuca, the

San Juan Islands and the Georgia Strait. Although the bay commanded the entrance to the Strait and provided access to the sea, its shallow rocky bottom and exposure to northwest winds were disadvantages. The pallisaded settlement and port of Nuñez Gaona was briefly established at Neah Bay in spring 1792 under command of Salvador Fidalgo. Because of tensions with the Makah and an unsettled political relationship with the British, Neah Bay was abandoned in the fall of 1792, leaving behind only the crude bricks of a primitive bread oven. The last established Spanish foothold on the Northwest Coast was also the first to fall.

Two hundred years later, our explorations are very different. Instead of exploring to conquer, we are exploring to learn how to protect the marine environment. Although this place has been on the map for several centuries, we don't know much of what's below the surface other than rough contours of the bottom. Sustainable Seas will help us map living communities and habitats, and help us detect changes over time. It will help us make decisions.

There is a continuous thread of exploration that extends back to the time of Juan de Fuca. It involves discovery and it involves mystery. But it also involves something more important - not just what flag flies over this part of the world, but what biological riches of the marine environment will be passed on to future generations.

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Native American Tribes - Sanctuary Partners

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

In June, 1999, an unfamiliar gray ship anchors near Tatoosh Island and its deck crew busies itself lowering a small, odd vessel over the side. DeepWorker 2000 explores a new realm on the Olympic Coast, its pilot and support crew gathering new information about an unexplored corner of North America.

In 1792, an unfamiliar ship nears Tatoosh Island and its deck crew busies itself lowering a longboat over the side. The small craft explores a new realm on the Olympic Coast, its master and support crew gathering new information about an unexplored corner of North America.

Imagining both scenes, we probably place ourselves on the vessels, seeing with our Euro-American minds-eye the unfolding scene. But instead, imagine that we are standing proudly on the rock outcrops at the very tip of the land, interrupted from our daily work and astonished to see strangers visiting the shore we know intimately, and which our people have known for generations.

Four coastal tribes-the Makah, Quileute, Hoh and Quinault-depend upon the sanctuary as protection of marine resources upon which their people depend.

Most histories overlook this perspective, yet for descendents of those observers, the perspective has survived overwhelming odds and thrives today. Members of the

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four Olympic Coast tribes-the Makah, Quileute, Hoh and Quinault-justifiably assert that the discoveries of European explorers were not original discoveries at all, rather just the first of many trespasses that forever altered the fabric of a world they well understood at the time.

Human presence on the Olympic Coast predates historical record and attests to the subtle understandings of the marine environment.

When Washington Territory's Governor Isaac Stevens negotiated treaties that would exchange Indian claims to much of their ancestral land in return for reservations and support from the U.S. Government, significant rights were reserved by the Tribes. Those rights include the right to fish, gather shellfish and hunt in usual and accustomed places. In the Treaty of Neah Bay, Stevens agreed that the Makah would retain their right to hunt seals and whales. Taken together, the treaties recognized the profound relationships between Native Americans and the marine environment. As documents, they became the "law of the land."

Nearly 150 years after the treaties were signed, the documents form important bonds between the government of the United States and the governments of each of the treaty Tribes. They also bind all parties-U.S. and state governments and the Tribes-as stewards of the marine resources that we increasingly depend upon in common.

(top)

When Olympic Coast National Marine Sanctuary was created, the U.S. Government pledged that the sanctuary would honor existing treaty rights to fulfill our part of the historic bargain. The sanctuary was designated with support from the four tribes of the Olympic Coast. In supporting the sanctuary, tribal resource managers saw the promise of a partner in preserving marine resources and the cultural links to the marine environment that Native Americans forged over the millennia. The tribes play crucial roles in assisting the sanctuary to shape policy, research and education programs through ongoing consultations, joint projects, and as members of the Sanctuary Advisory Council. On a day-to-day basis the sanctuary and the tribes act collaboratively, different perspectives focusing on the long-term health of a common priceless ecological and cultural legacy.

As the Sustainable Seas Expeditions visit Olympic Coast National Marine Sanctuary, Makah, Quileute, Hoh or Quinault observers may very well be watching from shore or as honored guests on ship tours of the operations. Without question, the perspective they see will be their own, as Native Americans and as individuals. But the gulf between clashing world views of 18th Century explorers has, we hope, diminished. And the outcomes of Sustainable Seas Expeditions will be knowledge new to all of us, and protection for the whole fabric of the marine ecological web that we manage - and share - in common.

(top) **RETURN**

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Relationship between Olympic Peninsula and Marine Sanctuary

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Robert Steelquist

Too often we view the world's parts without considering their relationships. Nowhere is this more evident than our separation of the ecological resources of the land from those of the sea. In reality, these are parts of the same system. And they influence each other in profound ways.

Olympic Coast National Marine Sanctuary, by definition, extends seaward from the coast, covering much of the continental shelf. But most of that area was dry land during the last Ice Age. The submarine canyons, which we are exploring during the Sustainable Seas Expeditions, were river valleys: steep-walled canyons lined with patchy vegetation, home to wild animals like mastodon, steppe bison and others.

Imagine the ancient Juan de Fuca River coursing through the meandering valley that lies just off Cape Flattery. With the collective power of all the Puget Sound rivers, and all the rivers of the mountainous coast of British Columbia, including the mighty Fraser River, a deep gorge was carved, and sediments from the vast interior of the land spilled into the abyssal plain of the Pacific. As the Ice Age glaciers melted around the globe, sea level rose, drowning the great river and creating the modern shoreline-the boundary between land and sea that we see today.

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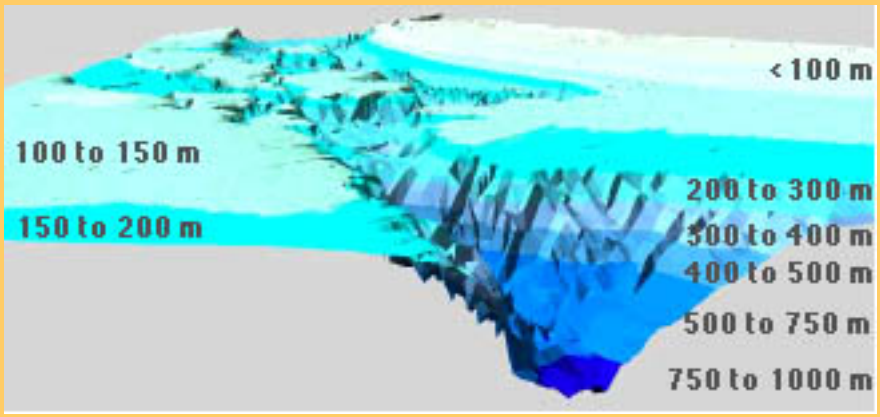

A three-dimensional view of Juan de Fuca Canyon.

In modern times, the relationship takes many forms. The lush temperate forests that the Olympic Peninsula is renowned for are relatively recent developments. Within the last 4,000 years the maritime climate of today evolved. Global changes within the ocean's circulatory patterns created a shift in climate, and an increase in precipitation that gave rise to the giant conifer forests we see today. With prevailing wet-season weather originating far out at sea, even snowstorms in the mountains are referred to as "Pacific" storms.

(top)

In biological terms, the ocean exerts powerful influence on land-based ecosystems. Salmon, another symbol of the Olympic Peninsula's rich ecological legacy, depend on both terrestrial and marine ecosystems for survival. Hatching in the gravel of the Peninsula's rivers,

they spend their early lives in the pools, riffles, ponds and lakes of the land. As they mature, they migrate to sea, spending up to four years fattening in the rich pastures of the North Pacific. As adults, they return to their birth-streams, to spawn and die. Not only does their return signify the renewal of life through their offspring, it signifies the nourishment of land plants and animals with their spent carcasses-gifts of phosphorus and nitrogen from the ocean.

We are all drawn to the ocean's edge to wonder at life's most basic questions, and marvel at the ocean's astonishing diversity.

Harlequin ducks and marbled murrelets are other reminders of the fundamental relationship between the forested river valleys of the Olympic Mountains and the marine waters offshore. Harlequins nest high in the shady river canyons, within the sound of the roar of white cascades. Soon, they migrate downstream and take up residence within the sound of the roar of white breakers, in the nearshore areas of the ocean. Marbled murrelets were until recently, ornithological puzzles. Spending most of their lives feeding on small fish off the coast, no one knew just where they nested, although is was suspected that they hatch their young high in the mighty boughs of old-growth trees. Persistent researchers confirmed this as fact. Now murrelets are beset by impacts from both the land and sea-clearing of old-growth habitat where they nest and capture in fishing nets and depletion of their food supply in the habitat where they feed.

The land affects the ocean too. What flows downhill ends up in the ocean. The effects of pollution on land, of soil erosion, fertilizer and pesticide use, even the introduction of common persistent viruses into the ocean, all reflect interconnectedness. Water quality in Olympic Coast National Marine Sanctuary is relatively clean because of few "upstream" industrial pollution sources. Yet the sanctuary is extremely vulnerable to oil spills, indirectly caused by our land-based consumption of petroleum products.

(top)

These relationships often exceed the limits of our perceptions of the environment.

They also challenge the institutions that protect the environment. When we see the world as separate compartments--Land, Sea, Sky, River--how do we adequately protect those things that depend on all of these parts in order to survive?

The dedication of Olympic Coast National Marine Sanctuary, in 1994, reflected a change in that perception of separateness. An important reason for creating the

Sanctuary was the fact that the core of the Olympic Mountains and much of the Olympic coastline are within Olympic National Park. In addition, since 1906, islets and rocks along the Olympic coast have been part of the National Wildlife Refuge System. Adding the continental shelf area in Olympic Coast National Marine Sanctuary revealed a recognition that the land, the islands and the ocean must be protected together.

The Olympic Coast sanctuary is comprised of 3,310 square miles of ocean. Drifters, like this moon jelly, travel on currents and feed on plankton that is nourished in the mid-waters where nutrient-rich deeper water mixes with the sunlit surface layer.

Our planet, though comprised of seven parts ocean to three parts land, is a single system. Water is a required ingredient for every living thing on Earth. Understanding how these systems interrelate, how they are mutually dependent and how to enlarge our vision and our institutions that protect the whole is our greatest challenge. At Olympic Coast National Marine Sanctuary, our job is that next step. During the Sustainable Seas Expeditions, we carry that vision and responsibility to new landscapes-where the depths of the ocean and the banks of an ancient river are one and the same thing.

(top) **RETURN**

Shipwrecks

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

The combination of fierce weather, isolated and rocky shores, and heavy ship commerce established, early on, the Olympic Coast as a graveyard for ships.

Olympic Coast National Marine Sanctuary is the graveyard for over 150 documented shipwrecks.

More than 150 wrecks have been historically documented in the vicinity of the Olympic Coast National Marine Sanctuary, an amount proportional to the commercial development in the region and the region's significance in the economic lives of the United States and Canada. There are few recorded shipwrecks prior to the mid-nineteenth century, and no authentically-reported wrecks during the eighteenth century. The number of losses increased significantly as Puget Sound developed as an economic center and as Victoria developed on the north side of the Strait in the later 19th century.

Ship losses were predominantly weather-related, including founderings, collisions and groundings. Many ships simply disappeared, their last known location recorded by the lighthouse tender at Tatoosh before they disappeared into watery oblivion. "Last sighted, Cape Flattery," is the grim epitaph for many unfortunate ships and crew.

One of the best-known wrecks on the Olympic Coast was that of the Austria, a Bath, Maine-built "downeaster" converted from a full-rigged ship to a bark to ply the West Coast trade. Fragments of the Austria remain visible at Cape Alava during extreme low tides.

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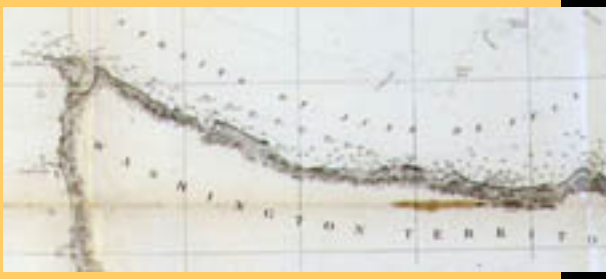
Tatoosh Island marks the treacherous entrance to the Strait of Juan de Fuca for ships.

An etching of Cape Flattery



An etching of the Strait of Juan d

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June 19, 1999
Daily Operations Meeting

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Coordinating a ship, a ship's crew, pilots, submersibles, launches, scientists, and technicians requires a constant flow of communications among every member of the expedition team. Every evening, after the submersibles have been serviced and the crew fed, the ship's galley is packed for the daily operations meeting. Led by Dana Wilkes, Sustainable Seas Expeditions operations chief, the "ops meeting" is a forum in which the day's events are dissected -- failures and successes alike.

The expedition crew gathers for a post-dive meeting.

Each DeepWorker pilot discusses his or her dive and what worked and what didn't. Dive supervisors go over details of each dive. Deck crew from the Discovery Bay talk about launch and recovery problems and solutions. After the day has been reviewed, Navy Chief Aerographers Mate Mike Nelson provides a weather forecast. Chief Mike is on loan for the project from San Diego.

Navy Chief Mike Nelson downloads satellite data.

NOAA Corps officer Dana Wilkes reviews the next day's dive schedule with the SSE crew.

Dana Wilkes then reviews the schedule for the next day's dives, including locations, and project objectives. With each expedition team member contributing a unique perspective and benefiting from the big-picture view, everyone finishes the day with a clear understanding of the day's events and the lessons we have learned as SSE continues to unfold.

(top) **RETURN**

June 20, 1999
GeoBear Goes to Sea

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

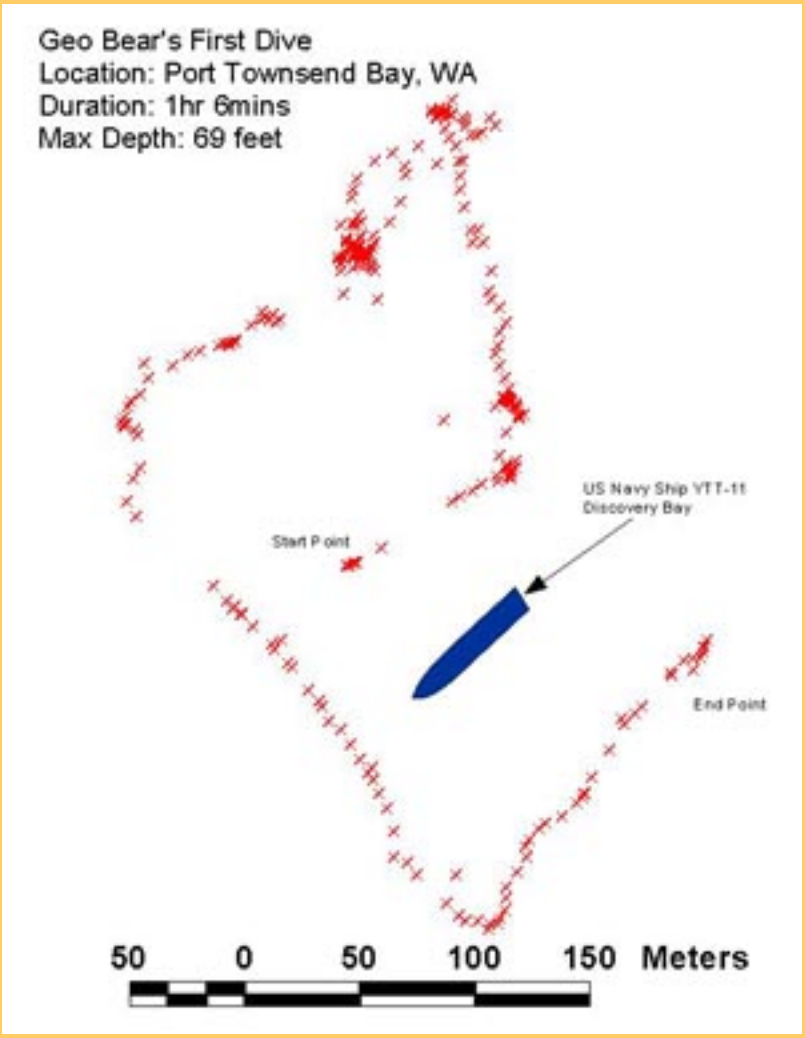
The furriest member of the OCNMS SSE crew is GeoBear, a stuffed bear who measures about 8 inches tall. GeoBear joined the cruise in Seattle as the class representative from first,

second and third graders at Chase Lake Elementary School in Edmonds, Washington. GeoBear spent much of the 1998-1999 school year touring national parks, reporting back to the students occasionally as part of their "National Parks" geography unit. During Sustainable Seas Expeditions, GeoBear will visit Olympic Coast National Marine Sanctuary. If he likes going to sea, he may decide to continue on to Stellwagen Bank, Grays Reef, Florida Keys and Flower Garden Banks National Marine Sanctuaries.

GeoBear in stateroom.

The decision to join SSE was made quickly. GeoBear loves adventure, meeting interesting people who work in the environment, and seeing America's most important places. The chance to visit a National Marine Sanctuary and dive in a submersible was just too good to pass up. The first night aboard the YTT Discovery Bay, GeoBear found his stateroom and settled in. Along with the other crew members he stowed his survival suit where he would be able to find it quickly in the event of an emergency.

GeoBear prepares to co-pilot DeepWorker with Olympic Coast National Marine Sanctuary Education Coordinator Bob Steelquist.



A track of GeoBear's mission.

On June 19, GeoBear got his first chance to dive in a submersible. He rode along as co-pilot with Bob Steelquist, one of the OCNMS pilots. Bob's dive was his final checkout dive in DeepWorker.

His mission was to dive to 69 feet and travel along a course that was set by the dive supervisor using only a compass. GeoBear had a good view inside the submersible, but visibility was only about 2 feet outside the sub. Driving in a straight line underwater isn't easy, especially when you can't see more than two feet.

GeoBear will have more chances to go on DeepWorker dives. Once the weather in the sanctuary gets better GeoBear will get the opportunity to see some fish.

Debugging Crane Operations

With Sustainable Seas Expeditions changing ships for the Olympic Coast NMS mission, many adjustments in launch and recovery operations have been necessary. Aboard the NOAA ship McARTHUR, subs were launched and recovered off the fantail using an A-frame crane. The YTT Discovery Bay has two cranes. The main crane launches off the side and the knuckle crane launches off the stern.

Navy torpedo recovery vessel YTT Discovery Bay with DeepWorker 2000 deployed.

(top) RETURN

June 21, 1999

Ed Bowlby, Research Coordinator
Olympic Coast National Marine Sanctuary

Tom Jagielo, Scientist
Washington State Department of Fish and Wildlife

Sponge photo taken from DeepWorker.

After the struggles of the past few days, we were finally able today to get some dives completed within the sanctuary's waters. **Ed Bowlby** was the first pilot to get the sub in the water this morning, and he provided the following account of his adventure:

"Once released from the ship's line, I engaged the electric thrusters and powered towards the rocky coastline I knew so well from previous scuba surveys. Cape Flattery is a spectacular area, both above and below the surface, but this time DeepWorker and I would travel to greater depths than my dry suit and scuba tank safely take me. After VHF radio clearance from the ship ('topside'), I flooded my ballast and trimmed out just below the surface. Then, I used the thrusters to slowly descend to the 120 foot depth.

"On bottom, I followed protocol and tried to establish communication with topside via through-water 'comms.' However, problems with the underwater comms systems continued to plague us and I had to monitor my own life support systems (and periodically report them to topside, since they might be hearing me but not vice versa). I had no worries since all systems were functioning properly, and I could continue to explore on pre-established safety protocols from our training program.

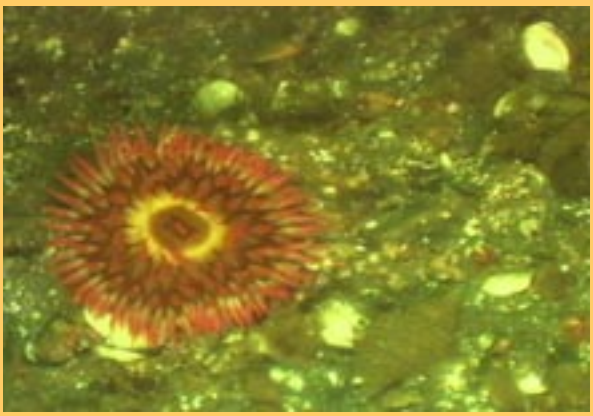
Lophophora photo taken from DeepWorker.

Anemone photo taken from DeepWorker.

"I marveled that at 120 feet, I had more than enough ambient light to see the seafloor clearly. Water visibility was fairly good for our area, about 10-15 feet.

Substrate photo taken from DeepWorker.

And once I turned on the high intensity lights for video recording, the red colors from various critters were very distinct. Although fish life was not particularly abundant in the gravel/cobble plateau I was 'flying' over, the area had an abundance of macroinvertebrates: various sea stars, sea pens, assorted sponges and sea cucumbers, etc. We had timed it just right to hit slack current, so I didn't have to spend effort keeping the sub stationary. Although the currents are what brings nourishment to areas such as this, supporting a diverse seafloor community, it also makes for difficult diving conditions, whether by sub or scuba. We humans try to pick our window of opportunity since we're so slow and cumbersome underwater (fish must think us pathetic, awkward creatures).



Telia photo taken from DeepWorker.

"There is always so much to look at that I wish I could have spent more time on the bottom during this first sanctuary dive, but with very limited communications between the sub and topside, I had to ascend after an hour. But at least I gained experience photographing with the sub's three camera systems, which allows for reviewing topside at one's leisure. And I began an evaluation of my own -- whether DeepWorker would be an appropriate tool for scientists to use, just as I use scuba diving in nearshore waters to monitor subtidal communities. So back to the surface and

retrieval by the ship. More pilots are awaiting their turns."

Later in the day, **Tom Jagielo** was able to complete a dive in the sub, and filed this report: "I have always enjoyed the long day length of the summer solstice, but this day is particularly special: I'm about to be launched from the Navy Ship Discovery Bay off Koitlah Point, near Neah Bay, for my first coastal open water dive in the DeepWorker 2000.

Tom Jagielo being launched from the Discovery.

"After the bustle of pre-dive activity my team closes the hatch, and then, an eerie silence. I have time to contemplate the magnitude of what I am doing; this journey into an environment seldom visited by my species. I'm comforted by the quality of the submersible, my knowledge of it's systems, and the professionalism of the individuals I'm working with on this expedition. We are focused. We are coordinated and working well together.

"In fairly quick succession, I'm lowered over the side, released by the diver, and cleared for descent. As I sink into the dark green depths, I feel like a stranger in this vast "aquascape", a brief visitor surrounded by my small envelope of life support. Arriving softly on bottom at 109 feet, I'm gratified to see boulders, rockfish, and, yes, lingcod! I've studied lingcod here at Cape Flattery since 1986, learning what I could from boats on the water's surface. What a different perspective to be on the seafloor, in their native habitat.

A swimmer unhooks Tom Jagielo.

"But, unfortunately, my stay on bottom will not be for long today. The tidal currents are swift at this location, and our window of slack water is narrow. I use my short dive time to gain proficiency in maneuvering at greater depth, operating the camera systems, and getting comfortable with the operation of "live boat" recovery at sea (the Discovery Bay is not anchored). Practice dives like this one are helping me to build proficiency for our planned undersea experiment, which will require two subs diving to a depth of 300 feet. We want to know if the DeepWorker can be used to obtain accurate counts of fish for assessing population abundance, particularly in rocky, rough bottom areas that are hard or impossible to survey with other techniques. One key question is: does the sub attract or repel fish? In other words, does the presence of the sub affect the accuracy of the fish count, and if so, how?

"Our dive plan was for me to ascend at 5 PM, and it comes all too quickly. Ascending slowly to the shimmering surface, the brightness grows around me. When I breach the surface I 'blow soft ballast,' which injects a large pocket of air under the sub to support me. While floating on the surface, I can see the Discovery Bay in the distance, and closer to me the "RHIB" (Rigid Hull Inflatable Boat). Accompanied by the RHIB, I motor over to the stern of the Discovery Bay, where the swimmer leaves the RHIB and connects me to the retrieval line. Shortly thereafter I'm on board the Discovery Bay, sharing my dive experience with my colleagues, and already eager for my next DeepWorker dive."

Tom Jagielo on deck after his dive.

We're optimistic that we will be able to accomplish more during the time remaining to us on this expedition. Tomorrow we plan to put two subs in the water together, to make observations and collect video images.

(top) **RETURN**

June 22, 1999
A Blown Piston

Robert Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Location: Neah Bay

Rain squalls and heavy swells have kept Olympic Coast's expedition tucked into the Strait of Juan de Fuca. During the evening of June 20, another factor came into play -- a blown piston in the main engine of the YTT Discovery Bay. On many ships, a blown engine means a complete loss of propulsion and an end to the project. Discovery Bay, however, is propelled by the main engine connected to a propeller, a bow thruster and two diesel-electric "Z" drives. The main engine provides power to move the ship at its cruising speed of up to 12 knots. The thruster and "Z" drives allow the ship to maneuver very delicately to hold station, which is critical for the YTT's normal work as a torpedo recovery vessel. Without the main engine, Discovery Bay is restricted to a very short range, but can still travel at 2 knots and maintain position.

Chief Mate Dave Bayard shows the blown piston from Discovery Bay's main diesel engine.

For Sustainable Seas, that has been a blessing, because weather has restricted our movements and with Discovery Bay's "Z" drives, we've still been able to continue submersible operations between Neah Bay and Cape Flattery.

The YTT's crew has taken the new challenge in stride, working long hours to get the engine repaired. Master Larry Hinton (known affectionately as Cap'n Larry) and Chief Engineer John Fritsch ordered new parts, which were delivered to Neah Bay and brought aboard Discovery Bay by the Olympic Coast NMS vessel Tatoosh. The engineering crew worked around the clock to get the head, burned piston and cylinder insert removed.

Assistant Engineer Aaron Streitberger "wrenches" on the main engine deep within Discovery Bay's noisy engine room.

Master Larry Hinton and Chief Engineer John Fritsch hold one of many conferences on the bridge as they work to get Discovery Bay's engine repaired.

(top) RETURN

June 24, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Bob Steelquist, Education Coordinator,
Olympic Coast National Marine Sanctuary

Location: Umatilla Reef
Weather: Sunny, for the first time since the mission started!

I was finally able to rejoin the expedition last night, boarding the Navy YTT Discovery Bay when it docked in Neah Bay to take on fresh water and supplies. This past week has been a little frustrating for me, being off the ship, because we had a lot of problems with cellular communications that slowed us down in our efforts to update the log on the website.

We pulled out of Neah Bay around 9:30 last night, and headed out to do some benthic sampling. Mary Sue Brancato is in charge of trying to obtain samples of the sea floor so we can see what's there, both biologically and geologically. They're using a device called a vanVeen grab, which is lowered by crane so it can literally "grab" samples of the sediment on the sea floor.

Mary Sue Brancato and Ed Bowlby discuss their research missions.

Last night was the second night of benthic sampling on this mission. The first time, they got a late start (4:00 a.m.) and could only work for a few hours before they had to make way for the sub ops work. But out of seven grabs, they were able to obtain five good samples. This time, they started at midnight, and continued until after 7:00 this morning, but all their efforts were met with frustration.

They attempted almost 30 grabs, but of those, only two yielded good material. All the others came up empty, either because the sea floor was too sloped in the areas they were sampling, or for some other unknown reason. It's just another example of the kind of challenges marine research projects are faced with every day. Sometimes you have to do a whole lot of work just to gather a small amount of data. Hey, if it was

easy, we'd already know a lot more than we do about what lies beneath the ocean's surface.

The team is equipped with two DeepWorker subs.

At 7:00 this morning, the other scientists, and the sub ops crew, started pre-diving the subs. Our plan was to get both subs in the water, but with a six-foot swell, it was pretty iffy whether we could even get one safely launched and recovered. Eventually, they lowered one sub into the water with Annette Hoffman at the helm. But at the last minute, Larry, the dive supervisor, decided to scrub the dive. The risk of injuring the swimmer under those conditions was just too great.

Instead, we did ROV ops during the late morning and early afternoon, waiting and hoping for calmer seas so we could try again with the sub. We dropped the ROV in about 200 feet of water, and were able to collect some good video image of flatfish and sea stars. The ROV was in flat bottom habitat, so there wasn't a huge diversity of life there, but we were very pleased with how well the operations went and how useful the ROV proved to be in making observations and taking video.

Finally, the seas started to smooth out a little bit, and as an added bonus, we got some sunshine, the first the mission has enjoyed so far! We were able to put one sub in the water, with Bob Steelquist piloting.

(top)

Here's Bob's dive report:

"Named for a steamer that grounded here on February 9, 1884, Umatilla Reef is one of the most feared places on the Olympic coast. The reef is actually an extension of Cape Alava, the westernmost point in the Lower 48 states. Between the reef and the Cape lies the Bodelteh Island chain, jagged remnants of Cape Alava's former headland.

"My dive on Umatilla Reef came during Thursday afternoon when we saw a brief burst of sunshine accompanied by calmer wind and seas. The day was like many I've seen when hiking at Cape Alava -- squalls early in the day, followed by a brilliant afternoon. These are days when the contrast between dull overcast and clear sky makes the scene look almost tropical. These are days when you hang your rain-soaked clothes out to dry and keep your fingers crossed that the sunshine will stay around for a few days.

"After ROV operations, when it appeared that a submersible launch was feasible,

Mission Coordinator Ed Bowlby asked me if I'd like to take the dive. I had picked a spot on the nautical chart just north of the Umatilla Reef buoy on the advice of Geoff Grillo, skipper of the charter boat Advantage, who often takes clients there to catch rockfish and lingcod. On the chart, the "rockpile" is a small dot shown at 19 fathoms of depth. Geoff told me to expect a distinct mound of rocks about 300 to 400 yards across. He said it would be covered with fish. He also told me that he would really like to see the video -- even after years of fishing the spot, he had no idea of what it actually looked like.

Bob Steelquist reaching to close the DeepWorker hatch.

"Discovery Bay Captain Larry Hinton liked the location. It was safely away from nearby hazards with a light current flowing northward, parallel to shore. I hurried to get ready for the dive. Eric Maiken, a Nuytco scientist working with SSE, helped me pinpoint the exact location for leaving surface and plotting compass courses once underwater. The careful preparation proved to be essential, because DeepWorker's battery power would not last very long if I got lost or had to spend a great deal of effort finding the target location. For the dive to succeed, I would have to leave surface, find bottom, and make a beeline to the reef. Wasted time would make a short dive even shorter.

"Even with the swells down, the launch was difficult, although with days spent on perfecting the techniques of craning the subs, the crew performed flawlessly. Once in the water, I was towed by the launch to get closer to the magic spot. As DeepWorker wobbled under the tow, dome just underwater, I was surrounded by a swirl of bubbles and spiraling foam. The beauty of water in motion surrounded me.Soon the radio voice of Dive Supervisor Larry Shumaker came on, telling the launch to drop me. A short visit from the swimmer who released the tow rope and I was adrift, bobbing on the ocean, a net of water splashing overhead, and above that a beautiful sky.

(top)

"Everything I trained for was unfolding perfectly. As the magic words "DeepWorker, this is topside, you may dive when ready," crackled through the radio, my hand was already on the ballast valve, ready to flood the tank and begin descending.

"Within 30 seconds, I had slipped under the lapping waves. Donning the underwater radio headset, I could hear the tracking pinger, the crackle of static and the electronic hum of current surging to the thrusters that were pushing me to the bottom. Like others before me, I was going down at Umatilla Reef. Unlike them, I was thrilled -- not terrified -- and I was going under in a submersible. Most importantly, I would be coming back up.

"Downward I plunged. The brilliance of the blue sky had given way to the fluorescent

green upper waters. Thirty feet, 50 feet, 80 feet. Darkness crept from below; a canopy of green overhead grew paler and paler. One hundred feet. A blizzard of marine snow surrounded me, the flakes seeming to fly upward as I plunged deeper. One hundred twenty feet. One-forty. "Should be on bottom any time now," I thought. One-fifty. At 156 feet, a bright sand bottom greeted me, rippled with uniform waves, like desert sand. "I am on bottom," I proudly announced to topside.

"Over the radio, Ed Bowlby gave me a compass heading. I quickly spun DeepWorker to course and started flying over the bottom. To save power, I had decided not to use the sonar, relying instead on the headings, approximate range and tracking information that was being relayed to me from the ship. Visibility on bottom was only about 8 to 10 feet, but the pale sand bottom was plainly in sight. Rocks would be too, I figured, and continued my flight. Occasionally I'd see dull sand stars and tiny hermit crabs as they scurried over the sand.

"Topside gave me one last course correction, a slight twist to the starboard that put me on 330 degrees, about 100 yards off the reef. The new course placed my route directly parallel to the sand ridges. Flying the sub was like driving on a highway, staying within the lines. I leaned forward in my seat, straining against the haze of marine snow to see the looming form of the reef.

"The first sign of the rocks was a cluster of white patches against a dull black background. The patches slowly focused -- plumose anemones anchored on a broad lump of rock. A surge of excitement swept over me. I slowed the sub to a cautious crawl, inching toward the foot of the slope. More lifeforms appeared before me: basket seastars, with their fantastic-looking curled, branching legs; sea cucumbers, and brilliant red finger sponges, looking like tiny saguaro cactus. I nosed the sub as close to the rocks as possible, crabbing sideways to my left, gently tugged by a soft current in a blizzard of snowflakes. Through the DeepWorker dome I stared at this new world, astonished my the beauty of this dim place. The parade of creatures continued. A lingcod, then another, swam into a crevice before me, settling down and eyeing the sub's lights. A school of canary rockfish moved in on my right. Twenty or so of the brilliant orange fish stayed close to the sub. When I used the thrusters to turn toward them, they scurried off to the edge of the light, lingering at the dark edge of my visibility. When I quieted the sub, they returned.

"I tried to climb up onto the reef, but found that I was slightly negatively buoyant, meaning that without thrusting, I would descend. To thrust upward would mean stirring up a cloud of silt. Fearing that I might settle hard onto the rocks, I thrusted up and clear of the reef, landing a few feet away from the rocks on the bare sand. I quickly scurried "upstream" against the current to a new spot and repeated my drift along the slope-toe face.

(top)

"I repeated this maneuver three times, with each pass letting the current gently pull me, thrusting just to keep the nose of DeepWorker facing the rocks. In all, I probably

traversed no more than 6o feet of the reef's wall. On every surface, however, I found a carpet of life, scattered with seastars, anemones and sponges. Cracks and recesses were refuges to lingcod. Hovering over the rocks were rockfish schools. The almost magnetic attraction of sea-bottom structure became very apparent. The bare sand plains, while attracting their own forms of fish and invertebrates, were like desert. Animals on the sand surface seemed isolated and vulnerable. But on the complex structure of the reef, its microcurrents, its surfaces, nooks and crannies, many lifeforms can take hold to form a community. And as living forms demonstrate in almost every ecological community known, niche begets niche -- the rich community gets richer. In a sea of sand, this rockpile is an oasis.

"My enchantment with this ecological wonderland was interrupted periodically by faint calls over the underwater telephone for my life support readings. As necessary as these intrusions were, I tried to keep them short. What I really wanted to talk about was what I was seeing. But with a communications system that garbles even the most simple phrases, I saved my words for later. The descriptions would have to wait. The risk of confusing topside with extra adjectives would only frustrate everyone.

"Soon, the inevitable call came from above: "Deepworker, this is topside. Begin a gradual ascent and tell us as you pass every 20 feet." My voltage had dropped from 240 volts to 233 volts, just three volts above the safety limit of 230. As I had monitored the power usage, I knew I was getting low and that I'd get the call soon. I experienced what I thought pitchers must face when they know they are about to be pulled off the mound. With a sigh, I affirmed the message and switched my attention from enchantment to the business of returning to the surface. I took my direction to ascend "gradually" quite literally, however. I'd make my transition with patience -- to prolong the experience of the deep would also be the safest, most prudent way to return to the top. With my left heel gently pushing the footpad down, DeepWorker hummed upward. The dim green of the ocean's roof brightened as I pushed through the snow. Tiny jellys twisted in the turbulence as I ascended. Gradually the texture of waves appeared above me, a moving lattice of dancing, refracted light.

"DeepWorker popped out on top at 17:48, 45 minutes after she slipped below. Joggled by the swells and the slop of waves, we bobbed together, loose in the ocean. Almost immediately, the VHF radio crackled to life and clear voices with direct and business-like questions filled the little sub. Reverie over, I was back on the job as a sub pilot.

"Soon the swimmer attached the launch's tow line and we slowly lumbered back to the ship. Between the radio chat, I sat back and enjoyed the ride. I relived my short experience and savored the moment. I had been to the bottom on dreaded Umatilla Reef and found it a dazzling, life-filled place. I had experienced that most exciting state of human awareness, of discovery, of pure exploration. I had handled DeepWorker with professionalism and skill, achieving the single goal that united every member of the expedition for that dive. Charter skipper Geoff Grillo, I thought, will like the fuzzy video of a place he knows well only on sonar.

"For Olympic Coast's SSE, the dive to Umatilla Reef was a successful mission. For me

it was more. I glimpsed a place none has likely ever seen. It has indelibly stamped my memory with visions of a different world, one close at hand but very foreign. It has changed my perspective of Olympic Coast National Marine Sanctuary, my workplace. And I'm sure that it has changed me. Don't ask me how quite yet--the most important discoveries take some time to sort out."

After dinner, we reviewed the video from Bob's dive, and got busy post-diving the subs. Meanwhile, the ship started steaming around the corner back towards Neah Bay. We need to anchor in very calm water so they can try to repair the starboard Z drive (one of the ship's main drives).Tomorrow, we have two dives planned, including one using both subs. Mike Nelson's weather forecast is for gradually improving conditions: Calmer winds, flatter seas, and more sunshine. We're all crossing our fingers that it'll work out that way!

(top) **RETURN**

SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

OLYMPIC COAST

SITE INDEX

June 25, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Well, we were hoping to finish the repairs to the Discovery Bay's starboard Z-drive last night and get back out for some more benthic sampling, but it was not to be. The problem with the drive is a lot more severe than we thought, and probably can't be fixed until they can put the ship in drydock. On top of that, we have high seas that apparently came up from out of nowhere. When I awoke in the middle of the night, I thought we must be underway, because the ship was rocking and rolling so much! It turns out, that was just how rocky it was in the sheltered area we'd anchored last night!

The YTT Discovery Bay

The ship's engines do still work, to some extent, but they're very limited. So we may be able to get offshore a bit to do some more dives, if we get permission from the Navy to do so. In the mean time, we're sitting tight here near Neah Bay. We'll do some ROV operations, and possibly take some benthic samples, and when the seas calm down, we'll do some dives in the DeepWorker, as well.

We gathered at 11:00 a.m. for an update, and I eavesdropped on some of the pre-meeting chatter. Lexy, one of the sanctuary's volunteers, is on her first mission of this kind, and commented, "I've never had so much down time before!" to which Annette Hoffman replied, "Welcome to the world of marine research!" In other words, as frustrating as all this may seem, it's par for the course.

Someone else was overheard relating a story about an Alvin project he was on. The sub broke down, and the ship was held up for a full five days simply waiting for the project's funders to finish bickering about who was going to pay for the replacement parts! We can at least be grateful we don't have that sort of thing going on here!

I decided to take the first opportunity to catch a RHIB run into Neah Bay, where the sanctuary has a trailer set up as a remote office. From here, I can at least dispatch the occasional log update. Dan Orange, one of the researchers who came out last

night for the next leg of the mission, decided to go home early because the ship's technical problems would preclude his being able to do the cold seep work he came here to do.

(top)

I took Dan back to Port Angeles so he could catch a flight back to his home in Monterey, and we had a chance to chat a bit about his work. As a quantitative naturalist, Dan conducts science encompassing biology, chemistry, and a great deal of physics. He's promised to provide some more information about the cold seeps off the Washington coast that drew him here. Although he wasn't able to conduct the research he'd hoped to do with SSE, he's already looking at other ways to do what he needs to do here. Dan is also a board member of the Surfrider Foundation, and an avid surfer (his buddies call him the "Knee High Samurai" because he prefers to surf smaller waves).

When I got back to Neah Bay, I found five very hungry men waiting for someone to give them a ride to dinner. Three of the sub ops team (Larry Shumaker, Phil Otalora, and Ed Hoefing), and SSE planners Dana Wilkes and John McDonough, had been patiently waiting for me to wade my way through the many RVs and trailers winding their way along highway 101. We crammed ourselves into the rental car and drove the 30 minutes each way to a diner outside the small fishing town of Sikyu, Washington, returning late at night to the Neah Bay harbor.

I got the update over dinner. The afternoon's activities on the ship consisted of ROV operations, providing each of the scientists with the opportunity to pilot the ROV and become more comfortable with its operation. There's some discussion of transferring the ROV to the sanctuary's small boat, the Tatoosh, and running those ops from there for the rest of the week.

Tomorrow, the local sanctuary council will be on board the ship to observe sub ops activities. We'll dive the subs as much as we can, and try to get them into clearer water, where we can at least observe some of the native fauna and habitat. But we will not be permitted to take the disabled ship around the corner of Cape Flattery.

(top) RETURN

June 26, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Annette Hoffman, Scientist
Washington State Department of Fish & Wildlife

Mary Sue Brancato, Scientist
Olympic Coast National Marine Sanctuary

Location: Cape Flattery, Washington
Weather: Breezy, partly cloudy skies, 4 foot seas

Considering the limitations we're working under now, with a bad Z-drive and resulting restrictions on where we can dive, today was a very successful day. We started out with a two-sub dive, with Annette Hoffman in one sub, and Dana Wilkes piloting the other sub.

Here's Annette's description of her dive (which had some unexpected excitement!):

"We'd finally gotten permission to try a 2-sub dive, the weather conditions were cooperative and the crew was ready. This was our first attempt at completing one of our project dives where one submersible would station itself on the bottom and the other would come flying by. The purpose of this design was for the stationary sub to capture on film fish behavior toward the other sub as it approached. The videography from the stationary sub would then be used as proof of concept that assumptions about fish behavior could be quantitatively tested.

"I began my descent, calling out to the dive supervisor my depth at regular intervals. I was told that I should arrive at the bottom at about 100 feet. As I called out "9-0 feet" I began looking for the bottom. Then I called out "1-1-0" feet and began looking in earnest. As I called out "1-3-0" feet I began to wonder if I'd missed it. Deeper and deeper I went and dimmer and dimmer the ambient light became. I turned on the sub's lights, but still could not see the bottom. "1-9-0." Uh-oh, had I accidentally discovered an uncharted cavern? "2-3-0." Was there a bottom? "2-5-0, I am on the bottom." Hallelujah.

"It was very dark at 250 feet. Although my lights were on, they reflected off many small particles in the water, making visibility poor. Fortunately, on this dive the through water communications were very good. Actual sentences with three syllable words, and therefore unanticipated instructions, were easily understood. I was given the go-ahead to search for a spot where I would set the sub down and become the stationary sub. I turned toward shore and began fighting the current. My progress was slow but eventually I made it to a depth of 120 feet on bottom. I was told there was a whale in my vicinity, but I wasn't able to make its acquaintance. I didn't see very many fish, a few ratfish and that was all. I searched for rockfish, any rockfish, but found none.

"By this time I was beginning to wonder if I was too close to the rocky shore and whether or not there was enough time left to deploy the second sub. Therefore, I decided to set down where I was, fish or no fish, when... in front of me, curled up on the substrate was a small wolf eel. I backed up to try and get it in the cameras. As it became aware that I was interested in it, i.e. I failed to move on, it seemed to become uncomfortable and moved ahead on it's own. I followed, it moved again, and again I followed. I called to "topside" that I was in position for the experiment. As I held position near this eel, it seemed to finally decide to confront me. Very suddenly, it swam directly for me and although I backed up with my petal to the metal it proceeded to thoroughly check me out. It swam around the camera arm, around the lights and up to the dome until it was looking at me face to face. It opened its mouth and I could see its teeth and I have no doubt that it would have liked to bite me for my trouble. Then, just as suddenly it swam up and away, out of my life.

"I turned my attention back to the experiment at hand, but forces were converging to thwart it. The second sub showed some unexplained ground faults and the current threatened to sweep me away from my spot. We finally decided to abort the experiment and I returned to the surface. In no way did I feel this dive was a failure. I learned things, I saw things, and I experienced things. I learned about how difficult this type of data could be to collect, I saw and shared a moment with a wolf eel, and experienced drama that would help me put events into a different perspective when I returned to my familiar routines."

(top)

Gale continues:

After both subs were back on deck, the Tatoosh pulled alongside to drop off some day visitors, members of the local sanctuary council. Our visitors toured the ship, and stayed for lunch before reboarding the Tatoosh to watch the next sub launch and do a tour around Tatoosh Island.

The next pilot in the water was dive supervisor, Larry Shumaker. Larry needed to check out the systems on sub number six, which had showed some ground faults during Dana's dive. His dive was brief but successful, and the sub seems to be working fine now. I was charged with videotaping this, and the next few launches and recoveries, so the crew of the NOAA research ship FERRELL could use the tapes for

training.

After Larry's dive, the slack current was almost upon us, and we quickly completed the pre-dive on sub number seven so Mary Sue Brancato could get her dive in. The ship's skipper moved the Discovery Bay closer in to where we hoped Mary Sue could find some rocks to dive around. Rocky habitat tends to support a much richer diversity of life, and for the purposes of their work, our scientists really wanted to be able to observe the kinds of critters you tend to find living in and around rock formations, such as anemones and rockfish.

Mary Sue Brancato writes:

"My first dive within sanctuary waters at last -- 10 days into the cruise. I'm jazzed. After viewing the tapes of the dives of the four pilots to go before me, I'm anxious to have my own down under experience -- perhaps find some habitat diversity, perhaps a boulder patch. I have a desire to achieve a depth rating, but also to see some interesting marine life, and closer to the shore and shallower is likely to provide the latter. The cruise has been an exercise in being flexible, as each research element and research site has gone by the wayside due to problems with the ship or inexperience with the new subs.

"I decide capturing a glimpse of the habitat character from offshore to nearshore, while noting fish populations for the Washington Department of Fish and Wildlife study will provide the most benefit. I opted to conduct somewhat of a transect from offshore to nearshore in the Chibahdehl Rocks area near Cape Flattery, in the northeastern-most portion of the sanctuary. Because the other four pilots had gone before me, I had a fair idea of what to expect -- a blizzard! Lots of "snow", which is indicative of the rich environment we have -- the water column is full of plankton and pelagic critters. We wait for slack tide, as the currents have been strong.

"Dive supervisor Larry places me at what is expected to be about 180 ft to begin my transect, and provides an escape heading. I reach bottom at 225 ft and already the current is moving along. This is flashlight and HID light territory so I pull out a flashlight and start moving up the slope towards the shore. I'm surprised that the slope is so evident. The blizzard is raging, and the bottom looks similar to previous dives -- sand waves with considerable shell fragment. What you can't see from the video footage though is a close up of the substrate. As I cruise over it, all of the tubeworms, bivalve siphons and scallops retract or scoot out of the way. I wish I had a plankton net to discover what the "snow" is composed of. Otherwise, I saw mainly seastars, sea pens, and ratfish as far as what critters are evident by video, and as I go up the slope, more sea cucumbers and lingcod.

(top)

"Quite a uniform substrate for the first 45 minutes of the dive as I move up the slope from 225 ft to 145 ft. I maneuver to take photos and promptly send my flashlight to the bottom of the foot tube. Hmmmm...I pull out the 2nd and last flashlight,

wondering what I will do if I send that one down the tube and have to retrieve it while controlling my movement in the currents.

"So far, through-water comms are working surprisingly well for the first time. I'm running out of time, so I decide to head west, because the chart indicated some rocky habitat, and sure enough, within moments Metridium senile, the white, glowing sea anemone comes into view -- I exclaim to topside -- "I found rock, and rockfish!" It's exciting seeing several different species of rockfish, anemones and seastars along the rocky outcrop. I'm at 155 ft.

"I try to take photos and realize that the current is quickly becoming insurmountable. The 2 to 2.2 knots that the Deepworker can achieve are nothing compared to what the ocean can achieve. I'm struggling to hold my own, being pushed into the rocks. Just as it becomes a little nerve-wracking, I think topside is trying to communicate with me, but the comms have crapped out. I have to take my foot off full throttle to be able to hear them, which causes me to quickly lose control of my position. I think I hear "ascend" but I'm not sure, because there's the faint voice of a female (not Dorothy) yakking away on the headset. We know not to try to talk in full sentences so who is this?!

"I stay down a bit longer trying to establish whether topside asked me to ascend and then make the decision to ascend, telling them that, just in case they can hear me. I follow my escape heading and head to the surface, to find considerably different weather conditions on the surface from when I began my dive -- and I'm a good distance from the YTT Discovery Bay. The chase boat has to tow me to the ship. I find out that they did ask me to ascend, and that Annette, my recorder on the chase boat, also heard the faint female voice on the through-water comms! All in all, a fun and fulfilling dive and I'm glad to set about planning my next dive."

Gale continues:

Mary Sue's dive only lasted an hour, because before much time had passed the current began to pick up again, threatening to whisk the little sub away. With a maximum speed of only 2.5 knots, the sub can't fight a strong current. We brought the sub back on deck with some difficulty. Even with the tow line in place, the current kept pulling the sub out of alignment with the stern of the ship. Because of the broken Z-drive, the ship lacks the maneuverability that would normally compensate for such problems. Finally, they were able to line up the sub and pluck it from the water, landing Mary Sue safely back on deck.

We spent the rest of the evening reviewing video tapes of the dives, and watching more movies in the crew's lounge. We made our plans for tomorrow's dives, and will have to cross our fingers that the weather will cooperate with us for just a few more days.

(top) **RETURN**

June 27, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Tom Jagielo, Scientist
Washington State Department of Fish & Wildlife

Ed Bowlby, Research Coordinator
Olympic Coast National Marine Sanctuary

Location: Cape Flattery, Washington
Weather: Breezy, partly cloudy skies, 4 foot seas

So far so good! It looks as if we'll be able to dive both subs this morning, in an effort to complete Tom's fish behavior experiment. We're back at the same location Mary Sue dove yesterday, because she did see some rockfish, and they really want to get more observations of how rockfish react to subs in the water. Tom will be piloting one sub, while DOER's Phil Otalora pilots the other one.

Here's Tom's dive report:

"Today I am diving the morning "slack" water at Chibahdehl Rocks, not far from Neah Bay, near the mouth of the Strait of Juan de Fuca. The tidal currents really come ripping through here, so slack water is the best time to have a controlled dive. Set free from the USN Discovery Bay around 9:30 am, I'm given the OK to descend and I fall slowly to a depth of 184 feet.

"It's very dark; I need to use my flashlight to read off my life support readings to "topside". The current is really moving down here. When given the OK to proceed, I start heading toward shore. My plan is to photograph the large, slant-rocked reef located nearshore in about 100 ft of water. It takes full thrusters to make any headway against the building flood tide. After a lot of current-bucking, I'm finally on the reef, and it is spectacular.

"The rock formation extends from shore running in a north-south orientation and is slanted to the west. Fish are hovering near the top, apparently feeding on the rich stream of life flowing to them with the incoming tide. I saw several lingcod, kelp greenling, and numerous rockfish, which surround my vision dome. Again, the call to

surface seems to come all too soon; my hour undersea passed like a brief, but very memorable moment."

(top)

Gale continues:

This afternoon has Ed Bowlby diving the sub in an area which has been extensively studied by scuba divers. His intentions are to use the sub to extend those transects into deeper waters than the scuba divers have been able to explore.

Ed Bowlby explains:

"Our sanctuary inflatable boat towed me from the ship to my pre-selected drop point at Cape Flattery, close to the bouldery coastline. Two weeks ago, scuba divers had completed video transects at this location. My mission: Begin video surveys where the divers left off, in 60-80 ft. depths, and continue the transect to the 300 ft. contour."

"After going through the surface drill of checking for instrument alarms and confirming life support systems were functioning A-OK, I descended vertically to the 80 ft. bottom. As expected from my own scuba diving experience in the area, the 'shallow' end was mostly rock bottom and hosted many fish (rockfish naturally) and an array of rock-encrusting inverts. Visibility was better than expected (approximately 10-12 ft.) and we had timed my dive perfectly for slack current, which all our previous dives in this area had attempted to avoid (trickier than merely looking at predicted current tables, since local variations occur when the Pacific Ocean exchanges water with the Straits of Juan de Fuca).

"I turned on DeepWorker's camera systems and began the video transect, following a compass heading. The gravely-sand bottom showed a gradual incline, occasionally interrupted by rock outcroppings. I paused while passing over the latter to film the myriad creatures that inhabit these rock oases, including rock fish, greenling, lingcod and an array of macroinverts, such as anemones and sponges. I paused again, at a depth of 150 feet, turning off sub lights, to view the surroundings in the green glow of ambient light. Definitely enough light to steer by and read a book. Even the video was clear enough to identify bottom creatures.

(top)

"The seafloor continued a gradual slope and changed to a mixed shell-cobble bottom. I started encountering ratfish and a carpeting of sea pens and sea stars and the occasional sea cucumber. Although this uniform bottom did not show the diversity of the shallower rock habitat, it is still critical information. For example, various agencies are interested in knowing whether this deeper water habitat could support foraging sea otters (scuba divers assess this in shallower, more typical otter habitat), and although DeepWorker is literally just skimming the surface, it still gives us an

approximation of what prey species might be available. And it's a small start in our goal to characterize the various habitat regimes in the sanctuary, from shallow subtidal areas around kelp beds to canyon depths.

"Before reaching the 300 ft. zone, I came across a surprise. At 230 feet, I encountered a wolf eel resting on the featureless bottom, no rock crevice in sight. I filmed it briefly before continuing on the final legs of my transect. When I stopped at the 300 ft. level, a swarm of arrow worms 'buzzed' the sub's high intensity lights. I notified 'topside' that I was beginning a slow ascent. I stopped briefly at the 200 ft. level to snap off a few still photos of a dazzling pelagic invertebrate, a calycophoran, related to jellyfish. Then it was back to surface waters and recovery 'ops' by the topside crew. Quite an enjoyable and educational dive."

Gale continues:

After dinner, we met to discuss how to make best use of the little time that remains in the mission. Tomorrow, Bob and Mary Sue will dive again, and the Tatoosh will bring over media observers. We'll try to get one last dive in on Tuesday morning, but we have to be back in port by noon on Tuesday so that the Nuytco crew can start packing things up to ship off to the east coast. While each sanctuary gets to step back and take a deep breath after the whirlwind of SSE activities are over, for those of us who are on for the whole project, there really is no time to rest between missions. Not that we're complaining, mind you! The job is exciting and varied, and the rewards more than make up for the stress and fatigue.

(top) **RETURN**

June 28, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Bob Steelquist, Education Coordinator
Olympic Coast National Marine Sanctuary

Location: Cape Flattery, Washington

Today is the last day of diving for this mission. We're excited about what we hope to accomplish today, but a little wistful that the mission is almost over. There's so much more to see and explore!

Mary Sue Brancato was the first to dive today. On her last dive, we'd tried to put her in the water when the current at the entrance of the Strait of Juan de Fuca was slack, but she'd ended up spending her whole dive fighting the strong currents anyway. This time, we were able to time her dive a little better, and get her on the bottom when the current truly was at a minimal level. Mary Sue said the best thing about today's dive was being able to pilot around in calm waters, stop and look around, make her observations and take her video images, without having to constantly work to keep from being swept away.

She also went down in an area that was very rich in marine wildlife: rockfish, greenlings, sea stars, and anemones in abundance. Her maximum depth this time was 127 feet, and she successfully completed a video transect from Chibahdehl Rocks to Warming Beach, finishing out at a depth of 75 feet. Most of the habitat she covered was rock shelves and boulders, separated by areas of sandy bottom covered with a lot of shell fragments.

The change in the kinds of life you see when you get to hard substrate after traveling over sandy bottom is striking. There's a tremendous increase in the diversity of life you see on rocky habitat, and the sheer number of critters increases dramatically -- it's really exciting to come up on these areas.

Mary Sue was originally told she could keep diving until the current picked up, but eventually, after over two hours on the bottom, she got the order to surface. She tried the old joke, in reply to that order, replying, "Sorry, topside, I can't make out what you're saying. You're breaking up." But they didn't buy it, and she reluctantly brought the sub to the surface, where she was met with a surprise.

As soon as the sub broke the surface, the first thing she saw was a cluster of TV cameras on the Tatoosh, pointed right at her! After two hours of peacefully communing with the fish, she had to quickly shift gears to conduct an interview with reporters using the VHF radio. One of the reporters asked her whether she was more comfortable in, or out of, the water. She said she was a lot more comfortable underwater than she was giving interviews, but she handled it all splendidly. Back on deck, the cameras continued to pursue her, even taking close-ups of her feet while she was putting her shoes back on! She said she was glad she was wearing clean socks!

The final dive of the mission was Bob Steelquist's. He's provided me the first installment of his log entry about his dive, and promises to write more about it soon.

(top)

Here's Bob's description of the first part of his dive:

"I selected the dive location on my original project plan: a finger-like ridge projecting northwest into the Strait of Juan de Fuca in about 270 feet of water. To either side of the narrow projection, the bottom descended sharply to depths of greater than 300 feet. My project dive called for a descent onto the ridge near its tip with a quick transit across -- from side to side -- along a north-south axis. I would be looking for halibut, rockfish and lingcod -- fish known to live there based on advice I'd gotten from charter boat skippers who work the area. I asked Captain Larry Hinton of Discovery Bay if he would drop me on my location. His answer, in his characteristic warm,deep growl: 'Bob, I'll splash you anywhere you want to go.'

"Looking over the chart with Dive Supervisor Larry Shumaker, we opted for another approach. He thought it better to drop me at the base of the finger on a wide plateau, where I had a wide target. That way, we wouldn't risk the sub being carried by current into deep water and beyond the 300-foot depth limit that constrained all of our dives. From the plateau, I would fly a compass heading along the ridge axis for a 1-mile 'out and back,' like hiking an Olympic Mountain trail along a ridge spine.

"As the afternoon current died, my dive approached. Mary Sue Brancato helped me through the pre-dive. Everything went smoothly as we went through the list. As a team, we had spent 3 weeks working the procedures and becoming efficient at preparing the subs for dives. We finished all but the last few steps and then waited for current to go slack.

"After nearly forty minutes, Larry Shumaker returned from the bridge and said, 'Let's dive.' Excited, I climbed into the sub, we closed hatch, checked life supports and the deck gradually filled with crew, donning their hard hats as they took their places for the launch. Soon, the full motion of launch was underway. Swimmers ready, crane and winch operators in their places, radios crackling and the whole ensemble in synch.

"They dropped me just off the fantail and quickly released DeepWorker. I oriented to my compass direction, tucked my point-and-shoot camera and other necessities in convenient places and sat ready to descend. Larry Shumaker's voce came over the radio 'OK Bob, you may flood your soft ballast and descend when ready.'

"I knew I was too heavy as soon as the bubbles stopped flowing from the soft ballast tank. The sub was sinking without any power on the vertical thrusters. Thinking through the events of the predive, I realized that we had left 22 pounds of lead on the rear of the sub. Too late, I thought, to do anything about it -- let's just go down as easily as possible and see what the ballast is like on the bottom.

"DeepWorker dropped like a stone. Watching the depth gauge, I was at 175 feet within a minute, passing quickly through the green upper waters and into the darkness. Without knowing what was under me I pushed my heel into the left footpad to slow the plummet. The sub slowed. Two hundred feet... 225 feet...250 feet. I maintained my upward thrust to slow the descent and peered out the dome looking for the bottom. At 265 I caught a glimpse of a murky flat scattered with boulders. At 273, I felt a dull thud as the port battery pod touched down. Still thrusting to ease the contact, silt clouded around the sub and I settled down to survey my location. Even with very limited visibility, I could tell that I was on a field of compact sediment, with car-engine sized boulders scattered here and there. I reported my depth watched as a large rockfish and ratfish immediately took up station in the glow of my lights.

(top)

"The extra ballast weight made it impossible to fly smoothly. Instead, I was rototilling the bottom. Thrusting upward took me out of visual reference and created what I thought was an unsafe bounce -- I could easily bounce back down onto one of the rocks and have the weight of the sub crush the plastic air ballast tank beneath the pressure sphere.

"I oriented the sub to my planned course and stopped to assess the situation. So much for a hike out the ridge, I concluded. 'I ain't flying nowhere,' my inner voice mumbled.

"Plan B quickly formed in my head. 'Some days we hike for the distance,' I reasoned. 'Some days we hike to a beautiful spot in a mountain meadow and just settle down to enjoy the view.' On a high ridge above Juan deFuca Canyon's deepening head, I chose the latter.

"I spent the next hour roaming my boulder field. Rockfish hung motionless in the dark, moving only slightly as the lights bathed them. A ratfish followed the sub, making sure to stay in the light, looking me over. Scattered seastars lay on the flat bottom. Around me was the pervasive gloom of the deep, relieved here and there with boulders, covered with living things. Rockfish hover close by, like patient

attendants.

"One turn of the sub brought me to a large rock that sheltered a wolf-eel, whose brilliant purple head turned at me suspiciously. To my delight, he quickly extended his head and grasped what I thought to be a piece of food that sat just outside his den, pulling it into the hole. Did he perceive me as a large competitor intent on stealing his food? I wondered. The ungainly fish definitely seemed to be protecting it dearly. He emerged again and opened his jaws to threaten me. I was amused at his bluster -- baring his teeth to frighten a 3,000-pound submarine! Although he was wary of the sub, I settled down next the rock and spent the next few minutes shooting video close-ups of the wolf eel. It's color was a beautiful lavender, with large black spots along its back. Up close, it had a comical face -- fat cheeks, tiny round eyes, slightly human. It reminded me a little of Nowhere Man, from the Beatles movie, Yellow Submarine. The wolf eel gradually settled down, and I roamed off, continuing my ridgetop exploration."

The rest of Bob's dive went well; he will fill us all in on the details within the next couple days. Once Bob was back on deck, everyone crowded into the control room to look at the video images, and the sub ops team got started getting things ready to offload. We were all really pleased with how the last day of this mission had gone, but sad to see the mission over so soon.

Tuesday, the ship pulled up anchor at 3:30 a.m. and started heading back towards Port Angeles. All morning, everyone worked on packing things up and working with the computers to try to get some stills from our underwater video (we'll post them here once we get the computers to play nice with each other!)

Parking the ship at the Port Angeles pier was no picnic! The pier is only 330 feet long, the YTT is 186 feet long, and there was already a 130 foot Coast Guard ship docked there! Captain Larry did an expert job of bringing the ship in, and we got moving right away offloading our gear. All that's left for this mission is an open house on June 30, and an internet chat on July 1. Then, we're off to Stellwagen Bank. That mission starts on July 9, so stick around!

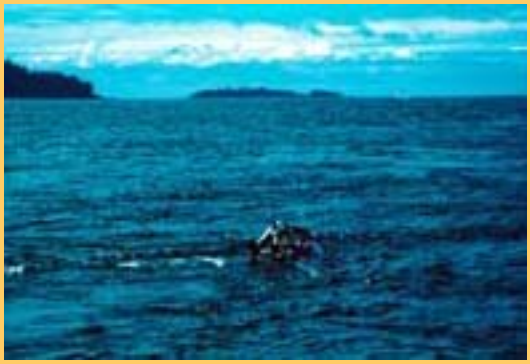
(top) **RETURN**

Summary of Investigations

Olympic Coast National Marine Sanctuary staff spent months organizing and preparing for the 1999 Sustainable Seas Expeditions. The Olympic Coast Expeditions had three primary objectives: 1) collect information to better characterize sanctuary resources and habitats; 2) bring this information "home" to the average citizen and in turn encourage a marine conservation ethic; and 3) test the effectiveness of using submersibles for inventorying sanctuary resources.

Technicians synchronize watches with pilots Dana Wilkes and Annette Hoffman in an attempted two-sub dive. Visibility and launch-timing problems subsequently forced the mission to be scrubbed. (Photo credit: Bob Steelquist)

Mechanical difficulties and adverse weather interrupted the missions, disappointing investigators and hindering their scientific investigations. However, all participants were seasoned veterans of logistical problems that occur while working in remote and exposed coastal areas, and they took things in stride. Project scientists intend to follow up on the research projects in forthcoming missions.



One planned project involved using DeepWorker to conduct surveys of benthic habitats exposed to different degrees of bottom trawling. Unfortunately, due to ship mechanical problems and some launching difficulties with submersibles, this assessment of seafloor communities had to be postponed. However, video transects were conducted at alternate sites off Cape Flattery, the northern most sanctuary boundary, where scuba divers conduct similar surveys in shallower waters. This confirmed that DeepWorker is an appropriate tool for benthic habitat assessments and extended one video transect half way across the continental shelf. Similarly, a project to use two DeepWorkers

simultaneously to record fish behavior for future population estimates was not conducted as planned, but the proof of concept was confirmed.

DeepWorker prepares to dive off Chibadehl Rocks, Olympic Coast National Marine Sanctuary. Tatoosh Island is visible in the distance. (Photo credit: Bob Steelquist)

Two scheduled science projects were not conducted at all. One combined exploration and science that would have been the first video survey of the Juan de Fuca Canyon. Mechanical problems and poor weather scrubbed this mission. Also, dives planned along a cold-seep area to examine geological formations and biological communities must wait for another year.

Olympic Coast's SSE operations crew. Clockwise from upper right: Andy Palmer, Tatoosh skipper; Ed Bowlby, Mission Coord., pilot and Research Coord.; Mary Sue Brancato, pilot and Resource Protection Specialist; Carol Bernthal, Sanctuary Superintendent; Annette Hoffman, WDFW biostatistician and pilot; Tom Jagiello, WDFW fish biologist and pilot; Bob Steelquist, pilot, Mission Log and Education Coord. (Photo credit: Bob Steelquist)

One of the greatest achievements of Sustainable Seas Expeditions in Olympic Coast National Marine Sanctuary this first year is the demonstration that multiple agencies and individuals can work together in difficult circumstances. The sanctuary offers a big thank you to all involved. This includes personnel from the U.S. Navy ship DISCOVERY BAY and our research partners from Washington Department of Fish and Wildlife, U.S. Geological Survey, and National Marine Fisheries Service.

(top) RETURN

Channel Islands GIS Workshop Summary

Twenty-one teachers and marine educators from nine states spanning the East Coast, Midwest and West Coast visited Santa Barbara, California in mid-July to participate in a three-day geographic information systems (GIS) workshop. Participants learned how to use GIS and other emerging technologies to access national marine sanctuary and Sustainable Seas Expeditions data to enrich classroom learning. During the first day of the workshop, participants learned to use ArcView software to explore maps showing biological, geological and economic features of the Channel Islands National Marine Sanctuary.

Julie Goodson, Channel Islands National Marine Sanctuary Education Coordinator, shows workshop participants how to use ArcView software to view sanctuary data.

On the second day of the workshop, participants boarded the *Spirit of Santa Barbara*for an extended field trip to the sanctuary. During their cruise, they collected water quality data and recorded marine mammal and vessel sightings using Global Positioning Systems (GPS) units donated by **Trimble Navigation**. Participants also hiked on Santa Cruz Island, visited the tide pools and captured images that were used to complete a GIS project the next day in class. They took home memories of dolphins "bow riding" at the front of the ship, an extensive **resource list**, data from the Channel Islands National Marine Sanctuary, and newly found enthusiasm for incorporating GIS into their classrooms.

SSE Education Program

Teacher Materials

Teacher Opportunities

Student Opportunities

Teachers Tonya Hanson (left) and Nancy Day (right) learn how to use a GPS backpack unit to determine the latitude and longitude of marine mammal and vessel sightings in the Channel Islands National Marine Sanctuary.

Workshop participants will receive Arc View software from **ESRI** upon completion of an "action plan" that describes how they intend to use GIS technology in their classrooms. Some examples of projects include: presentations for other teachers, developing new lesson plans with the sanctuary's GIS data sets and developing student field investigations that use GIS and GPS.

This special workshop was sponsored by NOAA's Channel Islands National Marine Sanctuary, the Center for Image Processing in Education (CIPE) at the Univeristy of California at Santa Barbara's National Center for Geographic Information and Analysis, and the Sustainable Seas Expeditions. There are plans to make the data from the workshop available on the Internet.

Kevin Flint, a high school teacher from Oxnard, California, records marine mammal observations in the wheelhouse of the *Spirit*.

Quote from Teacher Participant Paula Jones-Aieta

"I learned so much that I can take back to the classroom and the Massachusetts Geography Alliance. The workshop was intensive with content and application. I hope to link up with the education coordinator at Stellwagen Bank National Marine Sanctuary to incorporate information from that site into my classroom. I also plan to use ArcView with my students to map some proposed bike trails and open space in our towns."

(top)

Informal Education

1999 Education Archive

Marine Education Resources

Favorites of the Channel Islands GIS Specialist

Coast to Coast Digital Map Data Base: U.S. Census Bureau TIGER Mapping Service. Generates high-quality, detailed maps of anywhere in the United States, using public geographic data.

Maps and References: Geographic references available from the University of Iowa Center for Global and Regional Environmental Research.

National Data Buoy Center: Provides interactive marine observations from weather buoys throughout the U.S. and Europe.

National Geophysical Data Center: A national repository for geophysical data, providing a wide range of science data services and information.

NOAA Charts and Maps: This site provides "one-stop shopping" for maps and data produced by NOAA's National Ocean Service.

Wisely's GIS Yellow Pages: A comprehensive yellow pages for GIS Web sites.

ArcView/GIS Data

Arc Data Online: Contains a wide assortment of geographic information that users can access to create map images and download data.

BASINS EPA data: Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) integrates a geographic information system (GIS), national watershed data, and state-of-the-art environmental assessment and modeling tools into one convenient package.

ESRI Schools and Libraries Program: Provides information on GIS applications in K-12 schools, public and college libraries, museums, nature centers, and other areas of public education.

Map Machine (National Geographic): On-line atlas with customized map capabilities.

MassGIS: Commonwealth of Massachusetts' comprehensive, statewide database of spatial information for environmental planning and management.

National Atlas of the US: An on-line, interactive national atlas of the United States. Map layers can be used in geographic information, desktop mapping, and computer-aided design systems.

Pennsylvania GIS: Pennsylvania's official geospatial data clearinghouse.

TIGER US Census data from ESRI: A digital database of geographic features, such as roads, railroads, rivers, lakes, political boundaries, census statistical boundaries, etc., covering the entire United States from 1995.

US Census Bureau: Web Site for the U.S. Department of Commerce, Census Bureau. Includes population clocks and U.S. Census 2000 information.

Remote Sensing Images and Other Resources

Dundee Satellite Receiving station images (Dundee University, UK): Maintains an up-to-date archive of images from NOAA, SeaStar and Terra polar orbiting satellites.

Earth and Moon Viewer: Provides views of the Earth and the moon, including Earth from the Sun, Earth from the Moon, and the night side of the Earth, plus views from any location on the planet specified by latitude, longitude and altitude, from a satellite in Earth's orbit, and from above various cities.

Earthshots: Satellite Images of Environmental Change: An on-line atlas of before-and-after Landsat images (1972-present), showing recent environmental events.

Geomorphology from Space: An on-line gallery of space imagery consisting of 237 plates, each focusing on a geographic region that exemplifies a particular landform theme. Commentary, photographs, locator maps, and sometimes a geologic map accompany each plate.

Index of USGS Web services: U.S. Geogolical Survey index of Web resources, including biological, environmental, earthquake, mapping and marine geology resources, among other topics.

National Space Science Data Center images: An on-line photo gallery of popular NASA images taken from space.

Remote Sensing Core Curriculum: On-line textbook with state-of-the-

practice overview of remote sensing.

Satellite Active Archive search: Provides electronic distribution of data and derived data products from U.S. polar orbiting environmental satellites.

SIR-C/X-SAR Images: (Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar) images of earth provided by a joint U.S.-German-Italian project that uses a highly sophisticated imaging radar.

TerraServer images: Capability for viewing USGS and SPIN-2 imagery through your Web browser.

Topex/Poseidon satellite main page: A partnership between the U.S. and France to monitor global ocean circulation. Provides a variety of resources, including images, educational materials, data sources and on-line scientific results.

(top)

Earth and Environmental Sciences

Arizona Geographic Information Center: A clearinghouse of geographic data and information from the state of Arizona.

Earthquake Information Center: The U.S. Geological Survey seismology data center provides comprehensive information on earthquakes.

Exploring the Environment: This on-line series, which features an integrated approach to environmental earth science through modules and activities, is developed at the NASA Classroom of the Future™

Global Change Master Directory: A comprehensive directory about earth science and global change data.

Global Topographic Data: The Earth Resources Observation Systems (EROS) Data Center (EDC) Distributed Active Archive Center (DAAC) processes, archives, and distributes land-related data collected by EOS sensors, thereby promoting the interdisciplinary study and understanding of the integrated Earth system.

GLOBE Program (Global Learning and Observations to Benefit the Environment): Provides science and education activities and opportunities for students and teachers.

NASA Classroom of the Future (COTF): COTF engages students in "real science" by presenting them with actual problems currently under investigation in various science disciplines. In attempting to solve these problems, students may access the same data sets used by practicing researchers. Teacher resources and opportunities are also available.

Seismo-Surfing: A list of known Web sites where original seismic data or seismic research information is available.

Topographic Maps On-line: Provides an interactive topographic map of the entire United States.

USGS Mapping Information: A comprehensive mapping site provided by the U.S. Geological Survey.

US National Parks from Space: U.S. National Parks from Space is a joint NASA and National Park Service endeavor to provide Landsat satellite images of various parks via the Internet.

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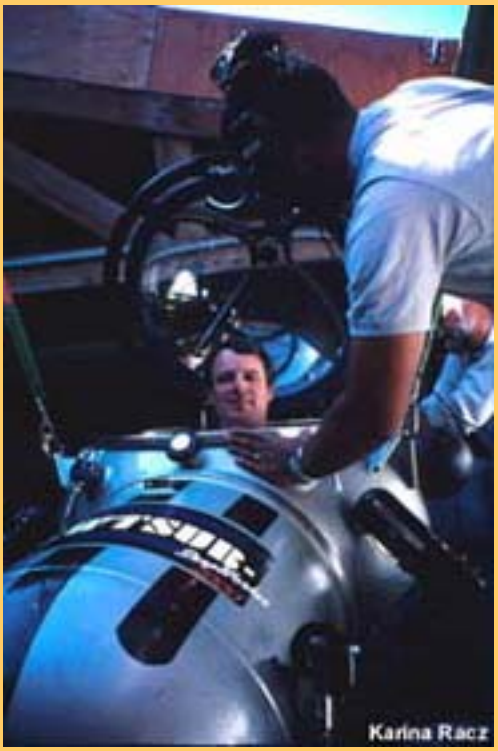
SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

GULF OF THE FARALLONES

SITE INDEX

Summary of Investigations

The Gulf of the Farallones National Marine Sanctuary was the first sanctuary visited by the Sustainable Seas Expeditions. Here it was successfully demonstrated that scientists and educators could safely operate the DeepWorker submersible in the marine environment. Twelve dives, including night dives were completed, but due to high winds most of the dives were made in Drakes Bay, the contingency site. On April 25th, the one day that winds subsided enough to get offshore, four dives off the Farallon Islands were completed. Eight hours of observation were made over rocky reef habitat in 60 to 125 feet of water. The success of this day was an indication of what can be accomplished with the DeepWorker given an extended window of good weather.



Dan Howard, Cordell Bank mission coordinator, in the DeepWorker submersible.

However, when weather prohibited the launch of the DeepWorker, a remotely operated vehicle (ROV) was used to gather images and data. The sanctuary collected about four hours of video during the Expeditions using an ROV. This footage includes hard bottom habitat around the Farallon Islands as well as documentation of soft bottom communities in the vicinity of Drakes Bay.

The Gulf of the Farallones National Marine Sanctuary mission coordinator in conjunction with the Sustainable Seas Expeditions chief scientists participated in an interactive Web chat during the cruise to electronically share pilot experiences and discoveries with the public. The exchange was spirited and interesting with many insightful and thought provoking questions and ideas. This mission of discovery was continued when the Farallones Marine Sanctuary Association and the sanctuary hosted a very successful student summit at the University of California's Bodega Marine Laboratory in Bodega Bay. Over 125 students from five high schools gathered to participate in the Sustainable Seas Expeditions experience. After listening to presentations by Dr. Sylvia Earle and other DeepWorker pilots and talking with scientists and educators, students broke into small groups to design

When weather prohibited launching the DeepWorker scientists made use of the capabilities of a small ROV borrowed from Deep Ocean Engineering and Research.

research projects based on what they had learned about the Expeditions and the DeepWorker.

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SUSTAINABLE SEAS EXPEDITIONS

TECHNOLOGY

SITE INDEX

EQUIPMENT

DEEPWORKER

NAVIGATION

CAMERA SYSTEMS

SONDES

ABOUT TECHNOLOGY

Testing and developing new technologies are critical components of the Sustainable Seas Expeditions. These pages describe some of the advanced technologies that will be used during various stages of the expeditions.

Alex Score, piloting the *DeepWorker* and fielding questions for the live web cast.

During the first SSE field season in the summer of 1999, the vision to conduct underwater research and exploration in the National Marine Sanctuaries with manned submersibles quickly materialized. Managers at all of the sites undertook the task of "choreographing" a science operation that was new for most of the sanctuaries.

During every mission, at least three technologies are used to explore a sanctuary. These include the *DeepWorker* submersible, the host research vessel, and the camera systems for recording flora, fauna, and

SHIPS

GORDON GUNTER

McARTHUR

NOAA SHIP FERREL

KA'IMIMOANA

DISCOVERY BAY

The *DeepWorker* off the coast of Hawaii

habitats. Other technologies, such as specialized GIS (geographic information systems) for tracking the movement of the submersible, and acoustic surveys using side-scan sonar to obtain accurate bathymetric readings, are also being tested and utilized.

Steve Gittings, with 75 ROV missions under his belt, is very well qualified to navigate a remotely operated vehicle (ROV) through the Flower Gardens.

A good example of technology development is the launch and recovery process of the *DeepWorker* submersible. This is potentially the most dangerous aspect of submersible operations, occurring, as it does, in the unstable and fluid environment of the air-sea interface. Deploying and recovering equipment at sea over the side of a vessel requires skill and practice, as well as a thorough understanding of the sea, the ship and the equipment. The ships and crews involved in the SSE last year were fully capable of handling over-the-side equipment, but this was the first time that they had ever conducted manned submersible operations. The requirements for handling manned submersibles are more involved than handling unmanned equipment. For the vessels, the requirements included on-board modifications and regulatory compliance. The modifications for

two NOAA oceanographic research vessels included the addition of refurbished cranes, and all of the vessels had to demonstrate compliance with the governing criteria for handling a manned vessel over the side. For each vessel, launch and recovery procedures best suited to the particular platform had to be developed that would not jeopardize the pilot or the DeepWorker submersible.

Steve Gittings deploys a remotely operated vehicle (ROV) from the surface.

Using three vessels (the third was a Navy Yard Torpedo Tender or YTT) over 80 days at sea, the SSE successfully conducted 173 shipboard launches and recoveries of the submersible in 1999. The SSE will continue to break new ground in the technology for oceanographic underwater research as it undergoes its second field season.

Select the technology of your choice to learn more about the special tools being used to conduct the Sustainable Seas Expeditions.

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DeepWorker

Introduction

The *DeepWorker* 2000 is a one-person submersible designed and developed by Canadian innovator Dr. Phil Nuytten and his company (see **For more information**). Its compact and lightweight construction carries one explorer at a time to depths as great as 2000 feet. SSE pilots can go substantially deeper and spend far more time below the surface than they can with traditional scuba operations, greatly enhancing their research capabilities. The submersible is easy to operate, making the depths accessible to scientists, educators, and others in a way never before possible. Because it is a one-person system, the pilot is also the researcher, navigator, and camera operator. The sub was designed to make operation as simple and intuitive as possible, so the pilot can devote attention to these other tasks.

Vehicle Specifications

Length: 7'0"
Beam: 5'6"
Height: 6'0"
Weight in air: 3,500 lbs.
Operating Depth: 2000 ft.
Payload: 300 lbs.
Life Support: 72 hours emergency life support (80 hours total)
Speed: 3.5 knots max
Crew: 1 person (pilot)

Sideview of the *DeepWorker* submersible

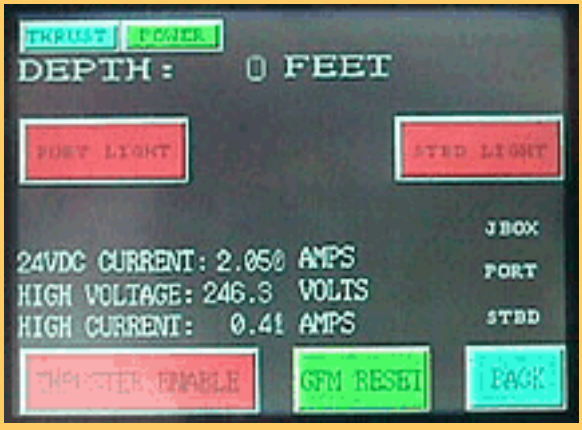
Construction

The *DeepWorker* is a small and lightweight system which is the product of advances in submersible technology over the last several decades, and some terrific leaps of insight and imagination from its designers at Nuytco Research. This submersible is a completely new design, and SSE was the first

major project to employ *DeepWorker* submersibles. *DeepWorker* subs have been used by NASA to recover space shuttle equipment, by various agencies in search and salvage operations in the wake of major airplane crashes, and in commercial industry.

The *DeepWorker*'s pressure hull consists of a 38-inch steel sphere attached to a 24-inch diameter by 36-inch long cylinder. A 30-inch diameter acrylic dome serves as the entry hatch and provides the pilot with a fantastic 250 to 270 degree field of vision. Beneath the hull are two 18-inch diameter titanium battery pods, each containing 10 high ampere, deep cycle, AGM batteries providing nominal voltage of 240/24/12 volts direct current. Maneuvering control is provided by two vertical and two horizontal 1 H.P. thrusters. Trim is controlled by a hard ballast system and fixed weights. A soft ballast system is provided for buoyancy on the surface and as a means of emergency ascent.

The *DeepWorker*'s life support system includes two externally mounted oxygen cylinders, two redundant mechanical oxygen controllers with electronic monitoring inside the cockpit, and two carbon dioxide scrubbers. Communications systems include VHF multi-channel radio for surface communications, and acoustic through-water telephone for sub-surface comms. Additional equipment includes sonar, cameras, manipulator arm, tracking beacon, precision laser measuring system, and scientific sampling equipment.



An example of a computer touch screen used to control many of *DeepWorker*'s main functions

Operation

The pilot uses a touch screen on the onboard computer system to control many of the sub's functions. *DeepWorker* is steered by foot pedals, a new innovation unique to this submersible. The right foot pedal controls forward, reverse, and turning. The left controls ascent and descent, and can also be used to move the sub laterally. With a little practice, maneuvering of the sub becomes as automatic as driving a car, allowing the pilot to devote more attention to other tasks. The

hands-free operation of the sub enables the pilot to simultaneously maneuver the sub and operate the manipulator and/or cameras, take notes, or even munch an apple.

During sub ops for SSE, the *DeepWorker* is piloted by scientists, educators, and SSE and sanctuary staff, while topside support is provided by Nuytco technicians, and their talented subcontractors from DOER Marine Operations (see **For more information**).

(top)

Additions to *DeepWorker*

The *DeepWorker* is highly adaptable for a variety of uses, with such accessories as manipulator arms, special cameras, and sampling equipment readily removed and replaced. For SSE, the subs are equipped with sophisticated camera systems, including lights, still cameras and video cameras, provided by the National Geographic Society. A high-resolution sonar system, specially designed for *DeepWorker*, is a standard part of the navigation system. It allows the pilot to navigate and avoid obstacles even in poor visibility. An electronic compass is standard. For SSE, the optional electronic tracking system will be employed, with WinFrog tracking software donated by Racal-Pelagos (see **For more information**).

A *DeepWorker* pilot sits in the sub prior to launching

The Advantages of *DeepWorker*

The unique design of the *DeepWorker* gives it many advantages over its predecessors. Submersibles in the past have been heavy and large, requiring dedicated vessels for launch and recovery. *DeepWorker* is easily transportable by trailer over land, and can be launched from a much wider variety of platforms.

As noted earlier, the ease of operation allows a much wider variety of pilots access to the deep ocean. And in contrast to the small view ports of older submersible designs, such as Delta and Alvin, the *DeepWorker*'s acrylic dome affords the pilot a wide view of the waters and sea floor around her. One pilot described the view from traditional submersibles as akin to "having a piece of

swiss cheese over your face mask." Several of SSE's *DeepWorker* pilots have experience as passengers in such subs, and are thrilled at the wide and unobstructed view afforded by *DeepWorker*.

Another advantage of *DeepWorker* is that it requires no tether to the surface. Many manned submersibles, and almost all Remotely Operated Vehicles (ROVs) are connected to ships with a tether containing power and communications cables. Tethers supply power and facilitate communications, but they also create problems. Tethers are heavy and create drag on the vehicle as it moves through the water, decreasing its maneuverability. Launch and recovery is more complicated, and tethers can also increase risk of entanglement. *DeepWorker* is a completely self-contained, lightweight submersible that can carry an explorer to significant depths at a fraction of the cost, and with far fewer logistical difficulties than with other subs.

For more information, visit these Web sites:

Nuytco Research, the designer and manufacturer of the *Deepworker*.

DOER, topside support for the *DeepWorker*.

Racal-Pelagos, the firm that donated electronic tracking software to the Sustainable Seas Expedition.

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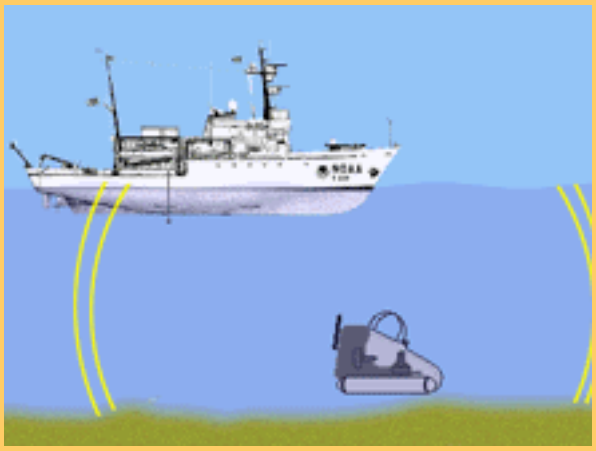
Tracking and Navigation

Dave Lott
GIS Specialist
NOAA/Special Projects



Surface tracking and navigation are an important support function for a submersible dive, particularly for an untethered sub like the Deepworker. Additionally, Geographic Information Systems (GIS) provide the ability to use bottom topography, imagery, and habitat information in real time during a dive.

Animation of the acoustic signals (click for larger image)

Tracking: Once it leaves the surface, the Deepworker is tracked acoustically by an ultrashort baseline (USBL) tracking system. A hydrophone mounted on the surface ship sends a low frequency "ping" into the water column. A transponder mounted on the back of the sub hears the ping, then sends two reply pings on different frequencies. The first ping gives range and bearing information, and the second ping gives water depth. This occurs about every two seconds throughout the duration of the dive.

NOAA tracking technicians use the TrackPointII system built by ORE of Falmouth, MA. It does the work of sending and collecting the acoustic signals, and

then converting that information into horizontal distance and bearing from the support ship, along with pressure depth.

The TrackpointII hydrophone mounted to the side of the ship

The red arrow shows the location of the tracking transponder mounted to the back of the Deepworker

Positioning and Navigation: The tracking system lets the surface support team know where the Deepworker is in relation to the ship; however it does not give coordinates on the Earth. To derive position information (i.e., latitude and longitude), a second computer running WinFrog software by Racal Pelagos, is tied into the support ship's global positioning system(s) and gyrocompass (a highly accurate, stabilized compass). The combination of the TrackpointII and the Winfrog navigation system allows the submarine to be positioned in real time on the Earth. This information is important for safety, for quickly returning to important sites in the future, and for long term research projects.

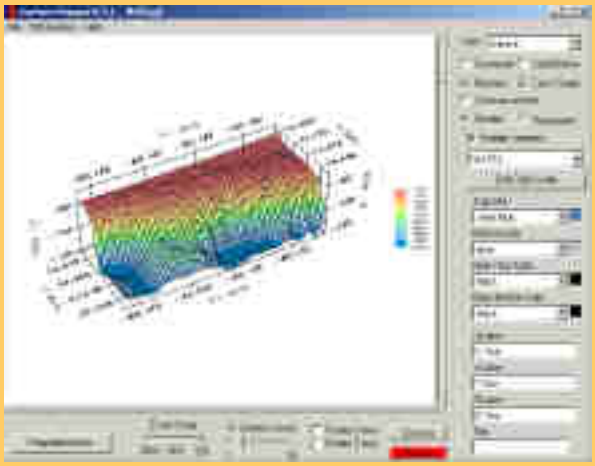
Mapping to Support Dives: By using the ship's echosounders (essentially a sonar that finds the bottom) and global positioning systems, more detailed bottom mapping can be accomplished on dive sites where data is limited.

Ideally, a grid system is set up so that the support ship's echo sounders can sweep back and forth over the bottom on proposed dive sites. The ship's crew often refers to this activity as "mowing the lawn".

NOAA GIS Specialist Dave Lott uses navigation software and GIS

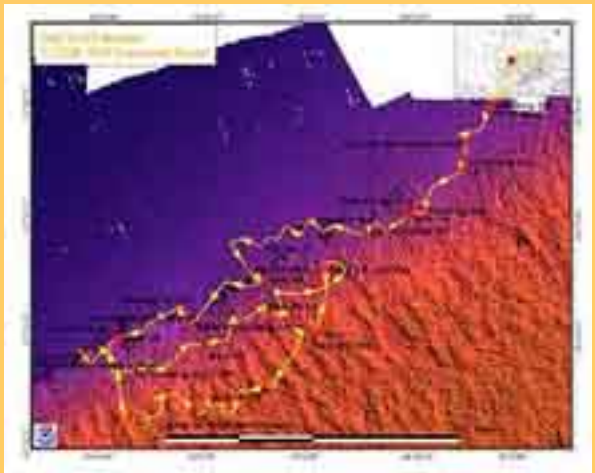
NOAA GIS Specialist Craig Russell helps pilots plan their dives

An ideal time to "mow the lawn" is when the sub batteries are being recharged and while the support crew is resting. The depth information is then reconstructed as a bathymetric map for use during Deepworker dives.



NOAA Technician Bruce Stone developed software to convert echosounder data into 3D maps

Geographic Information Systems: The navigation information can be fed both real-time and postdive into ESRI's ArcView GIS, which allows the support team and researchers to access other data layers (e.g., bathymetry, sidescan, and multibeam bottom imagery). The GIS is also used for predive planning and postdive analyses.



A Deepworker track using high-resolution multibeam imagery with a GIS system (click for larger)

(top) **RETURN**

Camera Systems

Kip Evans
Expedition Photographer
National Geographic Society

Lighting: The foundation of all imaging is lighting. SSE DeepWorker's are provided with two Burns 250 watt quartz lights, and two 400 Watt HMI's. The advantage of the quartz lights is that they can instantly be turned on and off. The HMI's are ballasted lights that require several minutes to light up, but they provide a total of 800 watts of light at a daylight temperature of 5600 degrees Kelvin. The HMI's Lights supply the illumination for TV cameras and for general 35mm still imaging. For more demanding photo applications, a 400 watt second strobe system is available.

35mm Still Cameras: The standard SSE camera is a Mini-Benthos 35mm camera that takes standard 35mm 36 exposure rolls of film, and is equipped with a 15mm lens. It is certified to 1,000 feet. SSE also uses a Benthos 378 35mm camera equipped with a 28mm lens and a 400 exposure film capacity. It is certified to 1,000 feet. Currently in the works is a new 35mm still camera that should provide all the useful features of a SLR. InsiteTritech out of San Diego is currently designing this new system.

High resolution camera systems for deep water photo documentation of the Expeditions. (Photo courtesy of Claire Johnson)

(top)

Camera systems: SSE's primary camera is a Sony DXC-950 3-chip with a Fujinon zoom lens, packaged by Insite Tritech. This camera, called the "Aries", is packaged in a 3,000-meter titanium housing with a depth rating of 10, 000 feet. Although it has several advanced features, some of the highlights include 750 horizontal TV lines of resolution, RGB, VBS and Y/C video output, a 14x zoom lens (5.5mm -- 77mm) and a remote control panel that provide access to the camera's iris, shutter speed, white balance and a whole host of other picture controls. The total camera package weighs about 27 pounds in air and 6.0 pounds in water. One of the best features the camera package has to offer is its dome port. It's a Hemispherical Quarts dome optically polished and water corrected for underwater use. This type of design maximizes clarity and sharpness in recorded subject matter.

Other Cameras: SSE also has access to a single-chip Panasonic camera packaged by Deep Seas Systems. It has a zoom lens that can be installed if a change in shooting is required. One of the best features of this camera is its ability to deal with low light conditions.

SSE also owns two Sony 999 "lipstick" cameras packaged by Deep Sea Power and Light. They have extremely wide-angle lenses and are very small (about the size of a large cigar). This

type of camera is perfect for the "scorpion tail," or as a video viewfinder for the 35mm cameras.

Black & White Video Cameras: SSE has access to a very sensitive Night Hawk tube SIT camera designed for filming sea life in very low lighting conditions. It is an expensive and delicate camera that should not be pressed into use on a daily basis. The best applications for this camera, is deep water shooting without the use of bright lighting.

Video Recorders: Small Sony Mini-GVD300 recorders are used in the subs. Each sub is also equipped with a microphone plugged into one of the audio channels. The GVD300 records at 550 horizontal lines of resolution.

Research Lasers: SSE uses a 2-4 laser package that helps scientist and technicians perform measurements underwater. The lasers are mounted around one of the subs cameras where they project 2-4 red dots (depending on application) on a particular subject a scientist might be interested in measuring. Post processing of laser embedded video is accomplished using Video Ruler and Optimums software.

Video Monitors: SSE uses a 6" high-resolution LCD monitor (756 X 556 X RGB) developed by Transvideo of France. The monitor has a full range of adjustment controls and a universal back that allows for RGB, Y/C or composite video inputs.

Editing Equipment: SSE is well equipped not only to record images on site, but also to edit and manipulate images while at sea. Currently, SSE uses 4 DV decks designed to dupe and transfer video material, 1 Beta SP recorder for archiving, a Macintosh G3 for desktop editing and a Epson Photo EX printer for producing color pictures. Desktop editing is accomplished with Edit-DV software and Adobe PhotoShop. Any video image captured during a submersible dive can be down loaded, edited and sent anywhere in the world in less than an hour.

(top) **RETURN**

Multi-Parameter Water Monitoring Systems - Sondes

Multi-parameter water monitoring systems were designed to address the emerging need to measure non-point source pollution. These systems are used in the field and operate with the push of a button, store data in memory, and communicate with computers. These instruments, sometimes called sondes, are ideal for profiling and monitoring water conditions in industrial and wastewater effluents, lakes, rivers, wetlands, estuaries, coastal waters, and monitoring wells. A sonde is a torpedo-shaped device that is placed in the water to gather water quality data. Sondes may have multiple probes. Each probe may have one or more sensors that read water quality data. If the sonde has 'on board' battery power, it can be left unattended for weeks at a time with measurement parameters sampled at a preprogramed sample interval and data securely saved in the unit's internal memory.

The torpedo shaped YSI 6600 sonde

The DeepWorker has been equipped with a multi-parameter water monitoring system. The YSI 6600 sonde, used in the Sustainable Seas Expeditions, measures temperature, conductivity, salinity, dissolved oxygen, pH, turbidity, and depth. The sonde is programmed to sample data at a 4-second rate for the duration of the dive. When the DeepWorker returns to the ship, data logging is stopped and the data is downloaded. The data is then processed and correlated to the DeepWorker's position allowing the scientists to further study and analyze each dive site.

The fast response of the sonde's sensors make the systems ideal for vertical profiling. The 6600 systems feature a patented Rapid Pulse Dissolved Oxygen Sensor, which exhibits low-stirring dependence and provides accurate results and does not require a stirrer.

Sondes may have multiple probes. This is a close-up photo of the end of the 6600 sonde with all sensors installed. Each probe may have one or more sensors that read water quality data.

The 6600's used on the DeepWorker are configured with a stainless steel pressure case in the event dives greater than 700 feet are required.

A handheld YSI 610-DM Display/Logger is used to calibrate the sonde, program it for the dive, and download the data from the sonde. The data is then passed to one of the ships onboard computers. Specialized software is used to graph and manage the data.

The 6600 sonde is designed for long-term in situ monitoring and profiling. It offers long battery life and large memory capacity, can be deployed to 656 feet (200 meters), and contains an additional port for chlorophyll. The sonde will log all of the parameters at programmable intervals and store 150,000 readings. At 15-minute intervals, it will log data unattended for about 75 days.

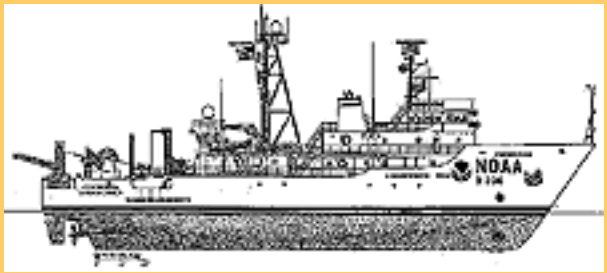
Visit YSI's web site.

(top) **RETURN**

NOAA Ship Gordon Gunter

The NOAA Ship *Gordon Gunter*

The NOAA Ship *Gordon Gunter* is the latest ship to host the Sustainable Seas Expedition. The *Gunter* normally operates in the Gulf of Mexico and Caribbean Sea, and will serve during both the West Florida Shelf and Florida Keys expeditions in August and September 2000. The *Gunter's* primary mission is to conduct fishery and marine resource research supporting NOAA's National Marine Fisheries Service, Pascagoula Laboratory in Pascagoula, Mississippi. The ship collects fish and crustacean specimens using trawls and benthic longlines, and fish larvae, eggs, and plankton using plankton nets and surface and midwater larval nets.



A pencil drawing of the *Gordon Gunter*. (Line Drawing by Bob Hitz)

Gordon Gunter was originally built as the U.S. Naval Ship *Relentless* in 1989, was transferred to NOAA in March 1993 and commissioned as the NOAA Ship *Gordon Gunter* on August 28, 1998, in Pascagoula, Mississippi. The *Gunter* is named after Dr. Gordon Gunter, a marine biologist and leader in marine research and education whose career has spanned more than 60 years.

The ship was extensively overhauled in March 1998. One of the modifications made was the installation of a custom designed

marine mammal observation and survey station located at the top of the pilot house. The station is outfitted with three "Big Eyes" binoculars. The ship also received modern navigation electronics and oceanographic winches, sensors, and lab and sampling equipment. The *Gunter* is considered the best fit, acoustically quieted vessel engaged in fisheries and marine resource work.

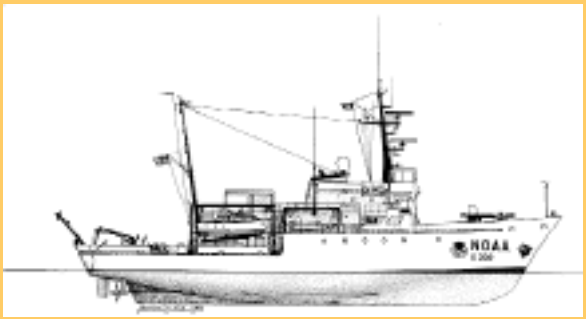
To learn more about the *Gunter*, including research projects and ship specifications, visit the ***Gunter*** website.

(top) **RETURN**

NOAA Ship McArthur

The National Oceanic and Atmospheric Administration (NOAA) ship *McArthur*

The National Oceanic and Atmospheric Administration (NOAA) ship *McArthur*is a 175-foot Class III ship that conducts oceanographic research and assessments throughout the Pacific Coast of the United States. The majority of the *McArthur's*work is done in several of the national marine sanctuaries on the west coast of the United States. The ship engages in measurements of chemical, meteorological, and biological sampling for many large scale programs like the Sustainable Seas Expeditions.



A drawing of the NOAA ship *McArthur*. (Line Drawing by Bob Hitz)

The *McArthur*is one of a fleet of research and survey vessels used by NOAA. Home port for the *McArthur*is the Pacific Marine Center on Lake Union in Seattle, Washington. The *McArthur*carries a complement of 3 officers, 19 crew members and up to 13 scientists. The scientists who carry out research aboard the *McArthur*come from many divisions of NOAA, as well as other federal and state government agencies, and academia.

The *McArthur*was commissioned in December 1966. It has an endurance of 30 days at sea, and a range of 6,600 nautical miles.

There are two working laboratories onboard - an oceanographic lab and an instrument lab. On deck, four cranes, two A-frames, and three winches move scientific equipment and smaller boats

SHIPS

GORDON GUNTER

McARTHUR

NOAA SHIP FERREL

KA'IMIMOANA

DISCOVERY BAY

from the water to the ship deck to the dock. The ship carries five other launches and small boats.

The *McArthur*is well equipped with electronic systems for communications, acoustics, and navigation. There are additional pieces of sophisticated scientific equipment onboard, including an Acoustic Doppler Current Profiler, an XBT Reporting system and a CTD system. CTD stands for conductivity, temperature, and depth which are measured by a sensor that is lowered and raised through the water column.

DeepWorker launched by crane on the *McArthur*

To learn more about the *McArthur*, including research projects and ship specifications, visit the ***McArthur***website.

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NOAA Ship Ferrel

The NOAA Ship *Ferrel*

The NOAA Ship *Ferrel*is equipped specifically for oceanographic studies of coastal and inshore waters. Though the *Ferrel*normally works a six-day week, she has an nine-day endurance, a range of 1,200 nautical miles, and a cruising speed of ten knots. Modified from a basic design for an off shore oil rig supply boat, she has twin screws and a bowthruster to improve maneuverability. Various instruments used in her work are prepared and deployed through the combination of a large open fantail, crane aft, trawl winch, an A-frame and oceanographic winch located midships.

A line drawing of the *Ferrel*. (Line Drawing by Bob Hitz)

Based in Charleston, South Carolina, the *Ferrel*works on projects along the East and Gulf coasts throughout year. The *Ferrel*supports three primary areas of research, with 45% of operational time going to the Office of Ocean and Coastal Resources Management, 37% to the National Sea Grant College Program, and 18% going to the National Status and Trends Program. Fourteen permanent crew members and up to eight scientists work the ship. The permanent crew provides their combined experience in deck machinery, research operations, project planning, surveying, and research diving to every scientific project.

The *Ferrel* was commissioned in June 1968. Two oceanographic

labs are onboard the *Ferrel* -- a wet and a dry lab. She has a moveable A-frame and four cranes and booms used to deploy instruments. Among the acoustical equipment used in the *Ferrel's* research is a side scan sonar recorder. The *Ferrel* carries four additional launches and small boats to assist in operations.

To learn more about the *Ferrel*, including research projects and ship specifications, visit the ***Ferrel*** website.

(top) **RETURN**

NOAA Ship Ka'imimoana

The NOAA ship *Ka'imimoana* (Hawaiian for '*The Ocean Seeker*')

The *Ka'imimoana*(Hawaiian for '*The Ocean Seeker*') is based in Pearl Harbor, Honolulu, Hawai'i, and supports oceanographic and climate research missions in the Pacific Ocean. Her primary mission is to support NOAA's Tropical Atmosphere-Ocean (TAO) program in its effort to improve our understanding of the role of the tropical ocean in modifying the world's climate. The ship cruises the equatorial Pacific Ocean for a month at a time, deploying, recovering, and servicing deep sea moorings that measure ocean currents, ocean temperatures, and atmospheric variables. This wide-spaced array of deep ocean sensors has been called the "largest scientific instrument in the world."

A drawing of the *Ka'imimoana*. (Line Drawing by Bob Hitz)

The *Ka'imimoana*was transferred to NOAA from the U.S. Navy in August 1993, converted to her present configuration in 1995, and reentered service in April of 1996. The 224-ft. *Ka'imimoana*has a range of 8,000 nautical miles and an endurance of 30 days, perfectly suited to its primary mission of large scale sensor deployment and recovery.

In addition to the TAO program, the *Ka'imimoana*serves as a platform for other research. With three winches, four cranes, an A-

Frame and a J-Frame, the ship is well equipped to lower instruments and boats into the sea. Measurements of upper ocean currents, surface salinity, carbon dioxide content, and upper air atmospheric soundings are taken while underway. Other ongoing research is a census of barnacles and marine life that inhabit the recovered moorings, and the periodic replacement of undersea hydrophone moorings used to locate undersea spreading centers and hydrothermal vents on the East Pacific Rise.

The *Ka'imimoana* cruises past a data buoy

The *Ka'imimoana*is outfitted with an upgraded oceanographic system. The Scientific Computer System (SCS) is a computer network that collects, stores, processes and retrieves a variety of real time oceanographic data from navigation and environmental sensors, and bathymetric sonar systems. The SCS consists of two networked computer systems that provide both data acquisition and data processing functions. One is dedicated to acquire, log, and display data in real-time. The second computer is dedicated to shipboard scientists for data analysis and their research. Data is transmitted worldwide through satellite communications links.

To learn more about the *Ka'imimoana*, including research projects and ship specifications, visit the ***Ka`imimoana***website. To learn more about NOAA's Tropical Atmosphere-Ocean (TAO) program, visit the **TAO program website**.

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US Navy Ship YTT-11 Discovery Bay

Scot Groulik
United States Navy

The 186-foot YTT-11 *Discovery Bay* range craft

The 186-foot YTT-11 *Discovery Bay* range craft was used, courtesy of the U.S. Navy, for the expedition at the Olympic Coast National Marine Sanctuary, June 16-30, 1999. The Yard Torpedo Test (YTT) range craft usually supports launch and recovery exercises for military operations, but has been made available for other organizations including universities and businesses. The Naval Undersea Warfare Center (NUWC) Division Keyport near Seattle, WA signed a memorandum of understanding between NOAA and the National Geographic Society which enabled the *Discovery Bay* range craft to be scheduled for the SSE exploration.

The *Discovery Bay* range craft is one of two YTTs which are part of the fleet of support ships at NUWC Keyport. Their support includes exercises on the three instrumented underwater tracking ranges in the region. A YTT has two Z-drive steering propulsion engines with 40' x 70' aft deck space. The complement of hydraulic cranes and vertical track winches are best suited for deployment of recovery vehicles.

Cooperative research and development agreements can also provide for the exchange of personnel, services, facilities and equipment to reach a mutually useful objective. NUWC Keyport is

A YTT range craft deploying a special purpose ROV

proud to provide its services to better understand our undersea environment and was honored to be part of the 1999 SSE exploration!

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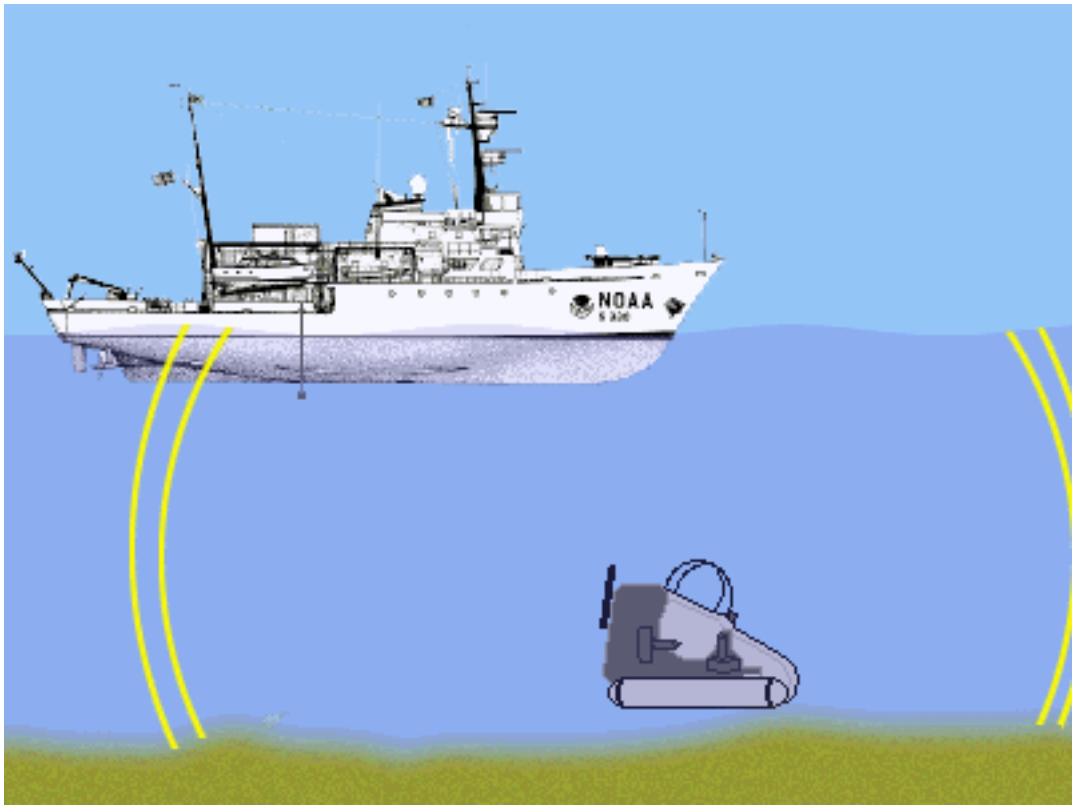
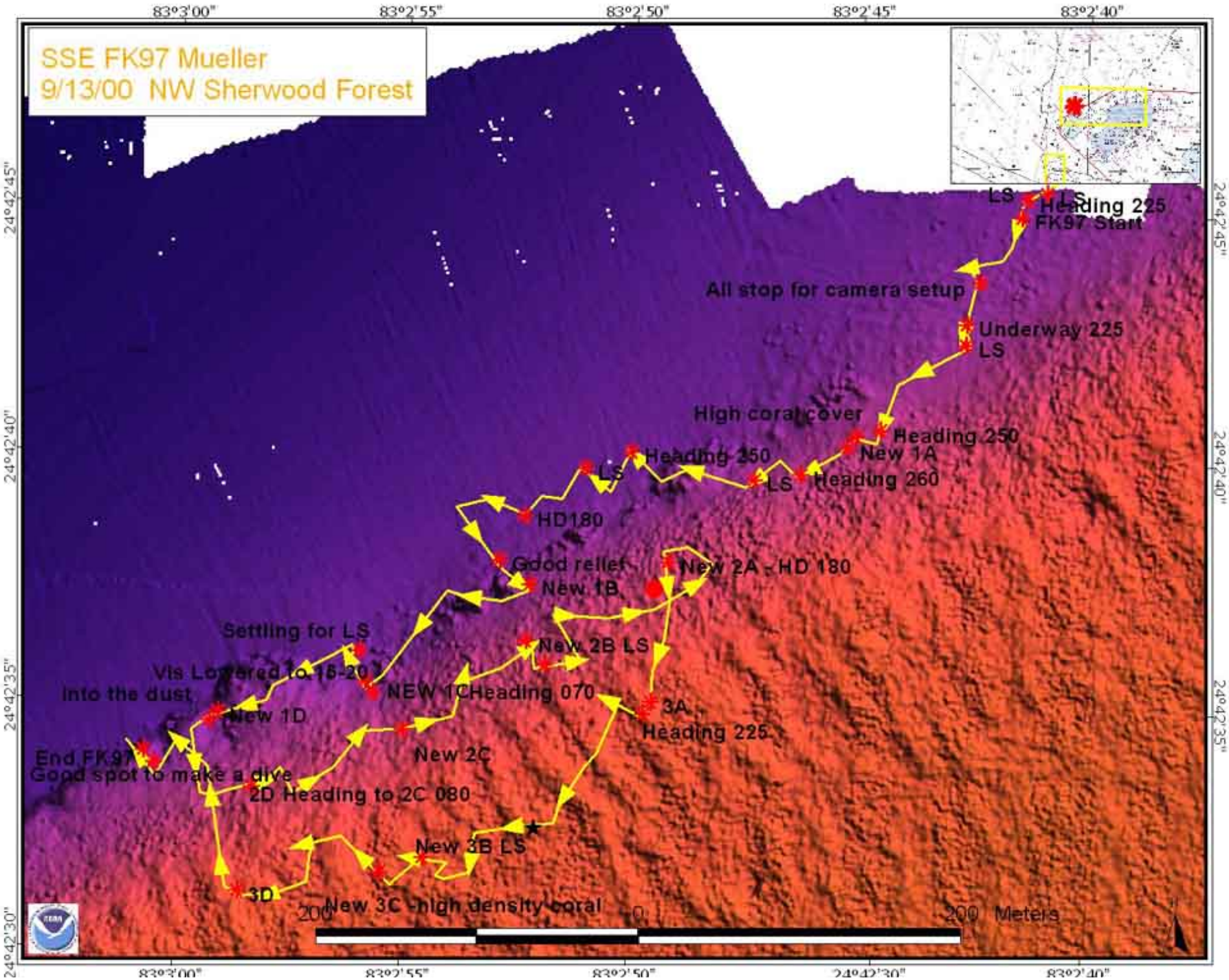

NOAA


SSE FK97 Mueller
9/13/00 NW Sherwood Forest
83°3'00"
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83°2'50"
83°2'45"
83°2'40"
24°42'45"
24°42'40"
24°42'35"
24°42'30"
LS
LS
Heading 225
FK97 Start
All stop for camera setup
Underway 225
LS
High coral cover
Heading 250
New 1A
Heading 250
LS
LS
Heading 260
HD180
Good relief
New 1B
New 2A - HD 180
Settling for LS
New 2B LS
Vis Lowered to 15-20'
into the dust
NEW 1CHeading 070
New 1D
3A
Heading 225
End FK97
Good spot to make a dive
New 2C
2D Heading to 2C 080
New 3B LS
3D
New 3C - high density coral
200
0
200 Meters

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The Sustainable Seas Expeditions Web Site

National Marine Sanctuaries Web site

The National Marine Sanctuaries Web site provides numerous other offerings on scientific, educational, and technical projects being undertaken by NOAA in the expeditions.

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EXPEDITION UPDATE

September 1 - 23, 2000

Track the Florida Keys expedition on this page. To learn about planned **education** and **research** activities, and other interesting facts, select a background essay of your choice. You can also follow expedition logs and updates.

Sept 1-2 The first two days of the mission were spent preparing the **NOAA Ship *Gordon Gunter*** and the DeepWorker submersibles for this expedition. **Billy Causey, the Sanctuary Superintendent, welcomes you.**

NOAA ship *Gordon Gunter*

Sept 3 Greetings from the *Gunter!* DeepWorker pilot Gale Mead dove the northern end of Riley's Hump in 200 to 400 ft of water. Rock samples were collected for further geologic study of this region. Dr. Sylvia Earle attempted a 1,600-ft dive at the southern end of Riley's Hump, but aborted due to some minor mechanical problems. When diving at 1,600 ft, everything needs to be working perfectly.

Sept 4 The ship is now directly off of the **Dry Tortugas** in an area known as Sherwood Forest. After not having been "in the saddle" for over a year, Dave Savage, Manager of the Florida Keys National Marine

LOG

Sept. 1 Welcome SSE

Sept. 4 Shark Visit

Sept. 5 Students at Sea

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Sept. 9 Sherwood Forest

Sept. 10 Counting Fish

Sept. 11 Personal Log: Cava

Sept. 11 Miller's Mountain

CORAL SPAWNING

CULTURAL HISTORY

DRY TORTUGAS

MARITIME HISTORY

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A "swimmer" as seen from the DeepWorker.

Sanctuary Upper Region, and Mary Tagliareni, Sanctuary Education Coordinator, climbed back in the DeepWorker to refresh their piloting skills and explore new areas. The NOAA ship *Whiting* had conducted multibeam surveys of the dive area earlier in the year, and these maps provided a good basis for selecting dive sites. The morning dive served as a checkout dive for Dave and ground truthing of the multibeam imagery map. NOAA tracking and navigation expert Craig Russell used the maps to guide Dave from coral pinnacle to coral pinnacle. After surfacing and a dive debriefing, Dave was able to directly correlate what he saw with the *Whiting* imagery. Mary took an evening plunge to continue the ground truthing and to serve as her checkout dive. Visibility was poor, but Craig was able to direct her to the coral formations based on the multibeam maps. **Read about a large shark encounter.**

Sept 5 Dr. Earle attempted a morning dive at the south end of Riley's Hump. The plan was to go to 1,600 ft; however, due to losing her on the tracking system, and a camera malfunction, the dive was limited to 1,250 ft. The evening dives were postponed to address these issues. A group of students from Coral Shores High School in the Upper Keys visited the ship and met with Dr. Earle. **Read about their experiences.**

Students visit the bridge of the *Gunter*.

Sept 6 In the morning, Dr. Earle dove to 1,630 ft at the south end of Riley's Hump in the Proposed Ecological Reserve. Even though it was a sand bottom that at first looked barren, it was actually teeming with life. Shrimp, fish, a sea cucumber, anemones, and crabs, all adapted to living in total darkness, were paid a visit by the DeepWorker and captured on film. Gale Mead dove in the same vicinity in the evening. She also captured excellent images of this never before explored area in the Florida Keys.

Sept. 14-16 National Geographic Alliance

Sept. 16 Open House

Sept. 2-14 Dive Maps

Sept. 23 Summary Log

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1999 MISSION LOG

A fish observed 1,600 feet below the ocean surface.

Sept 7 This morning, Sylvia completed another dive in the Proposed Ecological Reserve to a max. depth of 1,680 ft for about 4 hrs. She saw evidence of what appeared to be scrapings from trawlers in the sand and limestone bottom. In the evening/night, Gale Mead dove in a shallower area of Riley's Hump to a depth of 200 to 400 ft. It was a deep reef habitat with soft corals, but too deep for the hard stony corals. In other news, a newspaper reporter caught a shuttle to the *Gunter*to interview Dr. Earle after her dive.

Sept 8 Dave Savage conducted a fish survey dive in approx. 300 ft. of water. He saw large numbers of groupers and snappers. At one point during the dive, he observed a 30-lb. black grouper. He also saw bank butterflyfish, which are uncommon in shallow water. In the late afternoon, Dr. Earle and Ms. Mead were successful in completing a dual sub dive. **Read Dave Savage's summary of the first week's activities.**

Sept 9 The pilots continued a series of dives aimed at studying fish abundance. Laddie Akins from REEF, and SSE Education Manager Francesca Cava, both dove to approx. 150 ft in an area near Sherwood Forest. **Read about REEF and fish survey methodology**. Also, **read about Laddie Akins' search for the Sherwood Ledge.**

Sept 10 Mary Tagliareni dove to an area west of Sherwood Forest to continue surveying fish, but was limited by poor visibility due to silty water. In the afternoon, Laura Francis, the NOAA SSE Education Coordinator, completed another fish survey during her DeepWorker dive. **Read her report on counting fish at Miller's East.**

A big-eye spotted during Laura Francis' fish survey.

A red grouper observed during Francesca Cava's DeepWorker dive.

Sept 11 Two dives were completed today in the Proposed Ecological Reserve south of the Dry Tortugas. Both Francesca and Laddie completed fish surveys at depths up to 380 ft. **Read about Francesca's 14-year journey through the national marine sanctuaries.** Also, **Laddie reports on his successful dive on an area known as Miller's Mountain.**

Sept 12 The fish surveys continued today along the southern ridge of Riley's Hump.

Sept 13 Eric Mueller, from the Mote Marine Lab, and Mary Tagliareni conducted fish surveys in Sherwood Forest, an area known for its high density of coral.

Sept 14 The *Gordon Gunter* and SSE crew are heading to a deep-water area that could contain submerged canyons. Tomorrow, they will return for one more dive to Sherwood Forest before steaming to Key West for the upcoming Open House. If you would like to tour the vessel and speak to the scientists, come to Mallory Square on Saturday, Sept. 16, from 10 am to 2 pm.

Sept 15 The *Gunter* is in transit to Key West.

Mallory Square during the SSE Open House

Sept 16 Secretary of Commerce Norman Y. Mineta was among some 500 visitors to the SSE Open House in Key West today. The event allowed the public to speak to the SSE team and take a closer look at the NOAA ship *Gunter* and the DeepWorker submersibles. Ivy Kelley and Nancy Diersing, education specialists at the Florida Keys National Marine Sanctuary, were in attendance to assist visitors and record the day's events. **Read Ivy's summary of the SSE Open House** in Key West, and **Nancy's report on the National**

Geographic Alliance visit to the sanctuary.

Sept 17 Late last night, after departing Key West to return to the Dry Tortugas to resume the expedition, the *Gordon Gunter* ran into high seas. A rudder was lost while navigating these strong waters,

and forced the ship to return to shore, effectively ending the Florida Keys mission one week early. You can still **participate in the Sept. 26 Live Web Chat**.

View expedition Dive Maps.

Read the Summary Log of the Florida Keys expedition.

View a series of SSE Dive Maps illustrating the Florida Keys mission.

Welcome to the Sustainable Seas Expeditions and the Florida Keys

Billy D. Causey, Superintendent
Florida Keys National Marine Sanctuary

Billy Causey

Ahoy!

Friends, colleagues, scholars, and students from around the world, the Sustainable Seas Expeditions (SSE) for 2000 have arrived in the Florida Keys National Marine Sanctuary! I want to take this opportunity to welcome you to the second year of SSE discoveries and exploration here in the fabulous Florida Keys. Our Web page will put you in the cockpit of one of the DeepWorker submersibles, alongside the trained pilots, as they explore and discover the sea floor in the Sanctuary.

The second year of this extraordinary expedition started off the West Coast of Florida a few weeks ago. SSE Director Dr. Sylvia Earle and a team of world renowned coral reef scientists began exploring deep-water coral reef habitats that before now were only blips on a depth recorder, depth contours on a NOAA nautical chart, or details on side-scan sonar images. As a result of the deep-water exploration and assessments conducted by Dr. Earle and her team, we now have a much better understanding of many of the biologically diverse marine communities that have, until now, escaped the glimpse of scientifically trained human eyes.

By the compass, the West Florida Shelf is almost due north of the Florida Keys. According to the work conducted by Dr. Tom Lee, an oceanographer, the water currents that flow through the passes between the Keys come from the direction of Florida's West Coast. Just think: All of the larvae, or free-floating marine creatures, that are spawned along the deep-water coral reefs off the West Coast of Florida ride the currents to the Keys, where they settle out and grow ito adulthood. What a terrific scientific contribution it is to

know more about marine life in the deep-water coral reefs and its link to America's only living barrier coral reef, here in the Keys. It's all one big ecosystem!

Word from aboard the NOAA ship *Gordon Gunter*is that the SSE scientists have already made a couple of deep dives in the southern portion of the proposed Tortugas Ecological Reserve as they steamed into Key West this week. The excitement can't be contained! During these initial two dives, they explored a sheer drop of over 150 feet off the southern tip of Riley's Hump, a known fish-spawning site. We are learning so much about the coral reefs of the Florida Keys from SSE exploration and discovery that words can't do it justice. But photographs will, because each of the DeepWorker submersibles is equipped with cameras that are documenting these exciting new discoveries.

By following the progress of the SSE mission on this Web page, you will be able to join us in celebrating new discoveries as the scientists document them. This is my invitation to you, to come along as we explore and discover new things about one of America's most precious natural environments.

As the NOAA ship *Gordon Gunter*casts off its lines and sails to explore exciting new marine environments, join us via your computer as we head into the deep blue seas off the Florida Keys.

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September 4, 2000

Steven Baumgartner,
Operations Coordinator, Lower Keys Region
Florida Keys National Marine Sanctuary

Steven Baumgartner

My role during this mission of the Sustainable Seas Expeditions is to be the operations coordinator for the Florida Keys Dry Tortugas leg and swimmer for both the West Florida and Dry Tortugas legs. As an operations coordinator it is my job to assist in choosing dive sites, coordinate logistics between ship and shore, assist the sub tracking team, and scuba dive to ground-truth potential shallow dive sites for the DeepWorker submersible. To optimize the use of the DeepWorker,it is important to choose sites that normally would require extensive scuba bottom time and multiple visits for complete study.

The DeepWorker submersible is deployed over the stern of the NOAA ship *Gordon Gunter*. (Photo courtesy of Mary Tagliareni, FKNMS)

The DeepWorker allows bottom time to be extended, hence increasing the range and detail of exploration. Today, we did an 80-ft, 40-min scuba dive; the same dive aboard the DeepWorker would have extended our bottom time to four hours.

I am often asked to explain how I find and choose dive sites to explore in the Dry Tortugas. My answer is easy; for the past four years I have been conducting a "resource inventory" of the Dry Tortugas area for the Florida Keys National Marine Sanctuary (FKNMS). A "resource inventory" basically consists of mapping the area using an electronic depth sounder that records the bottom profile, such as contour changes. When we get an indication of a rise or hump on the bottom, we record the latitude and longitude with a GPS (global positioning

system) unit, then scuba dive to see what the bottom looks like. This type of profiling is work-intensive,

The NOAA ship Gordon *Gunter* (Photo courtesy of Mary Tagliareni, FKNMS)

but is very exciting, and can be rewarding as you find new coral formations or fish habitat. In the past two years, we have started to use new bottom mapping technology, such as sidescan sonar and multibeam sonar. Multibeam sonar gives an incredible three-dimensional map of the bottom. This technology is not new, but as interest has grown in the Dry Tortugas and the potential establishment of the Tortugas Ecological Reserve, more technical resources have been committed to mapping bottom topography of this area. The maps being produced give us a big picture of an area and are an invaluable tool in exploring large areas around and in the Dry Tortugas. Even with all the technology available, it will take years to thoroughly explore the waters in and around the Dry Tortugas and the Florida Keys.

I also have been asked about the future of the DeepWorker as a research tool in the Dry Tortugas. It is my goal for the sanctuary to purchase one in the next three years. The DeepWorker would do much to further exploration in the Florida Keys National Marine Sanctuary, not only in the Dry Tortugas, but thoughout the Keys. Stationing a two-man submersible in the Florida Keys would allow trained sanctuary staff pilots to take scientists and educators to depths unexplored, and allow extensive dive times to accomplish research projects more safely and efficiently.

I hope to be trained as a pilot for next year's SSE mission. Part of my training this year is as a "sub swimmer." Thus far, this has been the most exciting duty I have had to perform for the SSE mission. The swimmer releases the DeepWorker from the towlines that are attached to the ship during deployment at the beginning of a dive, and

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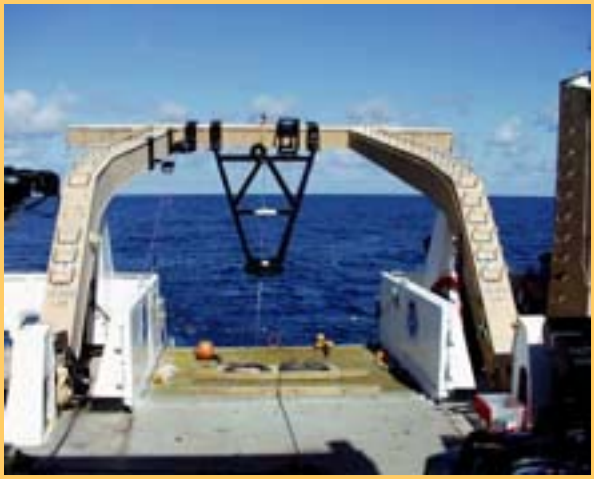
Steve, as seen by the DeepWorker pilot attaches the towlines for recovery of the sub. (Photo courtesy of Gale Mead)

reconnects the lines after completion of the dive for recovery of the sub to the ship.

Imagine swimming in 500 ft of deep blue ocean, 100 mi from land, and sometimes in the middle of the night. One night, I had a bit more excitement than I cared to have. At about 10:30 pm, after a 500-ft dive at Riley's Hump, the DeepWorker had surfaced. I was attaching the lines, preparing the sub for retrieval by the ship, when I saw a large, dark shadow loom up from below the sub just outside the beam of its lights. I could not make out exactly what it was, but I knew it was big. My first thought was that it might be one of the dolphins that I had seen earlier that day. As I finished preparing the sub, I noticed a school of squid in front of the sub lights. As I started to swim back to the chase boat, the large object looming in the darkness headed straight for me. It took only a few seconds for me to realize that it was a 6- to 8-ft-long shark! The actions of the shark motivated me to speed up and swim faster back to the chase

boat. On the way there, I met up with his "buddy" -- a 4-ft-long gray reef shark that was blocking my path. I don't know how I did it, but I bolted over the small shark and into the chase boat all in one motion.



The crane on the aft deck is used to deploy and recover the DeepWorker from the water. (Photo courtesy of Mary Tagliareni, FKNMS)

Over the years of diving I have encountered many sharks, but there is something unsettling about being in 500 ft of water, out in the middle of nowhere, and in pitch-black conditions. The good news was that I made it back to the chase boat with all my limbs intact. The bad news was that I had to get back in the water and finish hooking the towlines on to the sub so it could be lifted on deck. Just when I thought the big guy had moved on, during the last part of my swim, there he was again, lurking just beyond the sub lights. My thoughts were that this was payback for all the sushi I had eaten in the past! I swore then and there to abstain from eating it again, if only he would leave me alone. Well, he did leave me alone, and, as promised, I will refrain from eating sushi -- but only for a couple of months (slightly less time than promised). After my pulse slowed and I could think straight, I realized the reason for his presence. The lights of the sub had attracted a large school of

squid that followed the sub up from the bottom. Sharks love squid, and I just happened to be in the middle of their dinner that night. I wish I had been braver and hung around to observe them for a while. It was an opportunity missed.

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September 5, 2000

Mary Tagliareni, Education Coordinator
Florida Keys National Marine Sanctuary

Mary Tagliareni

A group of students from Coral Shores High School are having an incredible week of diving and experiencing the Dry Tortugas aboard the *M/V Tiburon*from Key West. Tim Taylor, of Taylor Made Excursions, worked with David Makepeace, marine science teacher at Coral Shores H.S., to provide students with this opportunity to study and learn in their own "aquatic backyard." Logistical support, transportation and weather conditions make it a challenge to dive in and explore the remote Tortugas area, 70 miles west of Key West.

Students from Coral Shores High School (Photo courtesy of Mary Tagliareni, FKNMS)

The students have been scuba diving the different habitats in this area to observe and learn first-hand why it is a proposed ecological reserve. As part of their field experience, they came aboard the NOAA ship *Gordon Gunter*to learn more about the Sustainable Seas Expeditions (SSE) and the DeepWorker technology, and to meet with SSE Director Dr. Sylvia Earle.

During their time in the Tortugas, they recorded some of their observations in the log entry below.

Student observations

The time we have spent in the Dry Tortugas has brought to light a number of problems and issues regarding our "aquatic backyard." A

few of these aspects are good, and some aren't. Some of the issues that aren't so good are the shrimp bycatch, the absence of predators and large fish, and the lack of diversity.

Bridge Ensign Andy Hall of NOAA explains to the students *t*he navigation equipment on the bridge of the NOAA ship *Gordon Gunter*. (Photo courtesy of Mary Tagliareni, FKNMS)

While fishing with the shrimpers, we learned about the main disadvantage of this activity: The bycatch. There is a 10:1-lb. ratio of bycatch to shrimp caught. This means that for every one pound of shrimp, thousands of crabs, fish and even corals are killed. We've also noticed an absence of predatory fish. We believe this is due to extensive fish trapping. Our dives also opened our eyes to the lack of diversity in the size, species, and populations of fish.

Although there was an absence of predators and lack of diversity, the coral formations were breathtaking. We agreed that Sherwood Forest had the most unusual coral formations that we have ever seen. Swimming through the unique caves at Tortugas Bank left us in awe. In addition to the coral formations, the experiences on the boat and the memories we've shared will surely last a lifetime.

Students' Schedule
Day 1: Scuba dive and snorkel at Western Dry Rocks; checkout dives

Day 2: Spent morning and afternoon with the shrimp boat, fished; scuba dived and snorkeled at the French wreck and K Reef

Day 3: Scuba dived and snorkeled at Sherwood Forest and Tortugas Bank

Day 4: Drift scuba dived at Riley's Hump; boarded and toured the NOAA ship *Gordon Gunter*

Participants:
Students: Ben S.. Lauren H., Deena W., Ian B., Nick M., Jorge D., Kristina F., Adam He., Kendall B. and Naomi L.

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Teacher: David Makepeace

Visitors: Austin Vance and Andy Vance

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September 3-8, 2000 Summary of Week One

Lieutenant Commander Dave Savage, Manager
Florida Keys National Marine Sanctuary, Upper Region

Dave Savage

The majority of the first week of the Sustainable Seas Expeditions' mission in the Florida Keys National Marine Sanctuary was spent in Tortugas South, one of two important areas in the sanctuary's proposed ecological reserve. The Tortugas Ecological Reserve, which should become finalized later this fall, will be one of this country's largest and most important no-take marine reserves. This area is a critical source of fish and invertebrate larvae for the coral reefs of the Florida Keys and southeast Florida, and is uniquely situated upstream from these areas in the Florida Loop Current. Once the Tortugas Ecological Reserve is established, large predatory reef fish, such as snapper and grouper, and crustaceans, such as lobster, will be allowed to grow and breed unhindered by human consumptive activities. The Tortugas area is also home to some of this country's most extensive and healthiest coral reefs.

The first week's submersible dives concentrated mostly on the deep areas of Tortugas South, which ranged in depth from 250 to 1,800 feet. What we found was surprising to those of us whose knowledge was limited to the shallow, low-profile reef environment on the top of Riley's Hump. The shallow Riley's Hump area is comprised of scattered small coral colonies and sand in less than 100 feet. We did know that large

The sand bottom provides camouflage for this fish living at 1,600 ft. (Photo by Gale Mead)

numbers of mutton snapper aggregate here to spawn in May and June.

Officers on board the NOAA ship *Gordon Gunter*surveyed the proposed submersible dive sites using the ship's SIMRAD sonar system. To our complete surprise, Ensign Mark Miller, the ship's Operations Officer, discovered a small seamount in 250 to 550 ft of depth, where we had assumed from sketchy bathymetric data that there was only a gradual slope and not the spectacular pinnacle that we came to explore. We called this site Miller's Mountain. Sylvia Earle and Gale Mead dedicated three dives to Miller's Mountain, where they found incredible numbers and diversity in fish such as grouper, snapper, and butterfly fish. They also found a series of smaller pinnacles surrounding the larger seamount.

In the following days, we moved further south and into deeper water. The target depth for this area was 1,600 to 1,800 ft near a limestone ledge that the ship identified during a nighttime bathymetry survey. Dr. Sylvia Earle and Ms. Mead accomplished four dives in this area, where they found and obtained incredible video footage of unusual deep-dwelling sea life, such as lantern fish (myctophids), tilefish, golden crabs, and giant isopods.

To establish a reference site comparable to Miller's Mountain but outside of Tortugas South, we moved five miles east in the sanctuary, along a 240-ft.-deep ledge that is the ancient "paleoshoreline" of what used to be dry land. The shelf edge, which has a vertical drop of nearly 40

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feet, is a natural feature for fish aggregations. I completed a three-hour submersible dive there, during which I performed fish counts on three sites at a maximum depth of 283 feet. I was amazed at the large numbers of grouper, scamp, snappers, and ornamental reef fish. I also saw tuna and amberjacks circling above me in shallower water. The water was so clear that I could see the surface from 240 feet, and I could see my surroundings without the help of the submersible's high-intensity lights.

The large eye on this little fish is necessary to survive at 1,600 ft. (Photo by Gale Mead)

The lights of the *DeepWorker* illuminate this crab accustomed to total darkness. (Photo by Gale Mead)

During the course of the first week, we also investigated two areas in Tortugas North, to the north of Tortugas Bank. We explored interesting pinnacles that were identified this past June during the NOAA ship *Whiting's* multibeam survey of the area. Mary Tagliareni, the sanctuary's Education Coordinator, and I completed two submersible dives in this area. We found numerous pinnacles covered with hard and soft corals and reef fish. This is an area north of Tortugas Bank that we previously believed was comprised mostly of sand with very litte coral coverage. Little did we know!

The Sustainable Seas Expeditions has provided the Florida Keys National Marine Sanctuary with a unique tool to explore depths that are inaccesible to scuba divers. It is very exciting to encounter new and unexpected geological formations and sea life on nearly every submersible dive.

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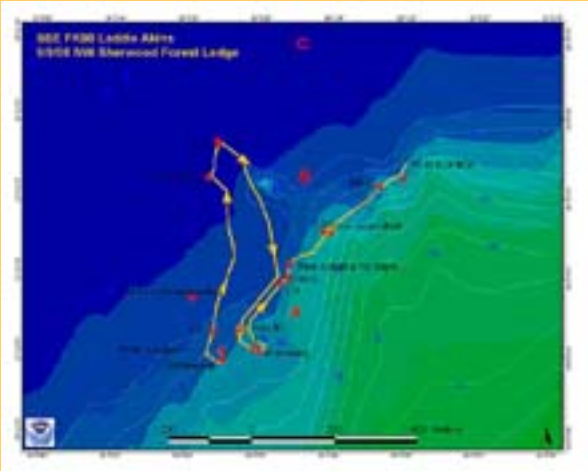
September 9, 2000
In Search of the Sherwood Ledge

Laddie Akins, Executive Director
Reef Environmental Education Foundation (REEF)

Laddie Akins

Have you ever wondered what's past the edge of the forest? Well, that has been a burning question of mine since 1997, when we first found the lush coral cover now known as Sherwood Forest in the Dry Tortugas. The top of Sherwood Forest rises to a depth of about 65 ft and covers an area of many acres. The exact boundaries of this newly discovered feature are not well known, but the extremely high coral cover and the abundance of large groupers are beginning to be documented. The **REEF** data base now has a growing number of fish surveys showing that more than 10% of the species in this area are members of the grouper family. All of the data in our system has been collected during SCUBA diving projects, which are limited to depths shallower than about 100 ft. We have never been able to determine the fish assemblages or boundaries of coral in deeper waters . . . until now!

The Deepworker 2000 submersible of the Sustainable Seas Expeditions allows us not only to visit the deeper regions of this area, but also to dramatically extend our bottom times. My dive plan on this day is to visit an area on what we think is the northwest edge of Sherwood Forest. The area is also part of a proposed no-take reserve that is in the final stages of gaining full approval from the National Park System, the Gulf of Mexico Fisheries Management Council and NOAA's National Marine Sanctuary Program. It seems that all agencies will move the measure forward, but documentation will be the key, both in establishing our baseline of knowledge and initiating the monitoring process in these reserves.



Laddie Akins' dive track. Click on map for a larger view.

The crew on the NOAA ship *Gunter*has run a number of depth-sounding tracks across the bottom, and has located a ledge running northeast-southwest that we believe may be the edge of Sherwood Forest. Francesca Cava's previous dive, just south of this area, found mostly sand with a few low-profile clumps of hard substrate. I am hoping that the *Gunter's*fathometer reading is correct in detecting this ledge.

The hatch closes at 2:05 pm and I am lifted off the deck and over the stern in a smooth launch. All systems check out on the surface and I begin my decent to the bottom around 150 ft below. Dave Lott, the NOAA computer and mapping guru, has printed out a bathymetric map of our proposed study area. His checkpoints give me a good idea of where the ledge should be, and in my communications with topside, I can receive updates on my relative position to the map references. Dave tells me that I have landed near "checkpoint alpha" and should head northwest to look for my ledge. I sit on the bottom for a moment to adjust the camera, and notice a number of small gobies guarding their holes in the sandy bottom. I zoom in with the camera to get a better look and discover an orange-sided goby sitting tall. These are fairly common in the rest of the Keys, given the correct silty-sand bottom habitat. I pan to the right and find a surprise -- a white-eyed goby, fairly rare and quite distinct, with its black dorsal ringed in white. The only other white-eyes I've seen have been march farther north, in Key Largo. A rare species, right off the bat! I have a feeling that this will be a good dive.

I begin my traverse over the sand, hoping that the ledge will drop off in front of me. As I cruise over the bottom at close to three miles per hr., I lean forward in my seat and train my eyes to see any upcoming features. Visibility is not at an all-time high today, and may be 20 feet at best. Ten minutes pass, then 15, and still no ledge -- only the endless sand prairie. I get an update from Dave that I am now northwest of where we thought the ledge would be, so I change my heading back to an easterly direction.

More sand.

At 40 minutes into the dive I am still feeling the excitement of

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flying the sub, but wondering if the supposed ledge is just a myth. I begin to see what looks like a holacline -- a layer of differing visibility -- in the water in front of me. Then, from out of nowhere, 20 ft in front of me looms a 20-ft ledge of craggy rock. I jam the foot-pedal controls into full reverse and come to a stop 10 ft from the ledge face. It IS here! I call topside with the news and begin a new fish survey along the edge heading south. The ledge itself is not very colorful, but the fish life here is in stark contrast to the surrounding sand flats. Like an oasis in the desert, the ledge provides shelter and food for numerous species that would never survive the open sand flats. I find numerous groupers -- red, yellowmouth, and scamp all around the base of the ledge. Bar jacks zoom by, and a number of purple reef fish hover around the structure on top of the ledge. As I follow the north-south break, I estimate the profile to be between 10 and 20 ft, depending on the exact location. A few black corals protrude from the side of the ledge. I continue on, wondering how far the ledge will run.

At about 400 meters from my initial discovery point, the ledge begins to flatten out. The profile is 6 ft profile, then 2 ft, then becomes flat sand with a scattering of 3-ft rocky structures. I stop to mark this location as the southern end of the ledge. While I sit here, a small wrasse bass pokes its head out from behind one of the rocks. Quite a surprise! Though they are known to be found in Florida waters, I have only seen them around the Flower Garden Banks in the Gulf of Mexico. As I shoot some of film, another small movement near the rock catches my eye. I zoom in with the camera and find another small bass -- an orangeback -- that I've only seen once, also at the Flower Gardens. Great treasures for a fish watcher!

I call up to topside that I am reversing my course to follow the ledge north now, and will move along the top of the ledge this time. I begin another fish survey and notice more purple reef fish and wrasses on top of the ledge, but fewer grouper. A few almaco jacks buzz by the sub, and then, off to my right, a faint shape catches my eye. I turn the sub toward the gentle upward slope, and slowly, appearing in the hazy visibility, looms the giant mass of a 5-ft jewfish. The largest of the groupers, jewfish can reach 7 ft and nearly 800 pounds. Historically abundant, their docile demeanor has left them prey to heavy commercial exploitation, and they are now rarely encountered. As a measure to bring their numbers back from near extinction, they received protected status in 1990. The fish take nearly 8 years to reach reproductive maturity, and we are just now beginning to see a slow resurgence in their numbers. These truly majestic fish are extremely approachable, and I get within 6 ft of him before he slowly moves away. A small movement in the fishing community is trying to reopen the season for jewfish, and I wonder how this one will fare if they are successful.

I move back over to the ledge and continue more surveys along its top. Another large black coral, also exploited in much of its range for jewelry, clings precariously to the side of the ledge. I see remnants of an old shrimp net draping over a 20-ft section of the ledge in front of me. I see it as yet another reminder of how destructive fishing practices are hidden from the public view.

Topside calls and it's time to surface. I take one more look at the ledge and consider this thin, 5-m-wide veneer of habitat and its function as an oasis of life. The oceans are so vast, yet the habitat for key species, like grouper and snapper, are so small. This small ledge occupies only a fraction of the surrounding bottom, but provides habitat for more than 90 percent of the sea life that I've encountered. On this dive, we have surveyed and documented the ledge that marks the boundary of one of the richest coral environments in the Caribbean. We now know where the habitat changes, and what lives at the "forest's edge." Mission accomplished, I secure my cockpit space and move upward and onward.

Read more about REEF's involvement with SSE.

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September 10, 2000
Counting Fish at Miller's East

Laura Francis, SSE Education Coordinator
National Oceanic and Atmospheric Administration

Laura Francis "at the office"

Today I completed my first DeepWorker fish survey dive in the Dry Tortugas as part of this year's Sustainable Seas Expeditions (SSE) mission to the Florida Keys National Marine Sanctuary. I am part of the SSE education and research dive team that will be on the NOAA Ship *Gunter* for four days conducting REEF fish surveys with the DeepWorker 2000 submersible (see www.reef.org). My team members are Mary Tagliareni, the Sanctuary Education Coordinator, Laddie Akins, Executive Director of the Reef Environmental Education Foundation (REEF), and Francesca Cava, SSE Education Manager for the National Geographic Society. Our goal is to collect data on fish species and abundance that can be posted on the **REEF Web site** and used in a variety of educational programs, including teacher workshops and curriculum materials. I have been preparing for this day for several weeks and have learned to identify some of the fish species that I might encounter in this area. A **REEF data report for the Sherwood Forest area** of the Dry Tortugas can be viewed on-line.

Fortunately, I just completed a kelp-forest monitoring cruise in the Channel Islands National Marine Sanctuary of California, where I spent a week conducting fish surveys while scuba diving. We used essentially the same methods as REEF, and I have a good understanding of the different families of fish and how to identify them based on body shape, fin shape and distinctive body markings. I also spent a day with Laddie Akins before this mission, going through slides of Caribbean fishes in the morning, and diving at Sand Key off of Key West in the afternoon. We identified 60 species of fish during our dive, ranging from tiny leopard gobies, which have a maximum size of about 3/4 of an inch, to the more substantial 4-ft-long great barracuda and greater amberjack. We

also saw many types of fish in sizes in between, including four-eye butterflyfish, bicolor damselfish and blue-headed wrasse. **Check out the REEF fish gallery** to see photos of some of these fish. Laddie is a wonderful and extremely patient teacher, and he loves to spend as much time as possible underwater counting and identifying fish. We exchanged squeals of excitement and grinned at each new fish we observed on our dive. In addition to species, we also recorded relative numbers of fish using the following abundance codes: S= 1 fish, F = 2-10, M = 11-100, and A = more than 100 fish.

After the Sand Key scuba dive, I had an opportunity to dive and count fish in the Sherwood Forest out in the Dry Tortugas, at a place we named Maid Marion's Lane (one of the exciting parts about exploring and diving in new areas is that you may have an opportunity to name them if a name doesn't already exist!). Both of these dives helped to prepare me for what I was going to see during my DeepWorker dive, although the sub would allow me to go deeper, stay longer, and perhaps see some different deep-water species.

This big-eye fish *(Priacanthus arenatus)* was observed at a depth of about 240 ft. It did not seem to be wary of the camera and lights on the sub. (Photo by Laura Francis)

My dive started at about 3 pm. We decided to splash down at a place called Miller's East, which is in the proposed Dry Tortugas Ecological Reserve. Once we completed the pre-dive, I climbed into the sub and prepared for launch. As soon as I was lowered from the ship and unhooked from the tow lines, I descended 247 ft to the bottom to begin my fish survey. I began my dive in a mixed sand and rubble habitat. It was quite dark down there due to the late hour of the day, the depth, and cloud cover on the surface. The first friendly faces I encountered during my dive belonged to two reef butterflyfish and a big-eye. The big-eye was easy to capture on video as it posed perfectly in front of my camera and did not seem at all wary of the lights and cameras on the sub. Other fish, such as greater amberjack and some of the groupers, seemed to approach the sub with curiosity, but quickly swam away when I turned on my bright camera lights.

Toward the end of my dive, I spent about 45 minutes near a high-

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relief ridge that provided shelter for several grouper species, including scamp and yellowmouth, as well as speckled hind and creole fish. I found it mesmerizing just to sit in one place and observe these fish as they were observing me in my small submersible.

I turned the lights on and off during that part of the dive and found that I had many fish circling the sub when my lights were off. They scattered, however, when I turned the lights back on. They did not seem to have as much of a reaction to the dimmer quartz lights as they did to the high-intensity lights that are best for filming.

About 30 yellowmouth groupers *(Mycteroperca interstitialis)* were observed at a depth of 288 ft. (Photo by Laura Francis)

After a few hours underwater, it was time to return to the surface. I could have stayed down for many hours just watching these fish swim around the sub. They seemed to be as curious about me as I was about them. I felt as if I were the one in the observation tank, and in some ways, I was! Once on the surface, I was smiling ear-to-ear. I was eager to share my fish observations and stories with the rest of my team and plan for the next day's adventure.

If you are interested in learning more about fish surveys in the national marine sanctuaries, check out the **September 2000 BRIDGE Data Tip of the Month**, where you will find information comparing fish species and habitats in the Florida Keys, Flower Garden Banks, and Gray's Reef National Marine Sanctuaries.

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September 11, 2000
A 14-year Journey through the National Marine Sanctuaries

Francesca Cava, SSE Education Coordinator
The National Geographic Society

Francesca Cava

On April 1, 1987, I arrived in Santa Barbara, California, as the newly appointed Manager of the Channel Islands National Marine Sanctuary. I was about to embark on the most exciting, and most daunting, job of my career. I was charged to manage, protect, collect science about, and provide education for, an area of the ocean bigger than the state of Rhode Island. My tools were a 30-ft skiff and my scuba gear and fins. At that time, there wasn't even an office or staff. Yet, I couldn't be anything but incredibly impressed with what seemed to me to be one of the most beautiful places on earth -- some call it the "Galapagos of North America."

Not only are the Channel Islands beautiful, they also surround a National Park that has frozen in time what California must have been like before it was settled. A mere 20 miles offshore of Los Angeles and its millions of people, the islands are home to more than two dozen species of marine mammals, hundreds of species of other animals and plants, and fewer than 50 people. How do you begin to do the job of sanctuary management and protection, especially if you consider that in your lifetime, as an air-breathing being, you may never even be able to more than glimpse what the sanctuary looks like? How could I see what was there, if it was changing, if it was healthy, or what might be affecting it?

As I got up every morning to go to work, these questions haunted me. I felt the pressure of my responsibility and wondered, "What can I do to make a difference?" After a couple of months, with the

help of several new friends and colleagues, we started a small program called Los Marineros. The goal of this modest program was to inspire kids to want to learn. Our concept was to introduce one class of mostly Hispanic 5th grade students to the concept that they had a vast underwater kingdom right on their doorstep that was theirs to explore. That year, with help from everyone in the community, including the mayor, the harbor patrol, national and state park rangers, the Santa Barbara News Press daily newspaper, the community college and countless others, these students made monthly field trips that opened their eyes to the invisible world that lay just beyond our sandy beaches. It was a discovery for us all, from the beginning trips in the harbor, to the grand finale, a whale-watching trip and visit to Santa Cruz Island, one of the islands in the sanctuary. That was the beginning of my introduction to the importance of marine education. Now, almost 15 years later, Los Marineros has grown to be one of the major science programs for the entire 5th grade in Santa Barbara, California, where I live. Not only did the program inspire those first students, it also inspired their teachers, parents and friends. More importantly, it fostered the creation of a community of people who cared about their sanctuary and began to think about what they could do to make a difference in protecting this precious resource.

Now, nearly 14 years later, this focus on education is what brings me to the NOAA ship *Gordon Gunter*as a DeepWorker submersible pilot for the Sustainable Seas Expeditions. Just as we were able to introduce the sense of wonder and excitement of a single sanctuary to students in Santa Barbara, now we want to open the world of other national marine sanctuaries to students nation-wide. Our mission is to explore newly recommended areas for marine protection off the Dry Tortugas, the outermost islands of the archipelago collectively known as the Florida Keys. This time, however, our equipment can take us places that scuba and fins can't. Our submersible can take dive much deeper than scuba divers can, and extends our time at depth far beyond the 20 to 30 minutes an average scuba dive allows. On top of that, driving the sub is incredible fun. Imagine "flying" this small vehicle, that is just barely large enough for one person to sit in, through hundreds of feet of water, and possibly seeing things that no one else has ever seen before. I can't begin to describe the adrenaline rush, and the wonder of what may lie just beyond the veil of water visibility.

Fortunately for me, these types of missions can only be possible with a huge support system behind the scenes. Each night, the *Gordon Gunter*"runs lines" of bathymetry to look for interesting sea-floor features. This allows us to target our dive to focus on habitats that are home to countless creatures.

So what did I see? My dives focused on two areas: One just off an

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Many species of grouper, including this red grouper *(Epinephelus morio)*, have been identified and counted as part of the REEF fish-count dive project. (Photo by Francesca Cava)

area called Sherwood Forest, the other called Miller's Mountain, near Riley's Hump. Both areas are aptly named. At Miller's Mountain, at a depth of 250 ft, I found a very steep wall that fell abruptly into the darkness, just as one might find on land. Near Sherwood Forest, despite poor visibility, the area was dense with sea life. My dilemma, however, was becoming proficient enough to drive the sub, operate the cameras, report on my life-support readings to the topside dive supervisor, and identify what I was seeing. I found that my eyes were darting everywhere, trying to process more than I could. I quickly found, however, that with a bit of patience, I could train myself to focus. I finally saw a giant amberjack, instead of just a flash of silver; small striped discs were actually reef butterflyfish. Then I almost saw a large fish just outside of my field of vision. Was is it a snapper or a grouper? Later, by studying my video and with input from my shipmates, I determined that it was a red grouper.

In the end, I realized that despite taking several hours-long dives, what I really need is weeks! A systematic approach that allows one to see the same area at different times of the year, or at different times of the day, would be ideal. Of course, you don't have time to think about this type of thing while you are in the sub. The hours flash by so quickly you try to capture everything you can. What was that neon pink fish with a yellow tail? There's a loggerhead turtle! Is he really trying to nibble on my sub floats? Two pairs of blue angelfish--are they mates? There are many more questions than answers, but at least we are beginning to understand the habitat, its overall health, and the species that depend on it.

This trip was more of a "teaser" than a completed mission. The more you see, the more you want to see. You begin to understand how important it is to be able to see for yourself what is out here, as opposed to seeing it through the eyes of a camera suspended from a robot in the water. As I mentioned at the beginning of this log, one realizes that to manage a marine sanctuary, one must *see* the sanctuary, all the way to the bottom, if possible.

The Sustainable Seas Expeditions will not provide all of the

information needed to manage and protect a marine sanctuary. It has, however, made possible the first submersible surveys of our sanctuaries. As a submersible diver and a marine educator, I am thrilled to be a part of this project. It's going to be a long job, and with all the vastness of the ocean yet to be seen, one that should never end.

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September 11, 2000
Diving on Miller's Mountain

Laddie Akins, Executive Director
Reef Environmental Education Foundation (REEF)

Laddie Akins

Visibility on our previous dives has been less than wonderful, so we've moved from the northern reserve area to a section of the proposed southern reserve that has been termed Miller's Mountain. Running east-west, it's really more of a ledge than a mountain. The bathymetric data from this area is very good due to the NOAA ship *Gunter's*mapping efforts during the past week. It appears that the ledge begins around 250 ft down and drops to close to 400 ft in a nearly vertical profile. If this is true, the fish life at the top and bottom of the ledge will be very different.

Phil Otollera, the dive supervisor, or "Dive Soup," as we affectionately call him, closes the hatch at 2:30 pm and I am lowered over into a deep blue bath. The visibility looks like it is much improved. I receive permission to dive, and I drop down through the sea, feeling much like a bubble going the wrong way. Dave Lott, the NOAA mapping and tracking master, has again supplied me with a great map of the area, complete with reference points and depth contours. We don't know for sure how extreme the contours are, but we do know that there is somewhat of a ledge to explore.

I drop to the bottom at 247 ft, only 50 meters from our planned starting point at "checkpoint alpha." The surrounding bottom is mostly a mixture of sand and low-profile hard substrate. All of the edges are smooth and there are no craggy rocks sticking up anywhere. Visbility is at least 40 ft, and immediately, I see a small group of 5-in-long, whitish fish moving around just off the bottom. I train my camera on them, crank up the HMI lights and zoom in for a closer look. Definitely not a shallow-water species that I know. I've done maybe 8,000 scuba dives in the Caribbean, and this

species is a first for me. They have very soft, ribbon-like dorsal fins with a long third spine, a pinkish body color and a long filament trailing off the tops and bottoms of their tails. I remember references to two fish that stick in my mind, and later confirm the identification of this species as streamer bass. A small group of striped grunts swim by, and a gathering of 2-ft-long grouper come to investigate this strange new fish with the bubble dome and electric fins.

I radio my intended heading to topside and move south toward the drop-off. Within 30 m, I see the slope and hit the edge right on target. I have only been down for 10 minutes before I am well into my planned survey location. A small squadron of amberjack swoops in and begins to circle the sub as company. I see at least 10 more groupers, mostly yellowmouth and scamp, congregated around rocky clumps at the top of the drop-off. Bank butterflyfish swim lazily around the bottom, deep-water relatives of four common shallow-water cousins that I often see. More wrasse bass and a crew of creole fish round out the scene. I move over the edge of the drop-off and descend slowly toward the bottom of the ledge. The scene turns slowly darker, like the transition from sunset to night. There is more and more blue and less and less light, until I level out at the base of the ledge at 380 ft. The scene is reminiscent of a moonlit evening in the desert. Large, rocky boulders, the size of large cars, stick up out of the surrounding sand. A few fish move slowly about. The deep bluish cast of the water and lack of light give the scene a surreal appearance and peaceful mood.

I focus on the task at hand, and redirect my attention to the fish I see here. I saw many more grouper at the top of the ledge. There are a few streamer bass and bank butterlfyfish, but not much else. I move along the base for a few hundred meters, then see a snowy grouper hiding behind a rock. Found only in waters over 200 ft deep, this grouper has a body covered with white, snowflake-like markings, and is easy to identify. I end my survey here, and head back up to the ledge crest.

Again, once I reach the top, I am surrounded by fish life. Almaco and amberjack swirl around the sub. Scamp gather to peer in at me through the DeepWorker's dome. Creole fish and streamer bass cover the bottom. I write furiously for a few minutes to get all of the names on my list, then begin another transit along the crest. I stop to give my life-support readings to topside and see a pair of speckled hind, another deeper-water species of grouper. These two are a bit more wary than the scamp and the yellowmouth groupers, and I have to work to get them on film.

I run four more surveys along the top of the ledge and note that my

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battery power is beginning to approach the low end of the safety scale. I receive permission from topside for one more foray to the ledge bottom to check for any differences at this new location. I drop to the bottom and discover large boulders just like the ones I found earlier. Along one side are a pair of unique sea urchins. Their long, stout spines are covered in algae-like growth, but their round, shell-like bodies are not. I shoot a few moments of identification footage, then head back up the slope. I've traveled nearly a mile since the beginning of my dive. Dave has updated me along the way, and I have nailed every point along our planned dive profile. The tracking and surface support has been perfect. I see a small scorpionfish lying in the sand and rubble on the way up, but most of the slope is fairly barren of fish life. I reach the top and ready my cabin for surfacing.

I've conducted seven 30-minute surveys on this dive and documented the assemblages of a previously unexplored deep ledge in the area of the proposed ecological reserve. I am excited about this very productive dive. The fish survey data I have collected will be entered on survey report forms and scanned into the REEF database. (Visit the **REEF Web site.**) This database already contains more than 25,000 surveys from around the Tropical Western Atlantic, though none are from depths beyond those accessible by SCUBA. Once the data are entered, they can be compared to data from nearby shallow sites and used to observe the differences in fish assemblages between these areas. In addition, the data provide a first-hand look at proposed reserve areas before they are set aside, and serve as a baseline for future monitoring and assessment work.

As I settle back onto the deck of the *Gunter*and the hatch is opened, I take a deep breath through a smiling face. This dive could not have gone better.

Read more about REEF's involvement with the SSE.

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SUSTAINABLE SEAS EXPEDITIONS
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September 14 to 16, 2000 The Sanctuary Hosts Students and Teachers of the National Geographic Alliance

Nancy G. Diersing, Education Specialist
Florida Keys National Marine Sanctuary

With the help of Ivy Kelley, education specialist at the sanctuary, National Geographic Alliance students examine plankton collected at sea as part of the Coral Reef Classroom program. (Photo courtesy of Laura Francis, NOAA)

As part of the National Geographic Alliance educational program, teachers and their students participated in a weekend field study program at the Florida Keys National Marine Sanctuary. The session was sponsored by the National Geographic Society and NOAA, under the direction of Dr. Sylvia Earle, a National Geographic Explorer-in-Residence and Director of the Sustainable Seas Expeditions (SSE). During their stay in the Florida Keys, the students and teachers, who hailed from Washington, DC, Chicago, Baltimore, and Miami, participated in many interesting and exciting activities. As part of the Coral Reef Classroom program, they snorkeled at a nearby coral reef to observe the many colorful reef fish and other reef animals. On the boat trip out to the reef, students collected plankton and examined many tiny plants and animals floating in the sea. They also learned about water quality by using scientific instruments to measure water clarity, salinity, dissolved oxygen, and temperature. Students and teachers toured a nearby state marine research facility, the Keys Marine Lab, where they learned about marine research being conducted by local scientists, and took part in a marine animal lab

exercise in which they observed spiny lobster, horseshoe crabs, sea cucumbers and other marine invertebrates. On their last full day, the group traveled to Key West to tour the NOAA research ship *Gunter*,which was hosting an Open House for the Sustainable Seas Expeditions. On board the ship, the students met briefly with U.S. Secretary of Commerce Norman Y. Mineta, who discussed the importance of protecting the ocean and its resources. After touring the *Gunter*and seeing the DeepWorker sub first-hand, the participants met with Dr. Sylvia Earle, who shared her expertise in the field of deep-sea research. As a wrap-up activity, students wrote essays about the trip, and shared some of their most memorable moments. Following are portions of some of the students' essays.

Student Oceanographer's Name: Yara T.
Teacher's Name: Mr. Parker
School: South Miami Middle School, Miami, FL

There are times in your life when you are given special opportunities. These opportunities may be thought of as an incredible experience and an event that you may treasure forever. When Mr. Parker, my 6th grade geography teacher, first asked me to participate as a Sustainable Seas Expeditions (SSE) Student-at-Sea, I wasn't sure what to say or expect. Coming here has inspired me to expand my views in life. There is another world out there waiting to be explored, and there are mysteries waiting to be discovered. I know that if we can spread the significance of all marine research and the beautiful marine life, we will be able to preserve these precious resources that are vital for our future and present lives.

The main purpose of the SSE is to make others aware of the marine environment found in the National Marine Sanctuaries, so what better way to do this than to see it? We have been given the chance to actually take part in this incredible expedition by interacting with marine life itself. In the past four days, we have learned the basis of marine exploration. We were able to touch and observe the animals' habitat and environment in action. We were also told about the DeepWorker 2000 submersible technology. This device enables the researchers to study the animals in their everyday lives. Now we must spread the significance of the ocean and its unexplored beauties and wonders to others who are not aware of it. This was truly an inspiring experience.

Student Oceanographer's Name: Mercedes L.

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Teacher's Name: Ms. Cox
School: Southwood Middle School

While participating in the Sustainable Seas Expeditions program, I had many new experiences and in depth discussions, many of which I may not have been able to have without participating. First off, I learned many things about the ocean that I'd never even thought about, things that dealt with deep-sea exploration. I found out that nearly 95% of the ocean is still unexplored, and all of the known species of sea life may represent only a small part of what exists in the world's oceans. I also found out that by examining new species of animal life, we could discover cures for many of the world's most deadly diseases. Second, I learned that only about 30% of Earth's oxygen comes from land, and that 70% of the Earth's oxygen comes from sea plant life.

By attending the program I have also had many hands-on experiences that are usually done by a marine specialist. For instance, I took the temperature of the water by using a Niskin bottle and a thermometer. I measured the amount of dissolved oxygen parts in the water by using a specially designed kit. I then measured the salinity of the water with an instrument called a refractometer. Finally, I used a secchi disk to measure the depth of visibility in the water. My final experience was snorkeling. This was my first time snorkeling, and it was by far the most exciting part of the entire program. I was able to see firsthand all of the underwater plant and animal life that were discussed in the classroom. Thanks to the Sustainable Seas Expeditions, I was able to learn about the key ideas that dealt with saving our ocean, and I had some really interesting experiences.

Student Oceanographer's Name: Jamila F.
Teacher: Mrs. Grogan
School: Neval Thomas Elementary School, Washington, DC

I was surprised when Mrs. Grogan called my mother to ask if I could go to Florida with her. My parents said yes. Then I started to pack for the trip. The plane ride to Miami was not as scary as I had thought it would be. When we finally got to Miami and arrived at Florida Sea Base, I had to hurry into my swimsuit to take a swim test. I did not pass, so I had to wear my life jacket. The next day we went snorkeling in the Atlantic Ocean. It was fun. I saw many different kinds of fish and coral reefs. The water was beautiful because it was clear and colorful. I was scared to jump off the boat, but I did. After that we went to the Keys Marine Lab. I picked up many kinds of sea animals. Some were slimy like the conch, some were rough like the sea cucumber, and some prickly like the sea

A student looks at a young queen conch during a tour of the Keys Marine Lab, a state-operated marine research facility. (Photo courtesy of Laura Francis, NOAA)

urchin. I did many things these two days, but the most important thing I learned is that the sea is just like the land -- we need to protect, explore, and learn more about the plants and animals. I will always remember the experience and will share what I learned with my classmates.

Student Oceanographer's Name: Keisha P.
Teacher's Name: Ms. Brooks
School: Ketcham Elementary School, Washington, DC

My experience here at Florida Sea Base has been very interesting. I learned how to swim and snorkel. When I saw the fish under the water, it was incredible. The boat ride was another great experience. The reason it was great was because I saw different colored lobster catchers, or markers, all over the water. The water was beautiful and clear, unlike the Anacostia River in my city.

The Keys Marine Lab was another great experience. The reason it was so great was because the creatures were very interesting. They all had different ways of living. For example, the hermit crab and the angelfish. They have different protection methods, different shapes and different feeding methods.

This was a super experience!

Student Oceanographer's Name: Mackenzie V.
Teacher: Ms. Bock
School: The Palombi School, Chicago , IL

Our small group of students and teachers has come together to learn about the coral habitats near the Florida Keys. During our stay at Florida Sea Base, we have snorkeled, participated in classroom lessons, studied marine animals at the lab, and toured the NOAA ship *Gunter*.

Before our snorkeling trip we recorded various observations about the ocean, such as turbidity, salinity, and cloud cover. We used scientific instruments, such as the secchi disk and refractometer, to help us make these observations. When we were snorkeling, we observed and photographed marine animals. We saw lots of rainbow parrotfish and yellow snappers, and two moon jellies.

During our classroom sessions we learned about coral reefs and the Sustainable Seas Expeditions (SSE). We were taught that coral polyps live in a symbiotic relationship with tiny, algae-like creatures called zooxanthellae, and we saw pictures of various fish and coral. We also learned that less than 5% of the oceans have been explored. It is the mission of the SSE to educate people about the reefs so that more preservation and exploration can take place.

At the Sea Base we were able to touch and observe marine animals, such as sea cucumbers and horseshoe crabs. We also spent a short time in a classroom. I learned that there are three ecosystems in the Keys (mangrove, seagrass, and coral reef), and that they are all being negatively impacted by humans.

Students and teachers board the NOAA research ship *Gunter*for a tour and to meet Secretary of Commerce Norman Y. Mineta. (Photo courtesy of Laura Francis, NOAA)

Our group was very lucky to be able to tour the NOAA ship *Gunter*. We spoke with the Secretary of Commerce, Mr. Mineta, and saw how they operate the ship and record data.

This has definitely been a once-in-a-lifetime experience, and I am sad to see it end, but I know I will have the knowledge and memories of this trip for a lifetime.

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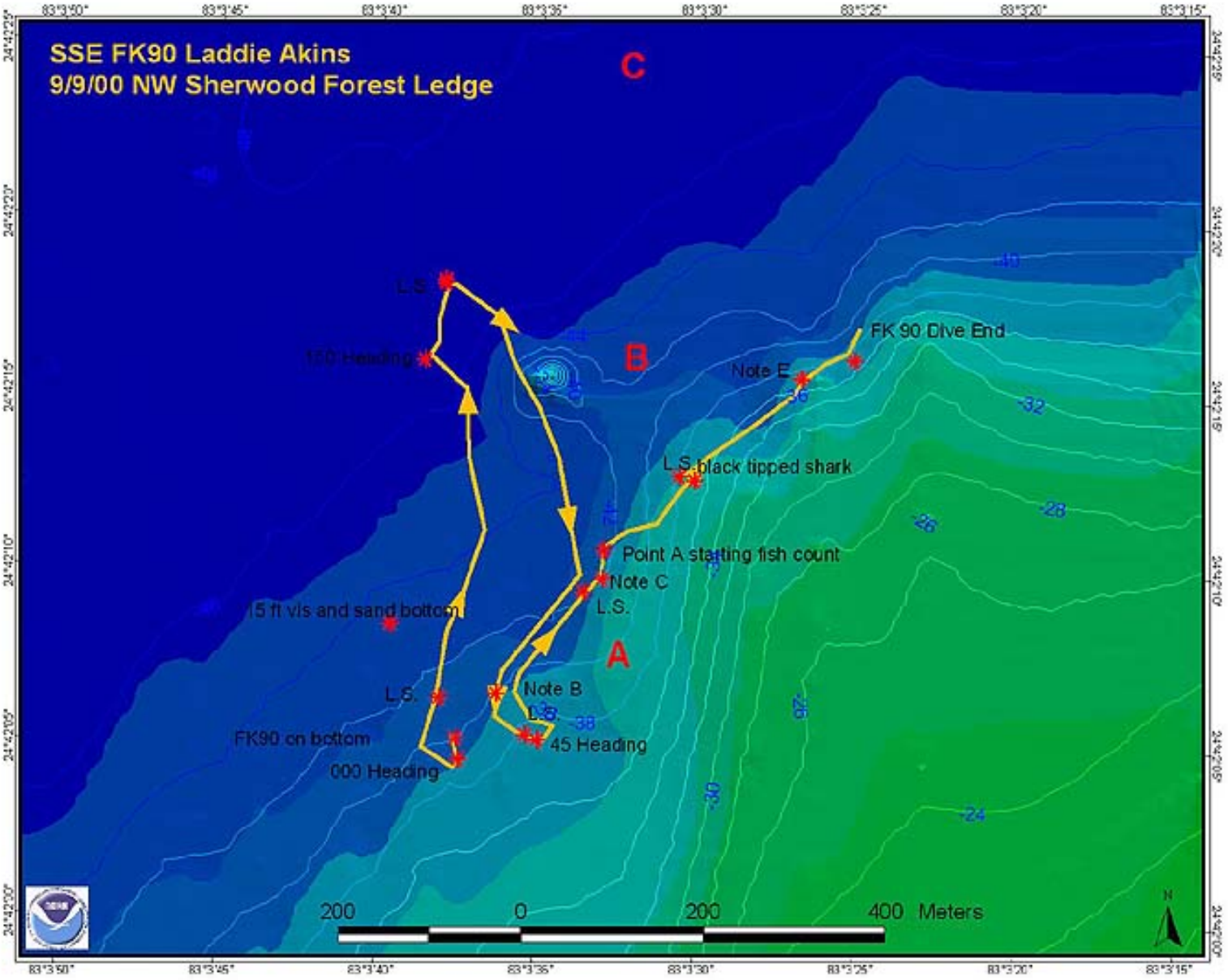
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September 16, 2000
Open House on the *Gordon Gunter*

Ivy Kelley, Education Specialist
Florida Keys National Marine Sanctuary

Ivy Kelley

Secretary of Commerce Norman Y. Mineta was among 500 visitors to an Open House on the NOAA Ship *Gordon Gunter*. In addition to a comprehensive tour of the ship, the Open House featured interactive educational activities sponsored by local environmental organizations that convened under colorful tents on Key West's Mallory Square.

The second Sustainable Seas Expeditions (SSE) visit to the Florida Keys National Marine Sanctuary (FKNMS) was the occasion that spawned the festive gathering. The stars of the ship were two DeepWorker mini-submersibles -- the one-person submarines that are the heart of SSE exploration.

Hurricane Gordon, perhaps in deference to a ship of the same name, provided overcast skies and light winds to cool the day as visitors

learned about marine mammals, environmental education opportunities, and ecosystem protection. Many visitors were motorcycle enthusiasts participating in the 28th Key West Poker Run in support of Sunrise Rotary charities.

The Florida Keys National Marine Sanctuary welcomed visitors and offered its usual array of interpretive posters, brochures and information about the coral reef ecosystem and marine protected areas. A "Kids' Tent" provided coloring pages and a reef ecosystem activity in which youngsters could build the reef ecosystem using pre-cut illustrations of coral, fish, and seagrass.

Key West's Mallory Square is home to the famous Sunset Celebration as well as many festivals and community events. (Photo courtesy of Brenda Altmeier, FKNMS)

Observations from Participating Organizations

The Reef Environmental Education Foundation (REEF) and Mote Marine Lab's Center for Tropical Research were especially proud to be part of the event, as their directors, Laddie Akins and Dr. Erich Mueller, respectively, were DeepWorker pilots for the SSE project in the Dry Tortugas.

Laddie reported that in the Dry Tortugas, 43 species of fish were identified at Sherwood Ledge, and 32 species at Miller's Mountain. He is particularly excited by this opportunity to characterize the deeper sanctuary waters unavailable to scuba divers, including areas where commercially valuable species are found. "Even with mixed gasses, the time constraints of deep scuba diving prohibit the lengthy observation needed to identify and quantify various fish species," he explained. "The DeepWorker offers unprecedented freedom that advances our knowledge of fish populations in the Florida Keys National Marine Sanctuary.

Dr. Mueller also expressed appreciation for the DeepWorker's ability to explore without the restrictions of regular diving. "I am studying coral diseases and the depths to which corals grow. The three to four hours of sub time on each dive have allowed me to find corals growing to a depth of 120 ft in the Dry Tortugas area. The sub also carries a camera that I use for data transects needed to quantitatively analyze the abundance of coral species. Recently, I participated in a U.S. Environmental Protection Agency research cruise to shallower depths (about 40 ft) in the Keys. We will compare the data from that cruise with our deep-water observations from the SSE. In addition, we can look at the area covered in the proposed Dry Tortugas Ecological Reserve, and see what it looks like at 1,600 ft."

The DeepWorker's observations will also be used to record the health of the Keys reefs over time. Joel Biddle of Reef Relief praised the collaborative efforts of government agencies and nongovernmental organizations to protect the reef. Reef Relief has concentrated its efforts of late on advocating advanced wastewater

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treatment systems and no-discharge zones in the Florida Keys.

Human impacts are also the concern of Save the Manatee's Brian Weinstein, who is creating a system of disposal bins for discarded monofilament line. "Don't leave your line behind," he said. "Fishing line decomposes very slowly, and, when tossed into the sea, can kill wildlife for years."

Although the Friends and Volunteers of Refugees (FAVOR) supports the U.S. Fish and Wildlife Service's predominantly terrestrial projects, FAVOR recognizes the interrelated ecosystems of the Keys, and is particularly concerned about mangrove forests. "I was impressed with Secretary Mineta's questions and his concern for the coastal environment," said Karen Nazzaro, FAVOR representative, as the Secretary made his way about the exhibits on Mallory Square. "While we work on the local level, it is essential that we have leaders who understand our issues and will take that knowledge back to the Capitol."

"Dolphins, because they are top predators, are potential indicators of ecosystem health," explained Laura Engleby of the Dolphin Ecology Project. "We are investigating the distribution, density, and life history of bottle-nosed dolphins in the Florida Keys, and how they relate to, and are affected by, environmental parameters such as water quality, habitat degradation, and toxins in the ocean."

The Marine Animal Rescue Society is dedicated to the conservation of marine animals through rescue, rehabilitation, research, and education, and rescues and rehabilitates stranded dolphins and whales stranded on South Florida beahes from Vero Beach to Key West. The group is currently caring for a stranded baby pygmy sperm whale that has defied the odds by surviving in captivity for more than two months.

The Dolphin Research Center was also on hand to share in the festivities. "We are excited to follow the SSE's progress and learn more about the ecosystems that support dolphins in South Florida and beyond," said Amy Miller, Education Coordinator.

Many scientists and educators attended Seacamp on Big Pine Key as budding environmentalists. According to Libby Carnahan, Marine Science Instructor at the center, "Our students are encouraged to 'observe and not disturb' reef inhabitants."

Bahia Honda State Park is a crossroads of postcard-perfect Florida Keys ecology and massive human visitation. The park has also

survived hurricanes and other natural calamities over the years. "Looe Key reef is a prime destination for many of our visitors," noted Park Ranger Monay Markee. "We are happy to learn from the SSE the latest discoveries about the offshore reefs of the Florida Keys, and to incorporate this knowledge into our education efforts."

The Florida Fish and Wildlife Conservation Commission (FWC) is charged with the protection of state and federal waters in addition to protecting Florida's terrestrial wildlife and resources, according to Officer Steve Acton. "Enforcement through education is an integral part of marine protection," he said.

Besides enforcement, the FWC distributes information about boating licenses and participates in educational activities supporting local special events, such as the sport lobster season. Steve's booth is always popular with visitors, as he can answer the most detailed questions about marine laws in the Florida Keys. He also distributes "goodies" such as safety whistles and posters of the snapper and grouper families.

National Geographic Alliance teacher Robin Parker, of Miami, and his students pose with the DeepWorker submersible aboard the NOAA ship *Gordon Gunter.*(Photo courtesy of Brenda Altmeier, FKNMS)

On board the *Gunter,*Secretary of Commerce Mineta had a meeting of the minds with students and teachers visiting from Baltimore, Washington, DC., Miami, and Chicago as part of a National Geographic Alliance tour. The 18 students ranged from fifth to eighth grade and earned their trip through essay contests and recommendations from their teachers. Secretary Mineta enthusiastically supported "as much exposure and opportunity as possible for young people to experience something new." He joked with them, "Someday, when you have my job at the U.S. Department of Commerce, I'll come back and ask you if I can see my old office!"

The students and Secretary Mineta were treated to "behind-the-scenes" tours of the tracking, videography, and operations responsibilities of the *Gunter,*and learned about the DeepWorker mini-submersibles stationed aboard the ship through interpretive talks by sub pilots.

National Geographic Society photographer Kip Evans introduced the students to what he called the "heart and soul of the SSE" -- the sub tracking station. Here, the sub's path is charted via Global Positioning Satellites (GPS) on colorful three-dimensional charts. According to Dave Lott, a NOAA tracking and navigation specialist, the sub may be tracked anywhere within a distance of 200 meters.

Secretary Mineta receives a lesson on underwater mapping from Dave Lott, a NOAA tracking and navigation specialist. (Photo courtesy of Brenda Altmeier, FKNMS)

"Radio communications are sometimes interrupted by noise from the ship itself, or even by underwater animals," Dave explained.

Kip's passion for photography was infectious as he showed the students his photographic and video camera equipment, and explained the fun and hard work that are the underwater photographer's life. "The digital video camera can store up to four hours of images, and footage can be reviewed and edited aboard ship. Still photos can also be obtained from the same tape," he said. He also explained how introduced light changes the behavior of underwater animals, and described unique sights, such as squid feeding on a school of fish.

The students were interested in the career paths of the National Geographic staff and NOAA Corps officers. "There are different ways to approach your goal, but the key is to set your sights as high as you can, and go for it," Kip advised them.

On the bridge, the students spoke with Ensign Mark Miller. He told of fascinating sights at sea, such as sleeping sperm whales. "Our ship is very quiet, so we can sneak up without disturbing them," he explained. The NOAA Corps is the smallest of the United States' seven uniformed services. The qualifications for an officer's commission include an undergraduate degree in the sciences and three months of intensive training at the Merchant Marine Academy in Kings Point, Long Island. The students were intrigued that Miller's Mountain, an underwater feature in the Dry Tortugas that they had learned about in the tracking room, was named for Ensign Miller, who discovered it.

After a peek at Key West's neighboring islands through a high-

powered telescope on the deck outside the bridge, the students left the ship to take a lunch break. That afternoon, they were treated to a meeting with Dr. Sylvia Earle, Director of the SSE, an Explorer-in-Residence for the National Geographic Society, and a world renowned ocean expert.

In her calm voice, Dr. Earle told of changes she had witnessed in the environment over the past 50 years, expressed concern for the future of the oceans, and congratulated the students on their concern for the health of the planet.

"We know more about the surface of Mars than we do about the depths of our own ocean," she stated, citing problems in funding and the absence of any ocean program approaching the strength of NASA's space program.

Dr. Sylvia Earle, a National Geographic Explorer-in-Residence and Director of the SSE, autographs her book for a future marine biologist. (Photo courtesy of Brenda Altmeier, FKNMS)

"We must be concerned by what we put in the ocean, such as all the runoff from our heavily fertilized agricultural areas, as well as what we remove," said Dr. Earle. "We have not asked ourselves the question, 'What is the value of a fish in the ecosystem?' We just ask, 'How does it taste?' " Dr. Earle's wisdom and her unflagging support of ocean issues were applauded by the students, who flocked to have their pictures taken with her as she presented them with certificates commemorating their visit to the Florida Keys.

Later that afternoon, the NOAA Ship *Gunter*sailed from Key West, off to new adventures and the conclusion of the second field season of the Sustainable Seas Expeditions.

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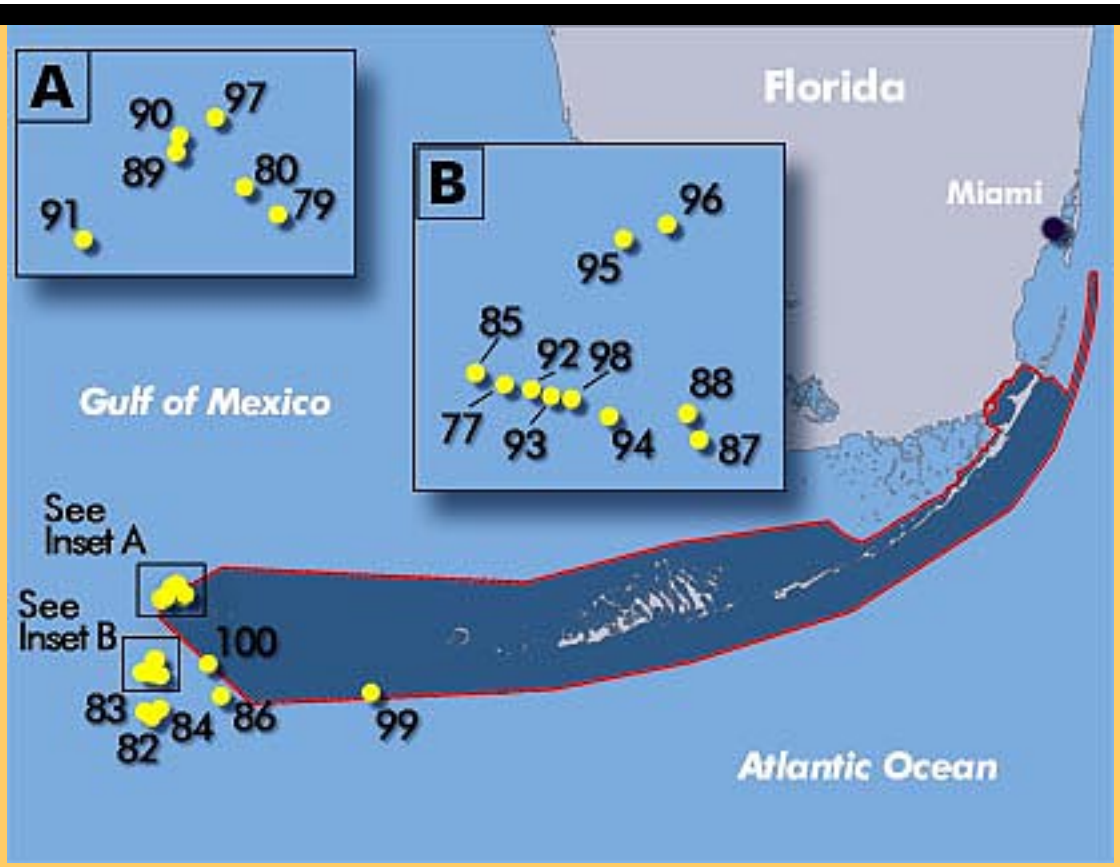
September 2-14, 2000 Dive Maps

Dave Lott and Craig Russell, GIS specialists from NOAA's National Ocean Service, Special Projects Office, tracked and mapped the *DeepWorker* submersible during the SSE mission to the Florida Keys sanctuary. Using a combination of GIS and sonar technologies, they produced this series of dive maps. The maps depict the underwater track of each *DeepWorker* dive, and include depth readings, life-support readings and pilots' comments. Together, they represent a critical component of the underwater log of the expedition.

During the Florida Keys mission, from September 2 to 14, 2000, pilots completed Dives 74 to 100. The yellow dots on the reference map below approximate where these dives occurred in the sanctuary. The sanctuary boundary is outlined in red. **Click on any dive number or individual map to view a large-scale version of that specific dive.**

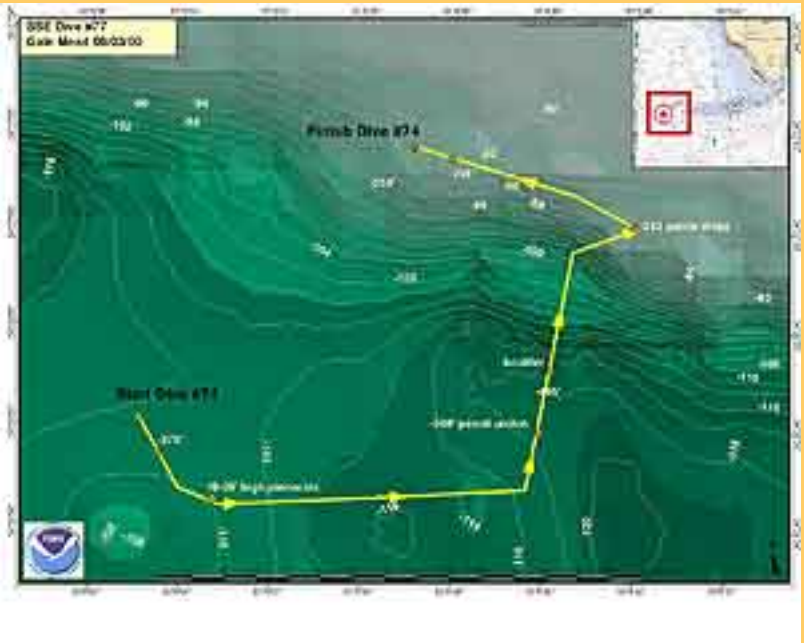


Dives 74, 75 & 76
Sept. 2, 2000
Pierside, Key West

No maps made, checkout dives

Dive 77
Sept. 3, 2000
Miller's Mountain

Click image to view a larger map.



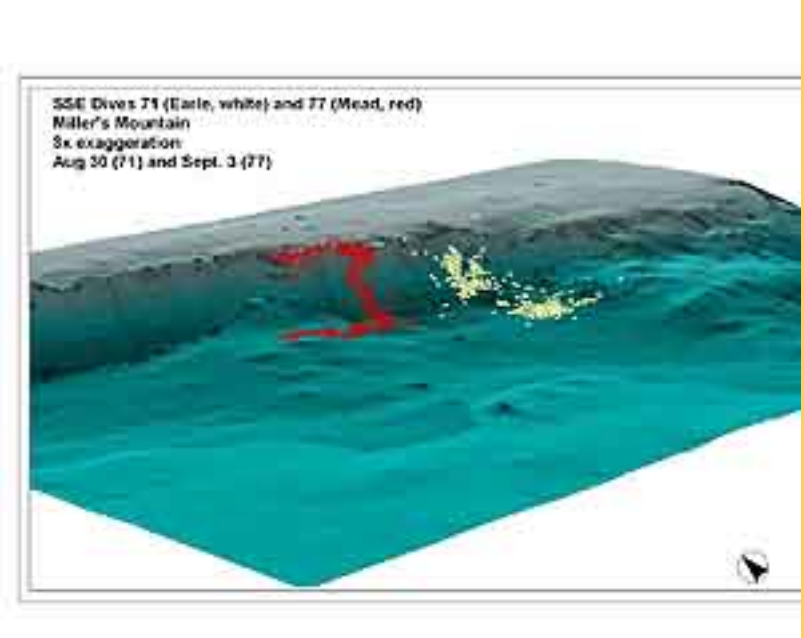
Sept. 14-16 National Geographic Alliance

Sept. 16 Open House

Sept. 2-14 Dive Maps

Sept. 23 Summary Log

Dives 71 & 77
Aug. 30, 2000
Sept. 3, 2000
Miller's Mountain
3D Map

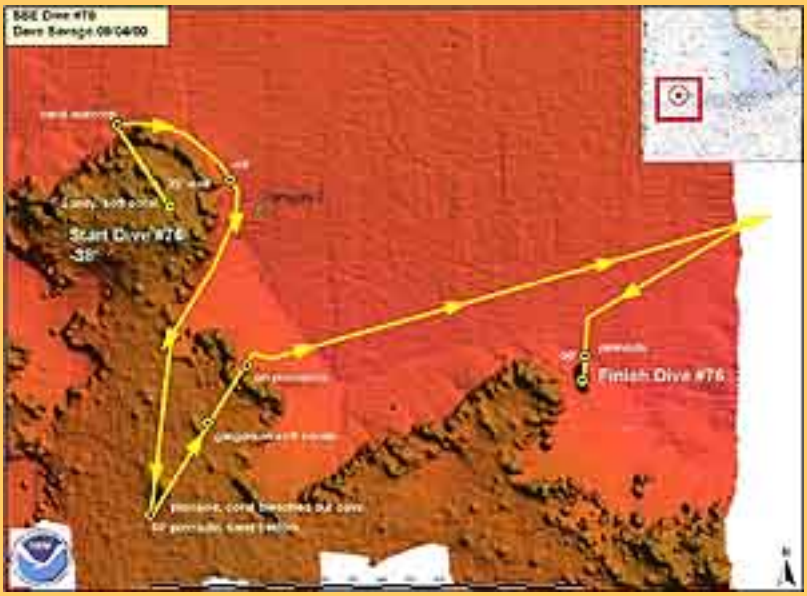


Dive 78
Sept. 3, 2000
South of Miller's Mountain

Dive aborted

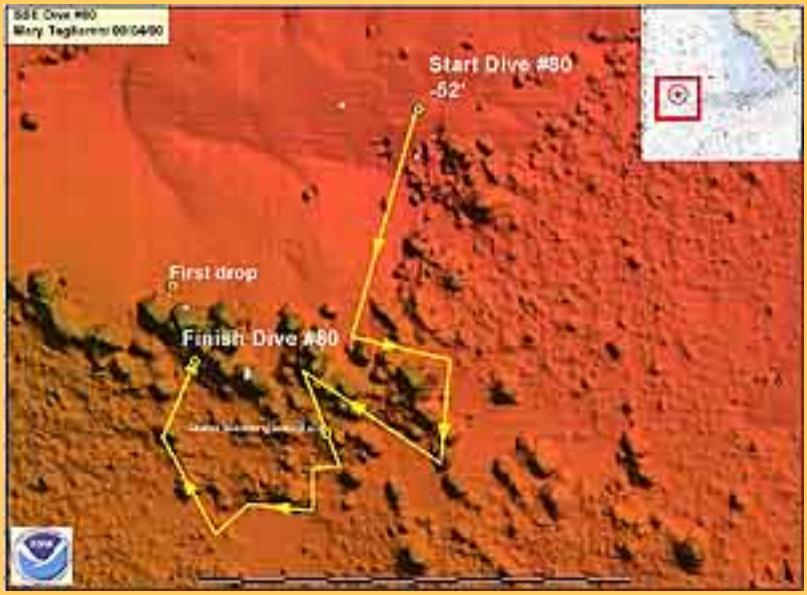
Dive 79
Sept. 4, 2000
Sherwood Forest

Click image to view a larger map.



Dive 80
Sept. 4, 2000
Sherwood Forest

Click image to view a larger map.



Dive 81
Sept. 5, 2000
George's Gorge

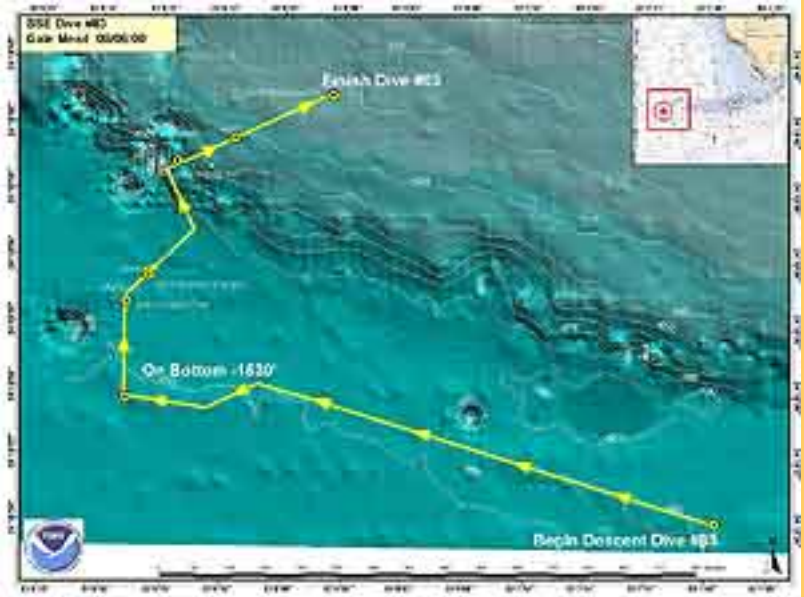
Dive aborted

Dive 82
Sept. 6, 2000
George's Gorge

Click image to view a larger map.

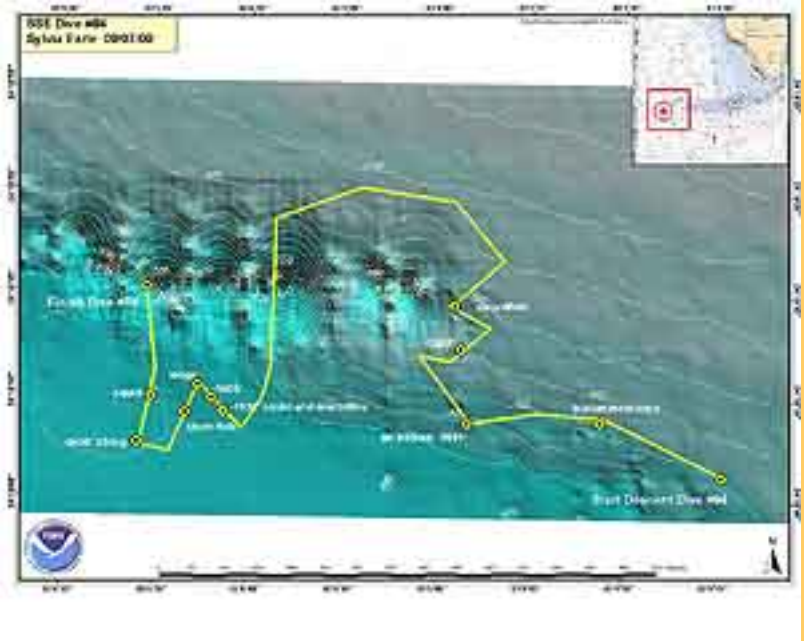
Dive 83
Sept. 6, 2000
George's Gorge

Click image to view a larger map.



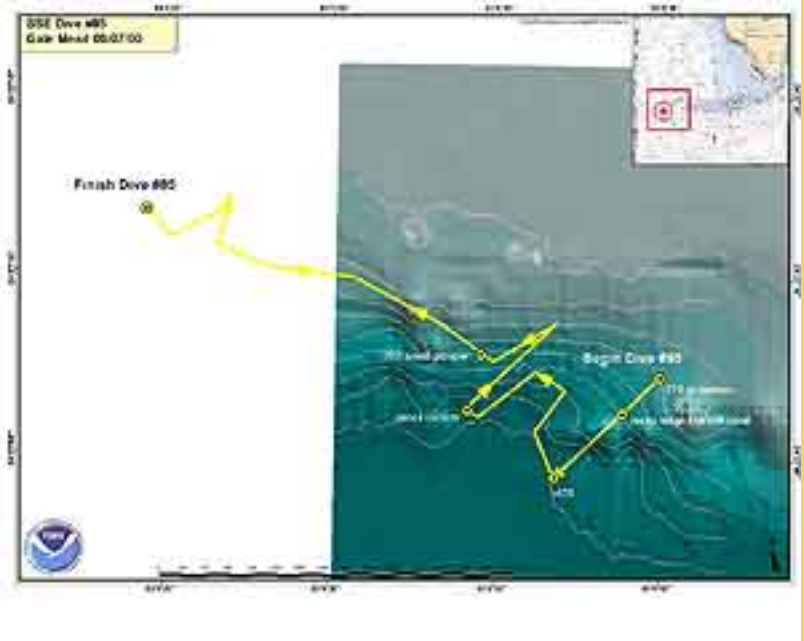
Dive 84
Sept. 7, 2000
George's Gorge

Click image to view a larger map.



Dive 85
Sept. 7, 2000
Miller's Mountain

Click image to view a larger map.



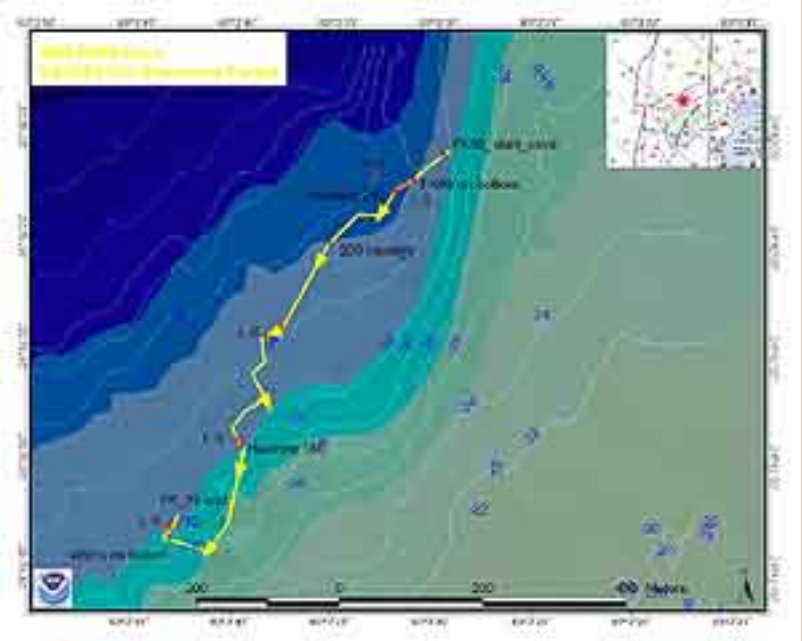
Dive 86
Sept. 8, 2000
Miller's Mountain

Dives 87 & 88
Sept. 8, 2000
East of Miller's Mountain

Click image to view a larger map.

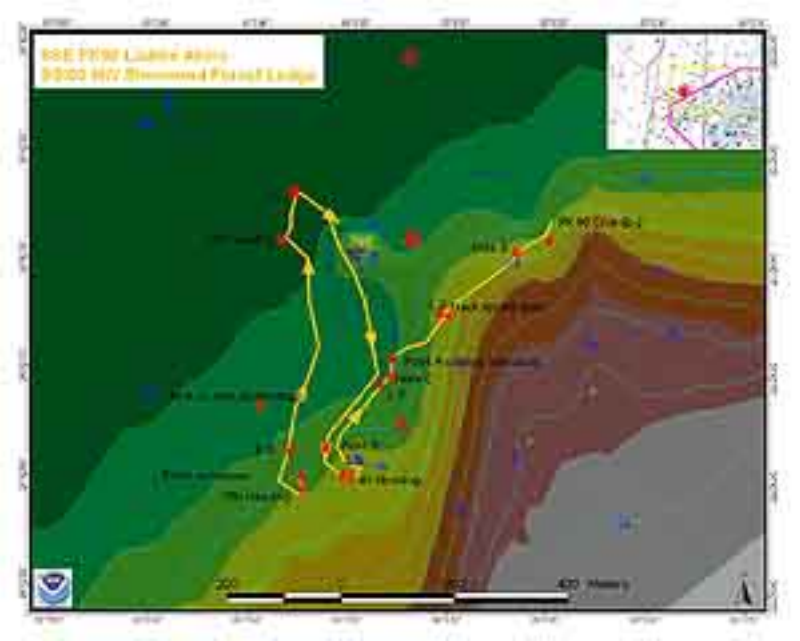
Dive 89
Sept. 9, 2000
Northwest
Sherwood
Forest

Click image to view a larger map.



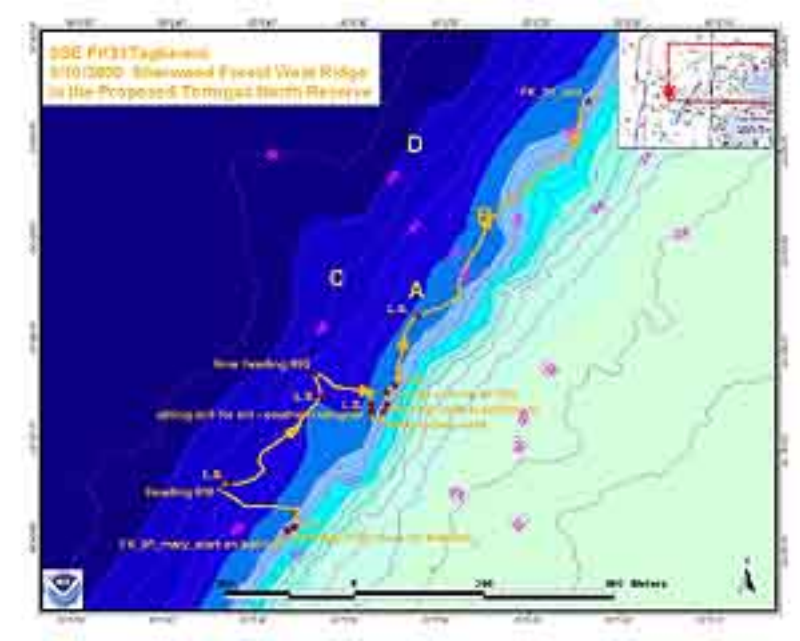
Dive 90
Sept. 9, 2000
Northwest
Sherwood
Forest

Click image to view a larger map.



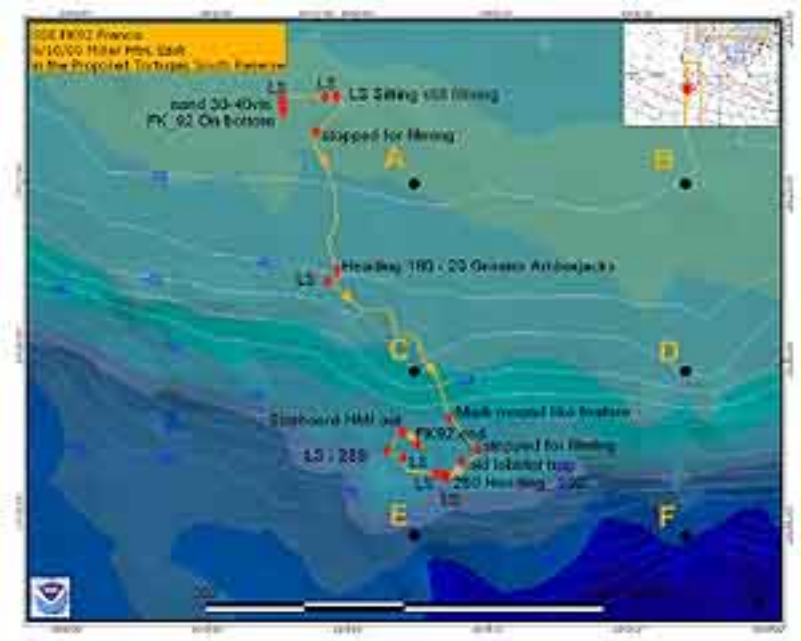
Dive 91
Sept. 10, 2000
Southwest Sherwood Forest

Click image to view a larger map.



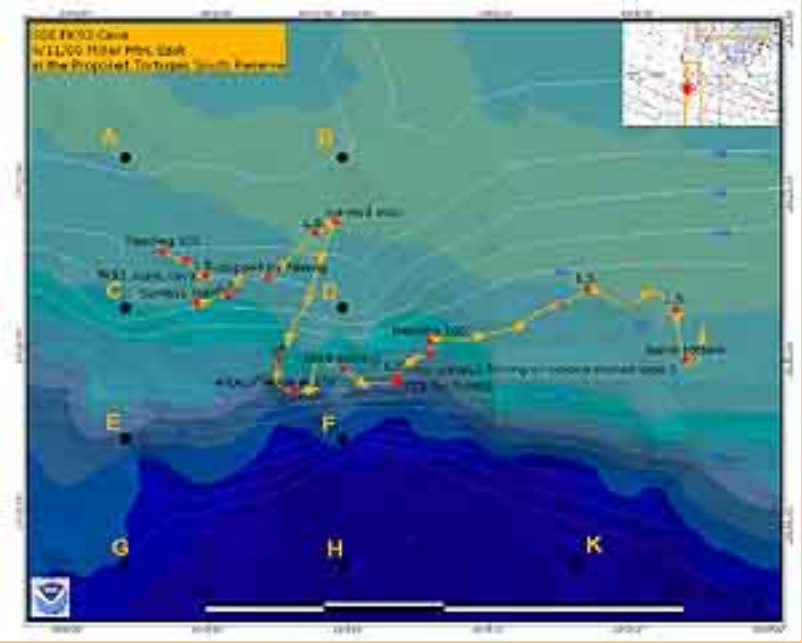
Dive 92
Sept. 10, 2000
East of Miller's Mountain

Click image to view a larger map.



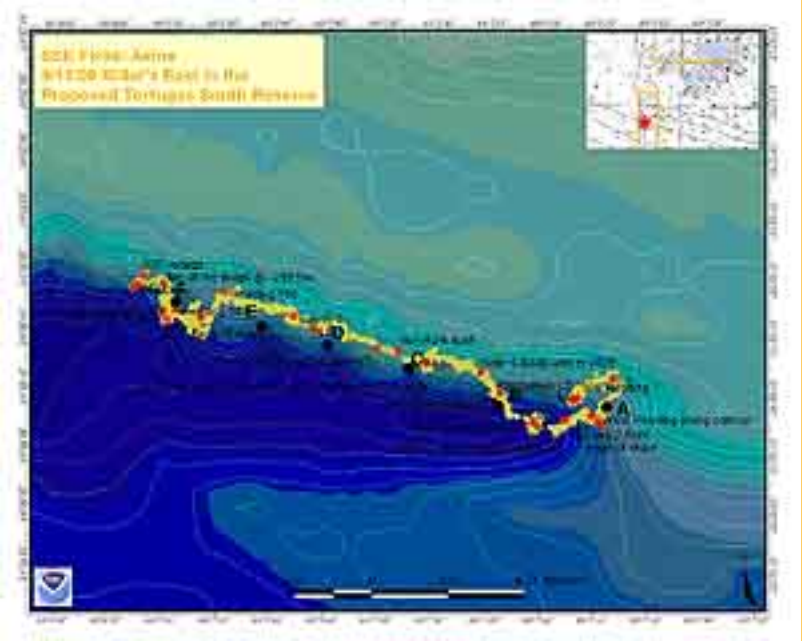
Dive 93
Sept. 11, 2000
East of Miller's Mountain

Click image to view a larger map.

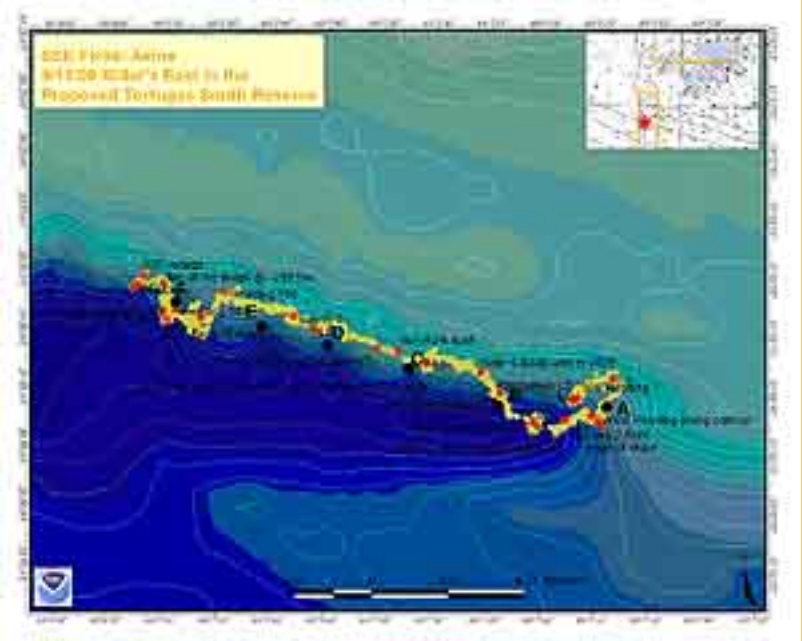


Dive 94
Sept. 11, 2000
East of Miller's Mountain

Click image to view a larger map.

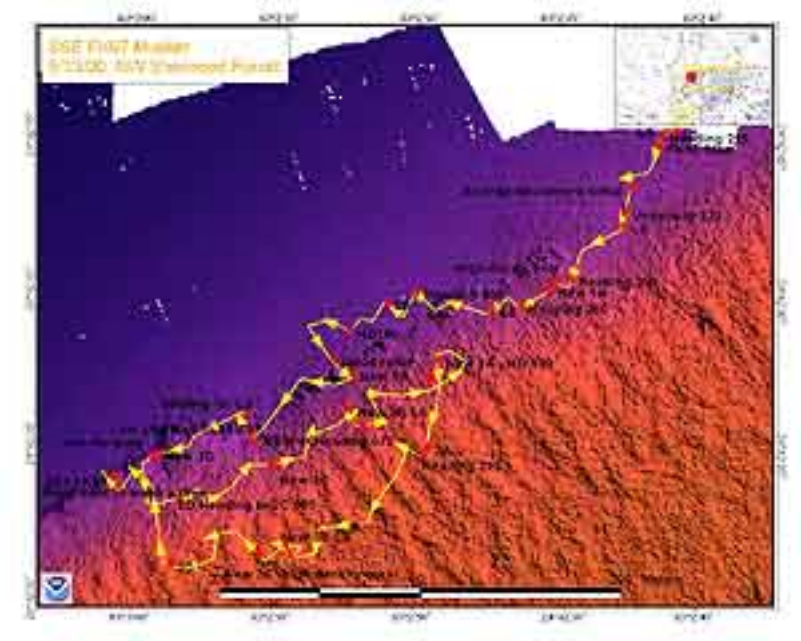


Dive 95
Sept. 12, 2000
South of Riley's Hump

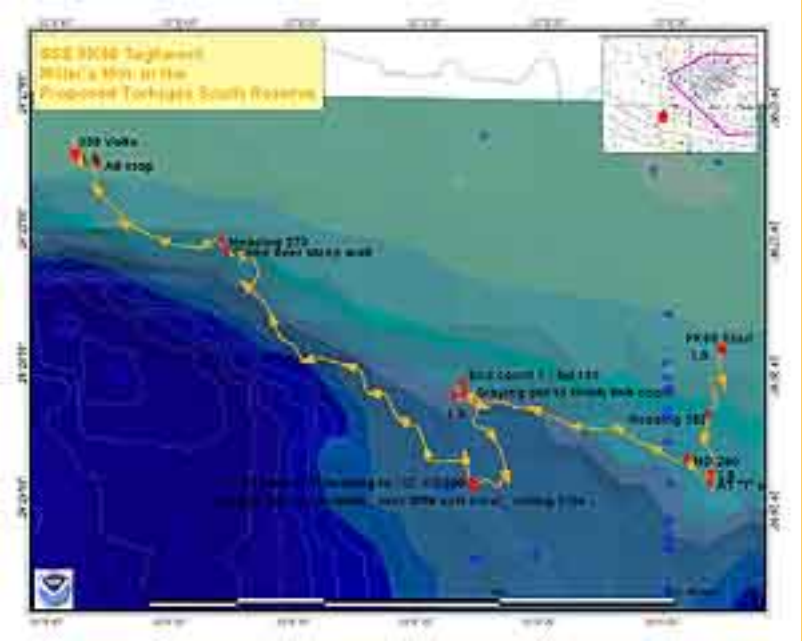


Dive 96
Sept. 12, 2000
South of Riley's Hump

Dive 97
Sept. 13, 2000
Northwest Sherwood Forest



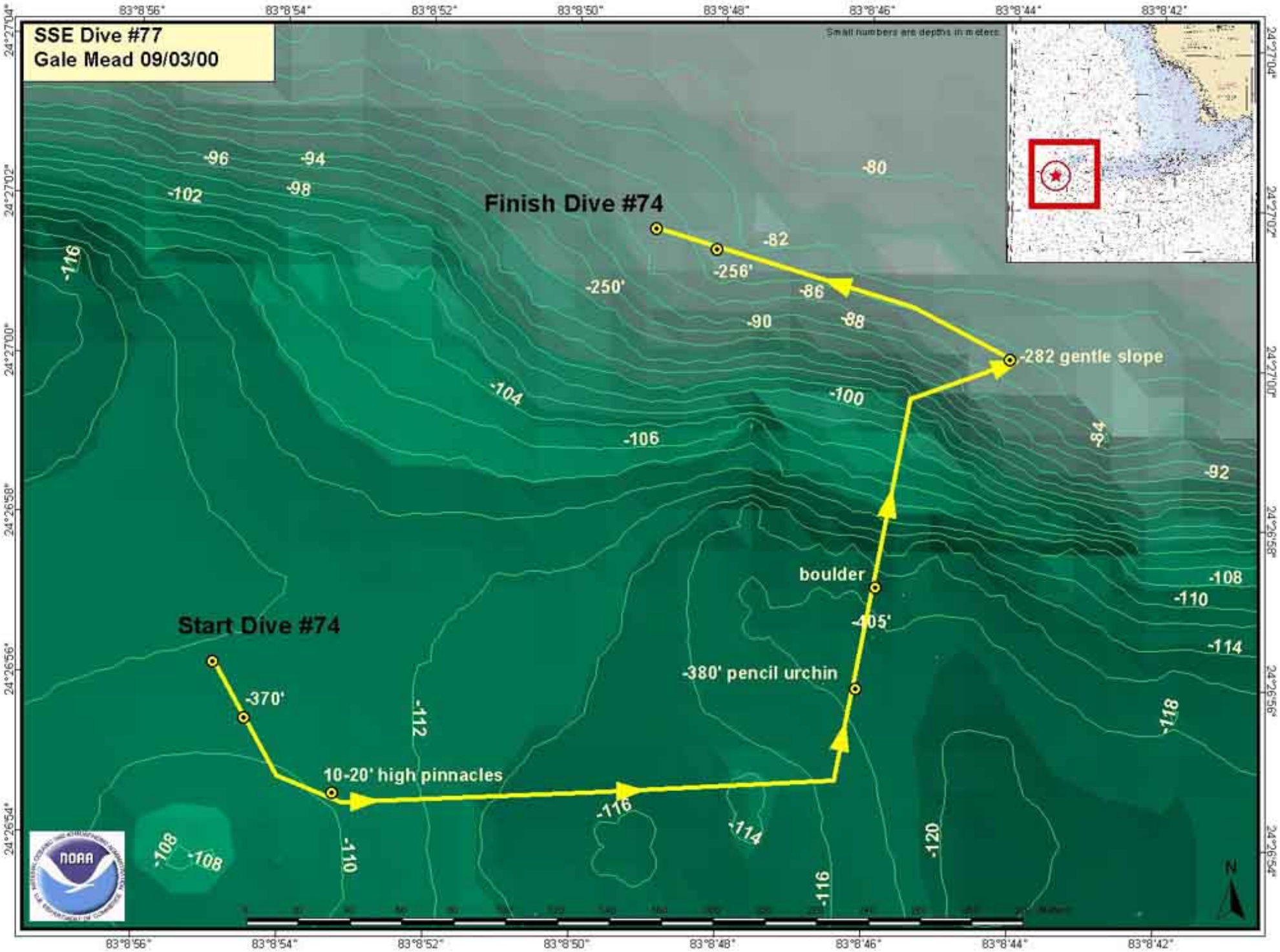
Dive 98
Sept. 13, 2000
East of Miller's Mountain

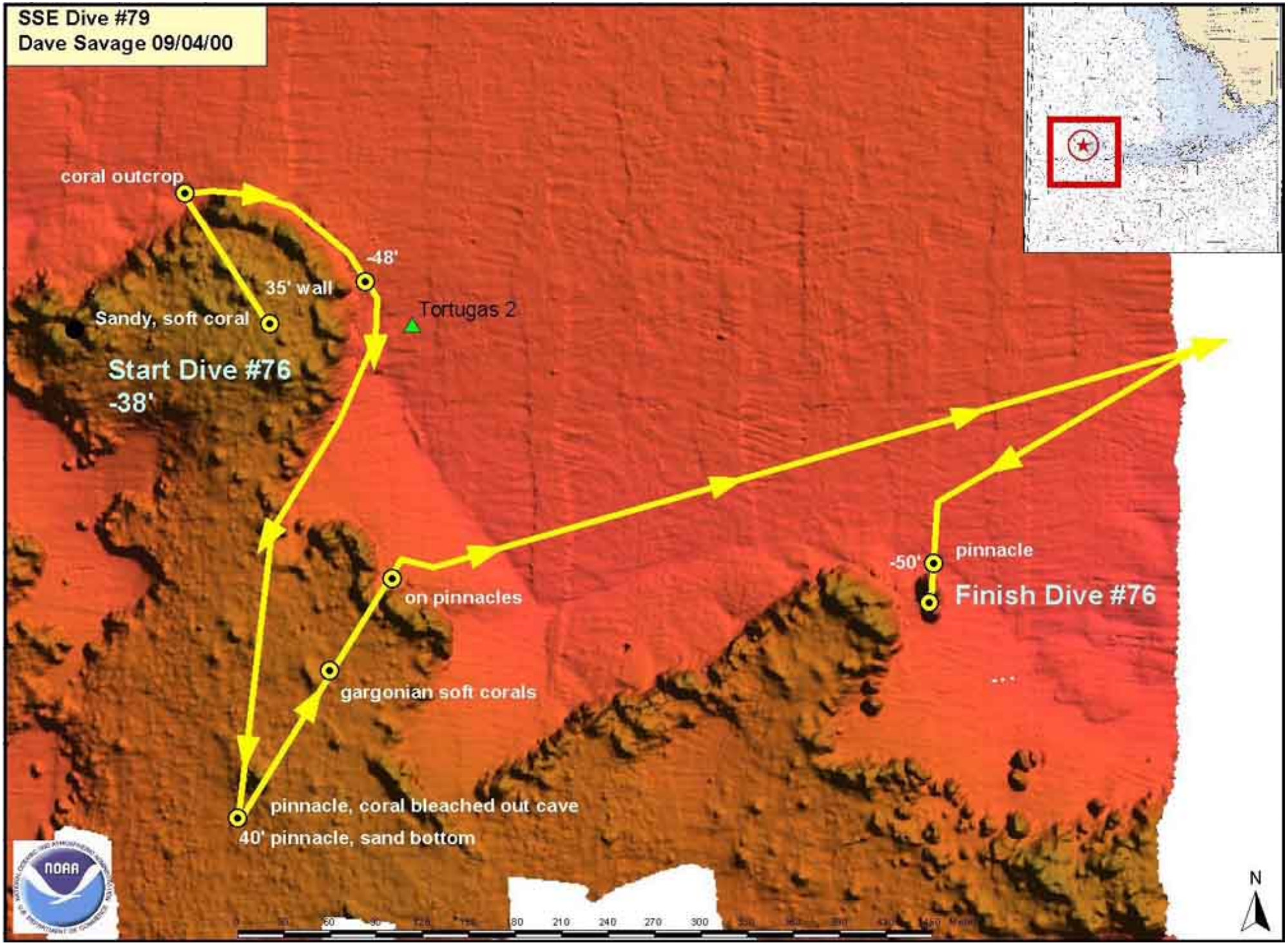


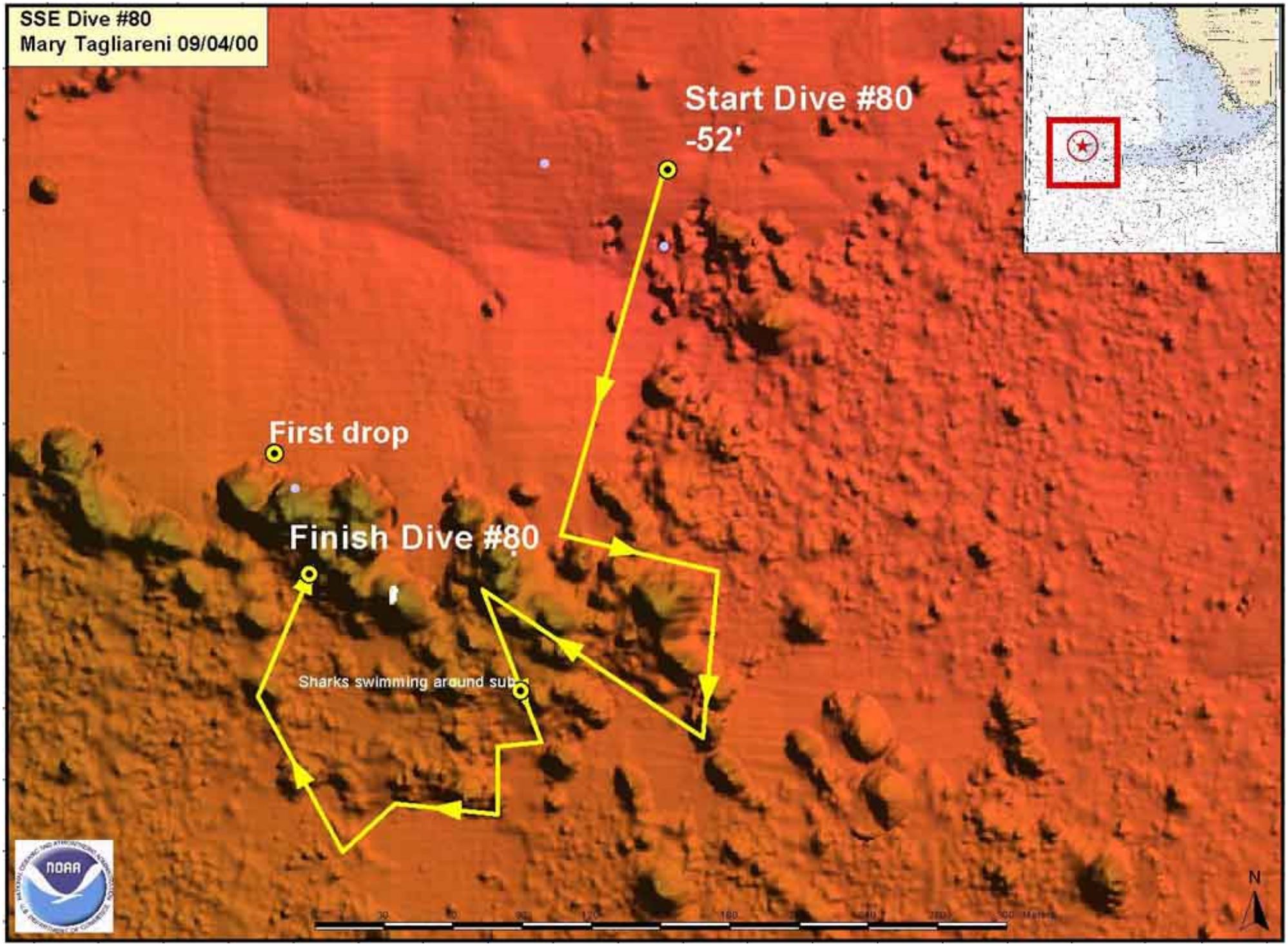
Dive 99
Sept. 14, 2000
Ballast Pile

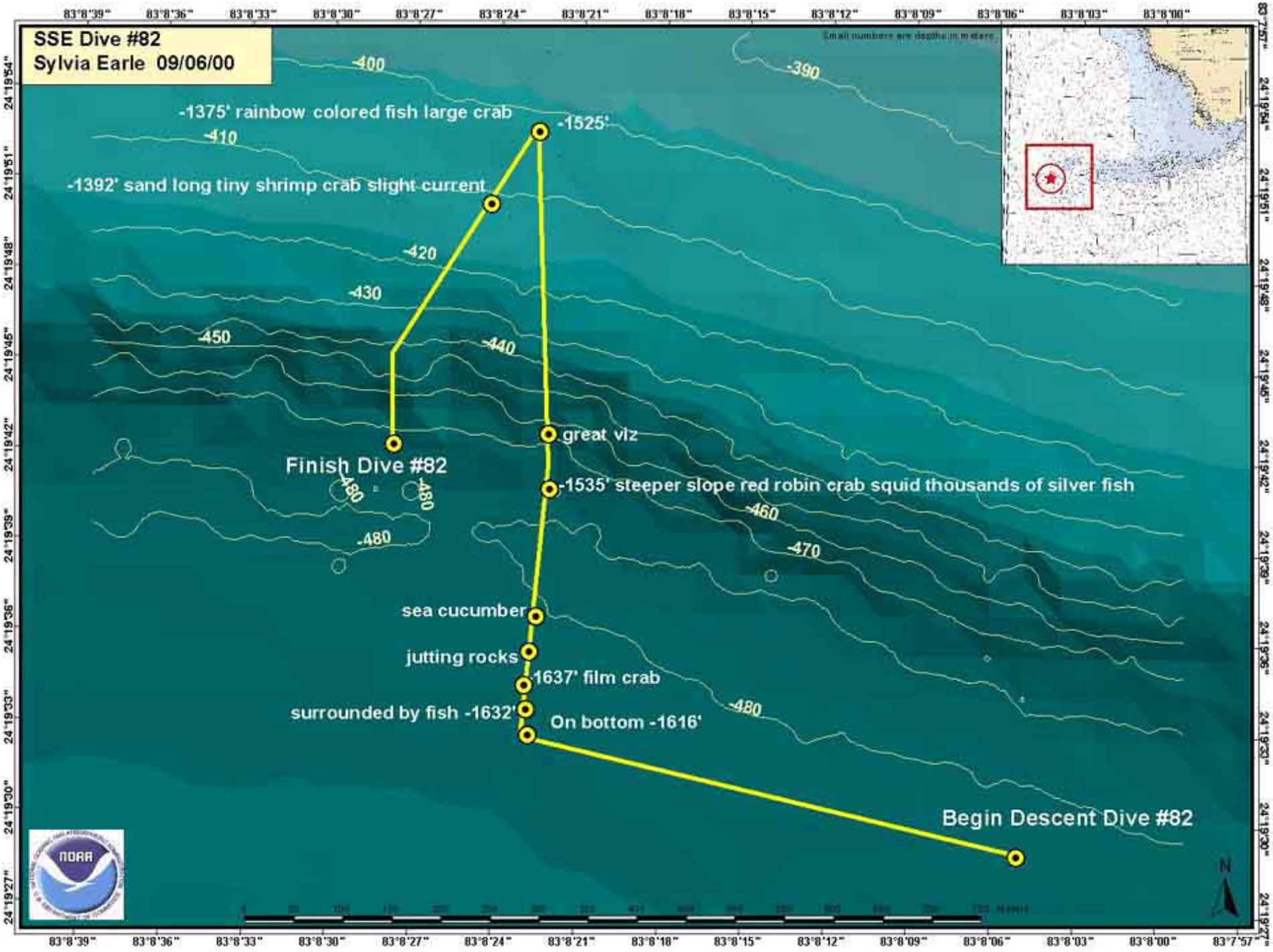
Dive 100
Sept. 14, 2000
Mote Reef

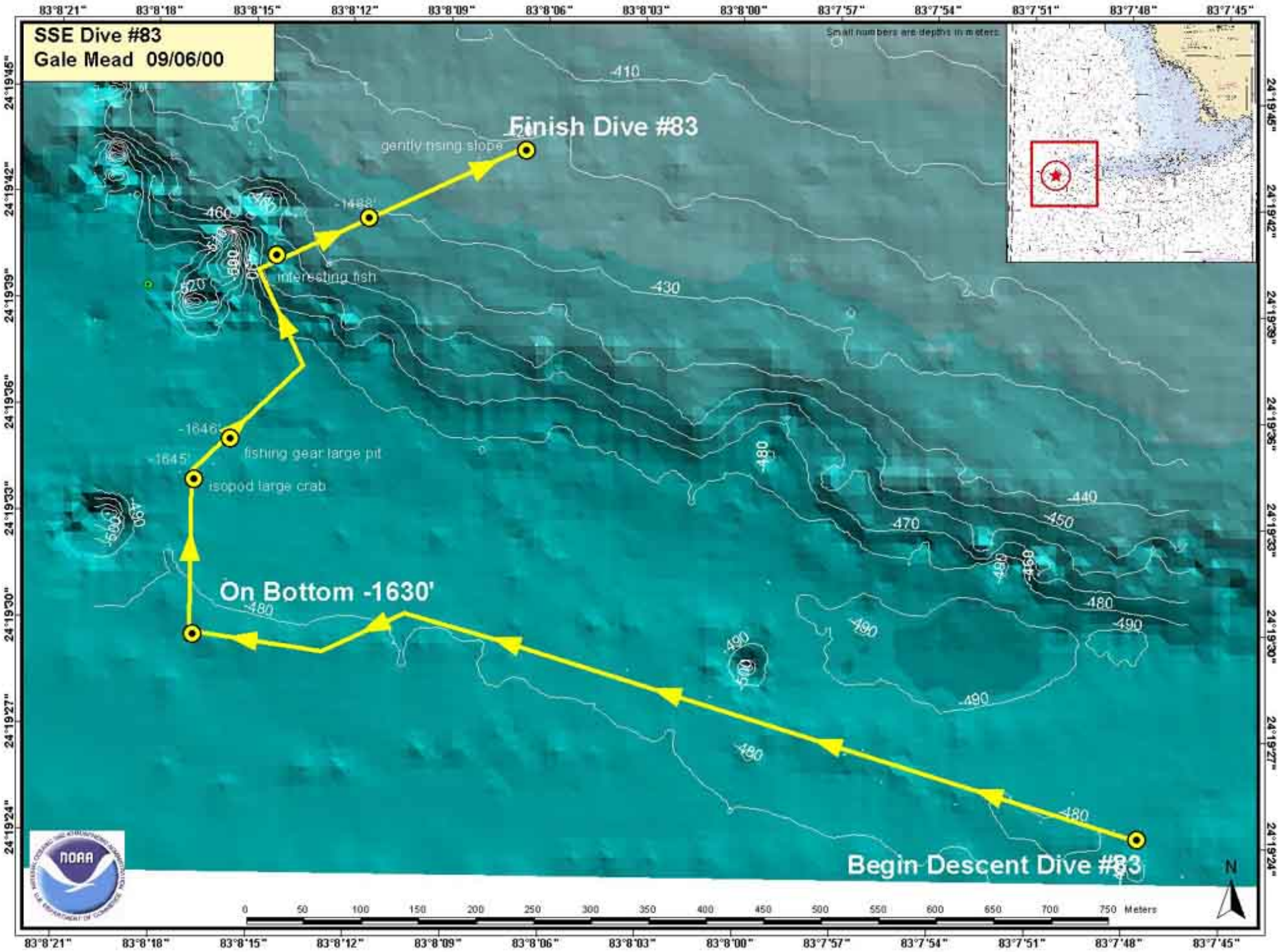
Top | **Return**

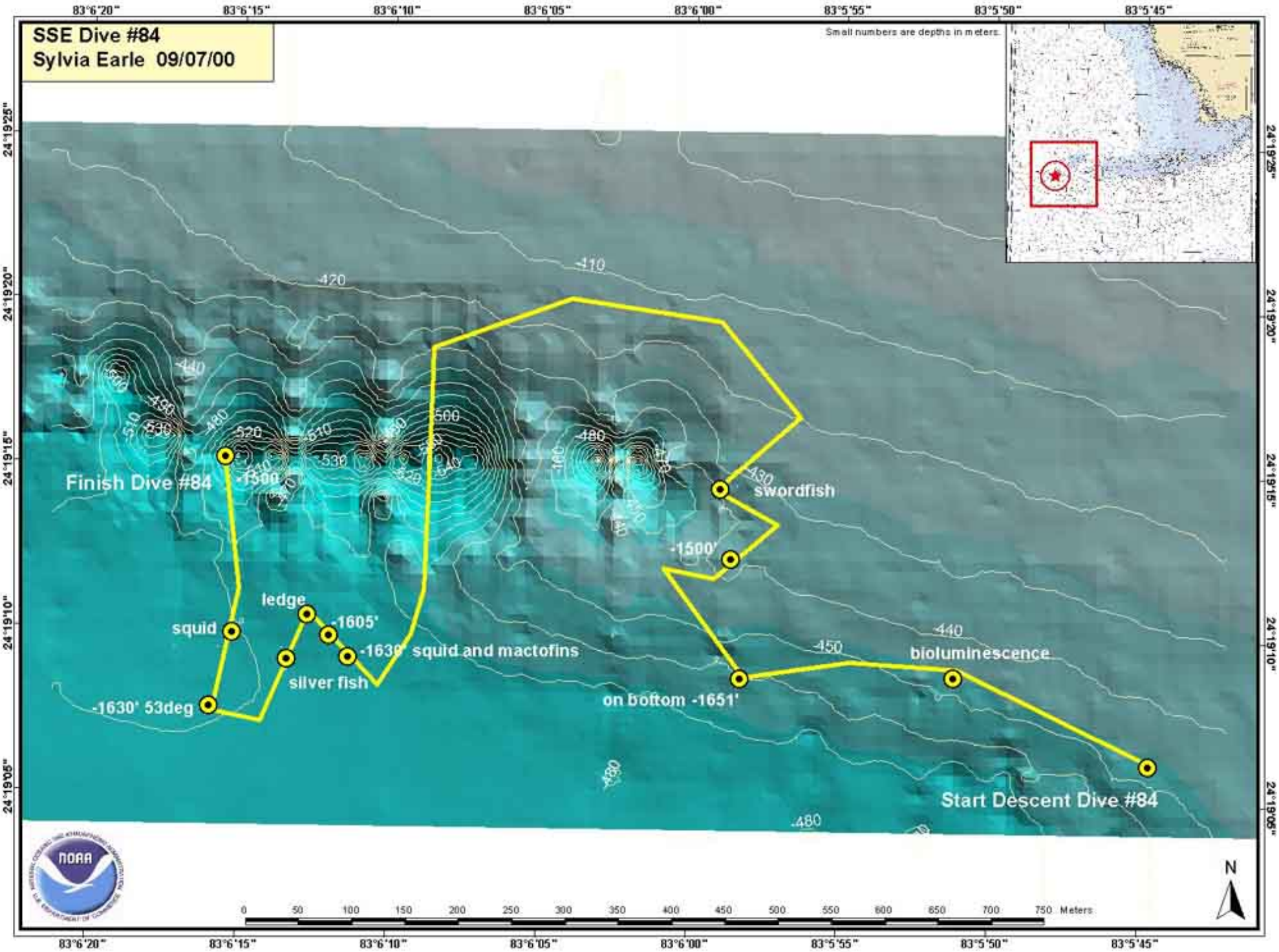

SSE Dive #77
Gale Mead 09/03/00
Small numbers are depths in meters
Finish Dive #74
-256'
-282 gentle slope
boulder
-405'
-380' pencil urchin
Start Dive #74
-370'
10-20' high pinnacles
-96
-94
-98
-102
-80
-82
-250'
-86
-90
-88
-116
-104
-100
-106
-94
-92
-108
-110
-114
-112
-118
-116
-114
-120
-116
-108
-108
-110
NOAA
N
83°8'56"
83°8'54"
83°8'52"
83°8'50"
83°8'48"
83°8'46"
83°8'44"
83°8'42"
24°27'04"
24°27'02"
24°27'00"
24°26'58"
24°26'56"
24°26'54"

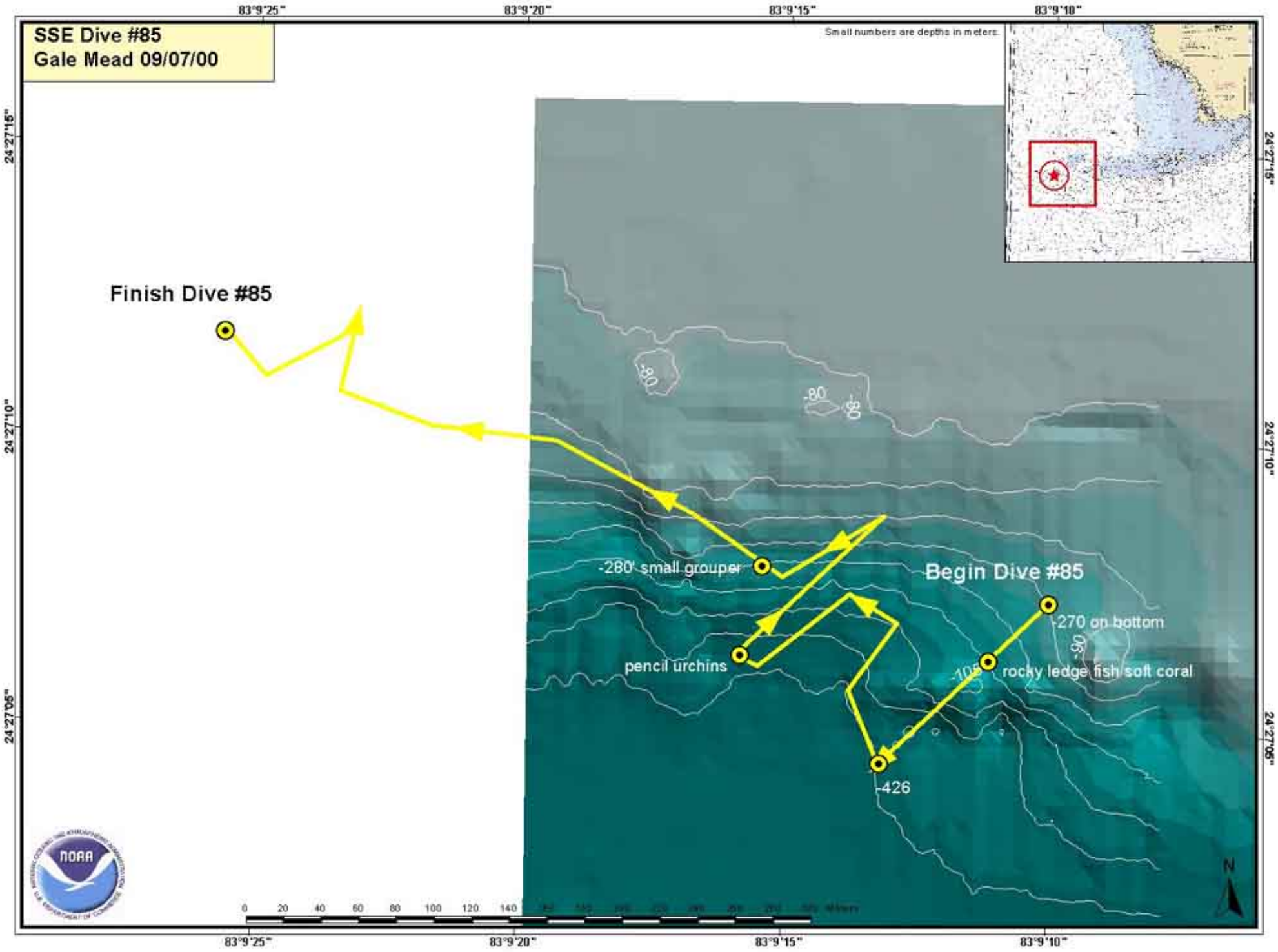

SSE Dive #79
Dave Savage 09/04/00
coral outcrop
-48'
35' wall
Sandy, soft coral
Tortugas 2
Start Dive #76
-38'
-50'
pinnacle
Finish Dive #76
on pinnacles
gargonian soft corals
pinnacle, coral bleached out cave
40' pinnacle, sand bottom
NOAA
N

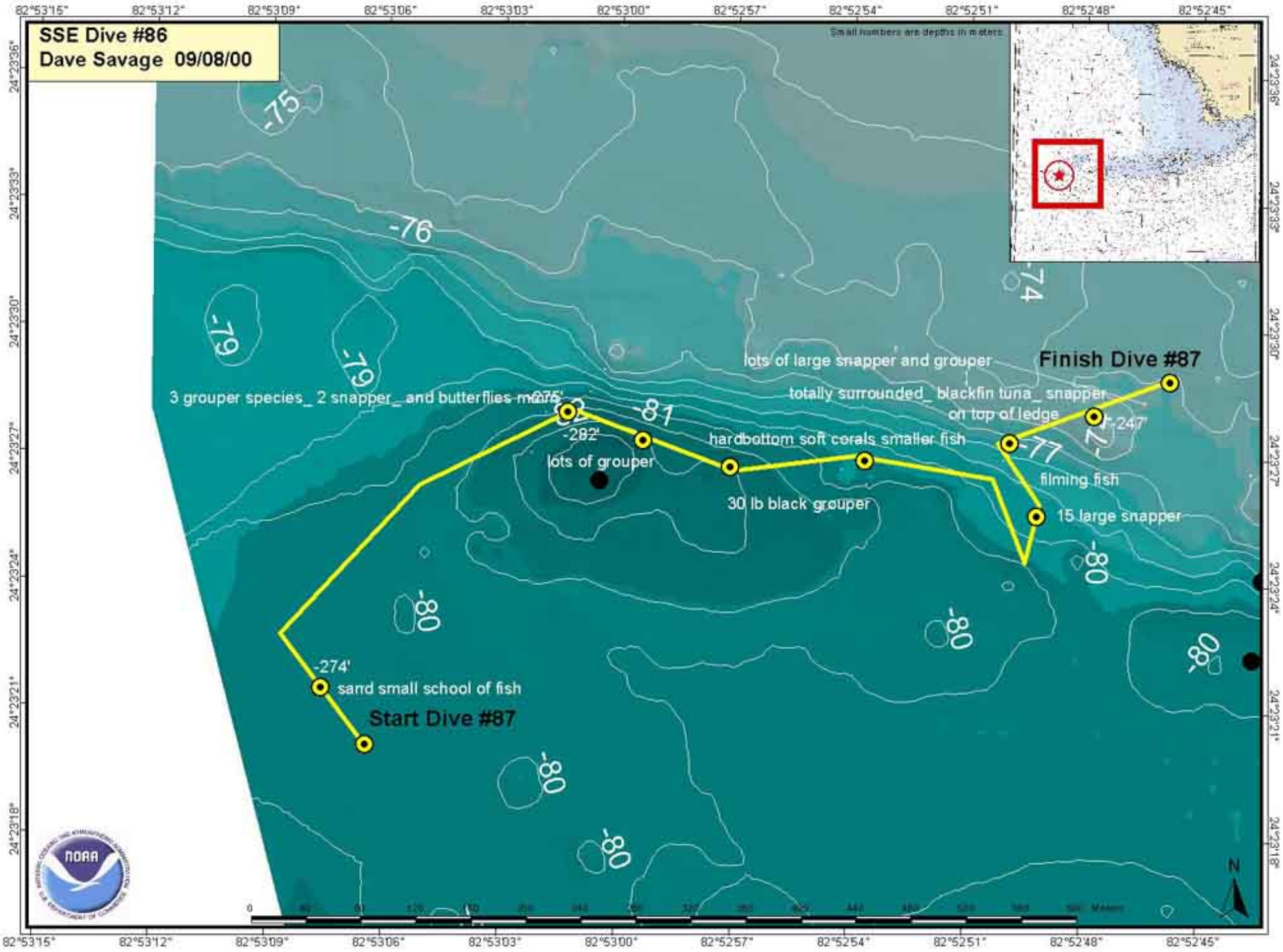

SSE Dive #80
Mary Tagliareni 09/04/00
Start Dive #80
-52'
First drop
Finish Dive #80
Sharks swimming around sub
NOAA
N

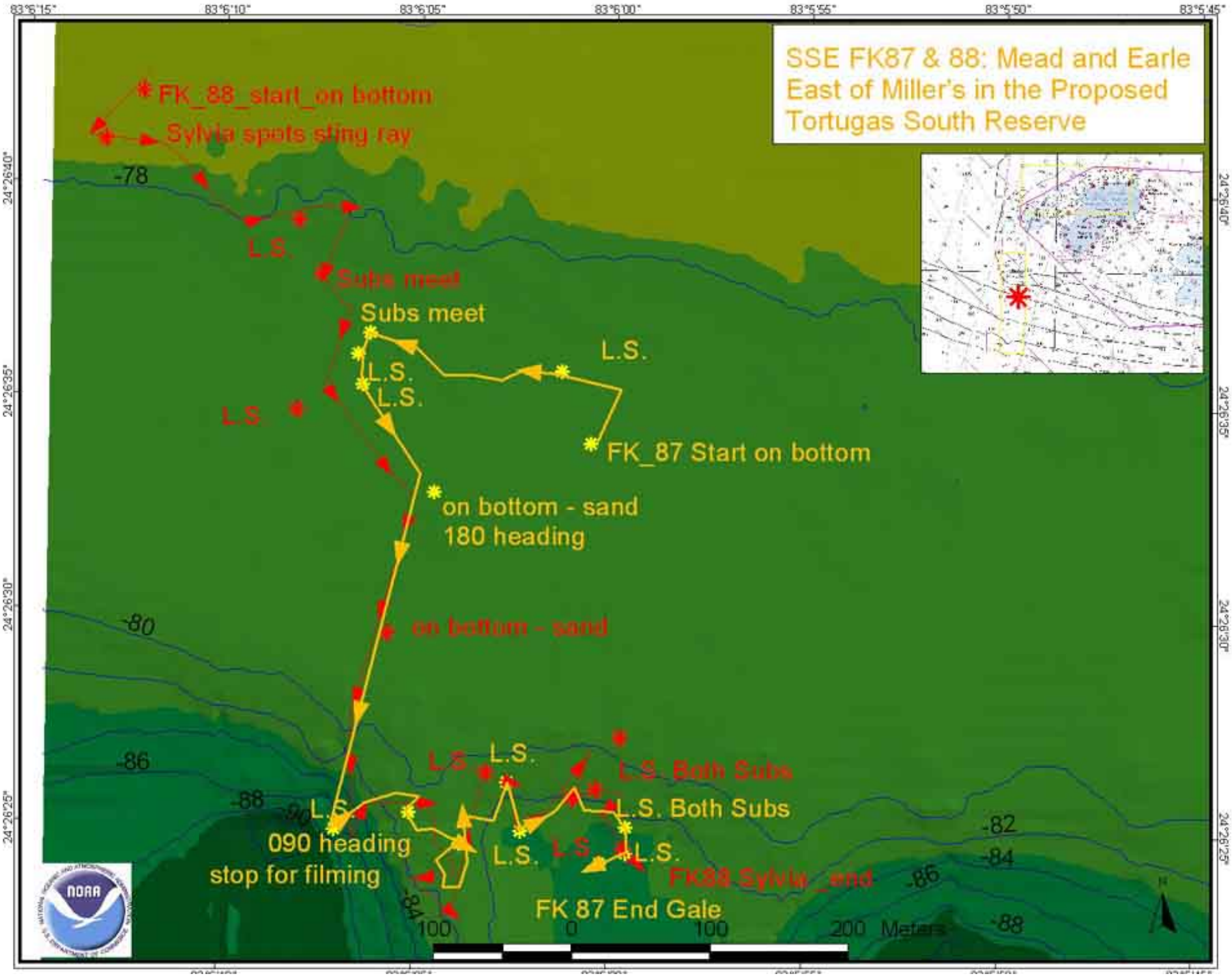

SSE Dive #82
Sylvia Earle 09/06/00
-400
-390
-1375' rainbow colored fish large crab
-410
-1525'
-1392' sand long tiny shrimp crab slight current
-420
-430
-450
-440
great viz
Finish Dive #82
-480
-480
-1535' steeper slope red robin crab squid thousands of silver fish
-460
-470
-480
sea cucumber
jutting rocks
-1637' film crab
surrounded by fish -1632'
On bottom -1616'
-480
Begin Descent Dive #82
NOAA
N


SSE Dive #83
Gale Mead 09/06/00
Small numbers are depths in meters
Finish Dive #83
gently rising slope
-1488'
interesting fish
-1646'
fishing gear large pit
-1645'
isopod large crab
On Bottom -1630'
Begin Descent Dive #83
410
430
440
450
460
470
480
490
500
520
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 Meters
N
NOAA

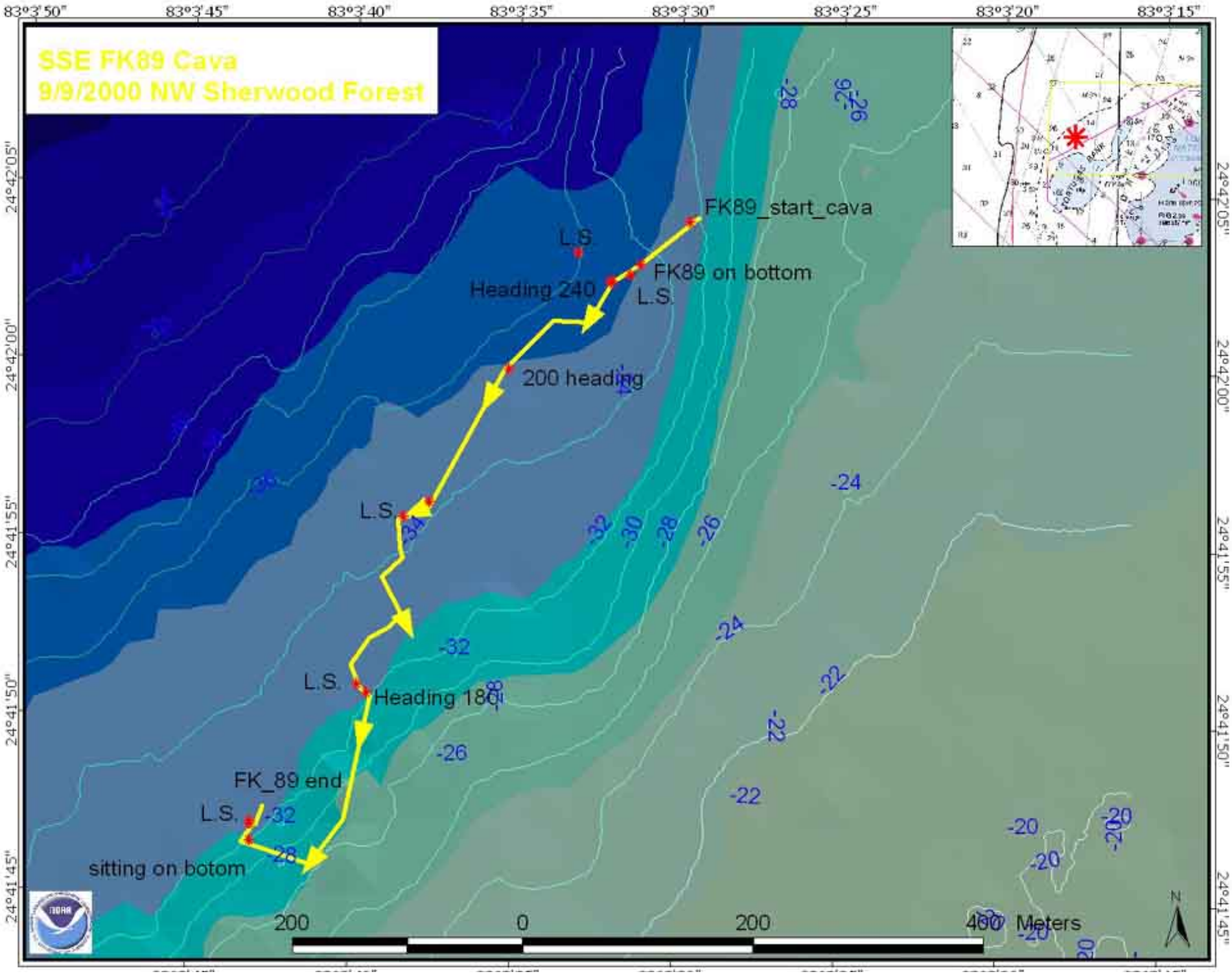

SSE Dive #84
Sylvia Earle 09/07/00
Small numbers are depths in meters.
Finish Dive #84
-1500'
swordfish
-1500'
ledge
squid
-1605'
-1630' squid and mactofins
silver fish
-1630' 53deg
on bottom -1651'
bioluminescence
Start Descent Dive #84
83°6'20"
83°6'15"
83°6'10"
83°6'05"
83°6'00"
83°5'55"
83°5'50"
83°5'45"
24°19'25"
24°19'20"
24°19'15"
24°19'10"
24°19'05"
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 Meters
N

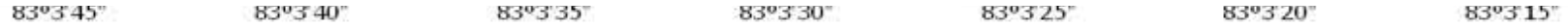

SSE Dive #85
Gale Mead 09/07/00
Small numbers are depths in meters.
Finish Dive #85
-280' small grouper
Begin Dive #85
-270 on bottom
pencil urchins
rocky ledge fish soft coral
-426
83°9'25"
83°9'20"
83°9'15"
83°9'10"
24°27'15"
24°27'10"
24°27'05"
0 20 40 60 80 100 120 140
N

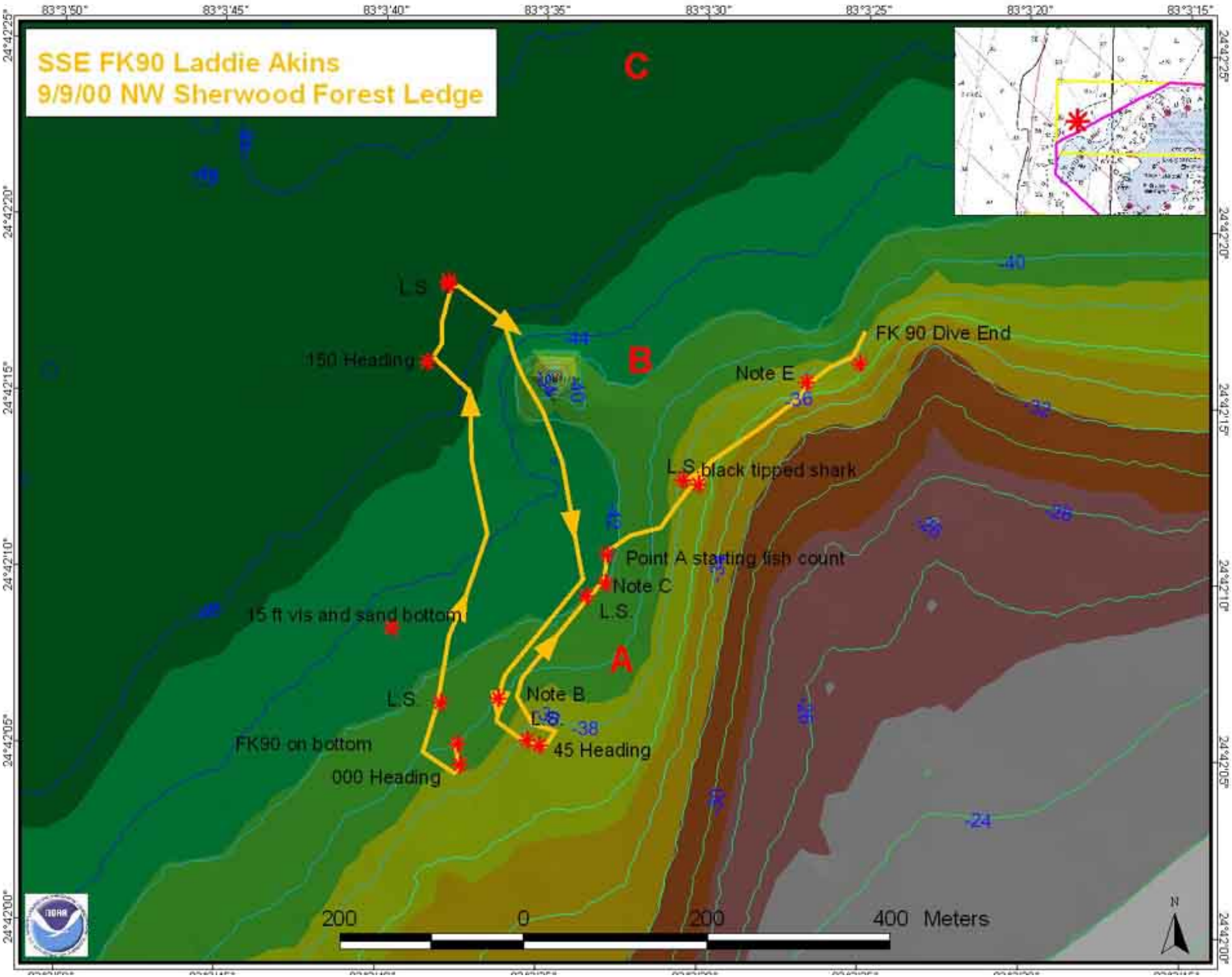

SSE Dive #86
Dave Savage 09/08/00
Small numbers are depths in meters
-75
-76
-74
-79
-79
-81
-77
-80
-80
-80
-80
3 grouper species_ 2 snapper_ and butterflies mate
-282'
lots of grouper
hardbottom soft corals smaller fish
30 lb black grouper
lots of large snapper and grouper
totally surrounded_ blackfin tuna_ snapper
on top of ledge
-247'
Finish Dive #87
filming fish
15 large snapper
-274'
sand small school of fish
Start Dive #87
NOAA
N
82°53'15"
82°53'12"
82°53'09"
82°53'06"
82°53'03"
82°53'00"
82°52'57"
82°52'54"
82°52'51"
82°52'48"
82°52'45"
24°23'36"
24°23'33"
24°23'30"
24°23'27"
24°23'24"
24°23'21"
24°23'18"

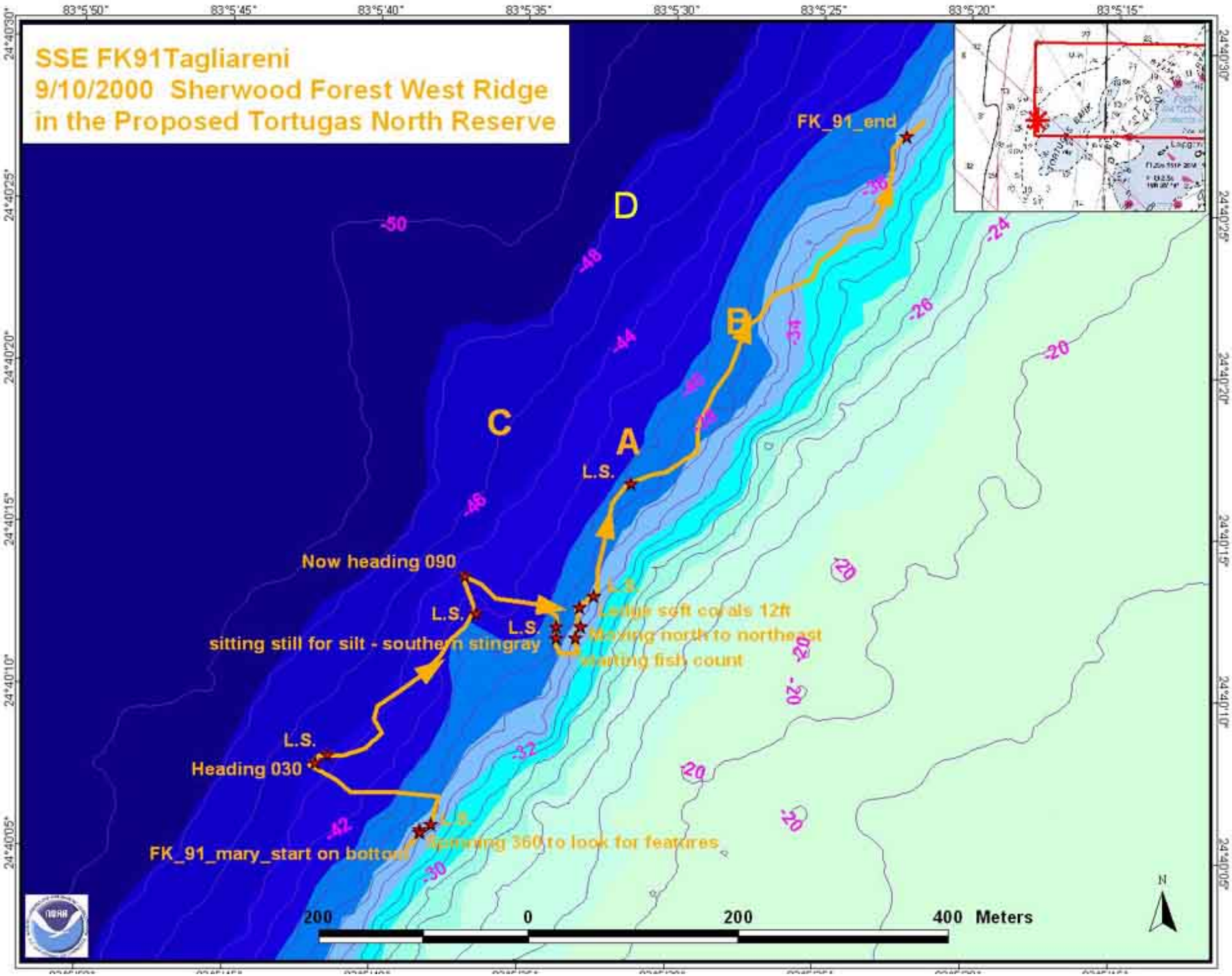

SSE FK87 & 88: Mead and Earle
East of Miller's in the Proposed
Tortugas South Reserve
FK_88_start_on bottom
Sylvia spots sting ray
-78
L.S.
Subs meet
Subs meet
L.S.
L.S.
L.S.
L.S.
FK_87 Start on bottom
on bottom - sand
180 heading
on bottom - sand
-80
-86
-88
-90
L.S.
L.S.
L.S.
L.S. Both Subs
L.S. Both Subs
090 heading
stop for filming
L.S.
L.S.
L.S.
FK88 Sylvia _end
FK 87 End Gale
-82
-84
-86
-88
-84
100
0
100
200 Meters
N
NOAA


83°6'10"
83°6'05"
83°6'00"
83°5'55"
83°5'50"
83°5'45"

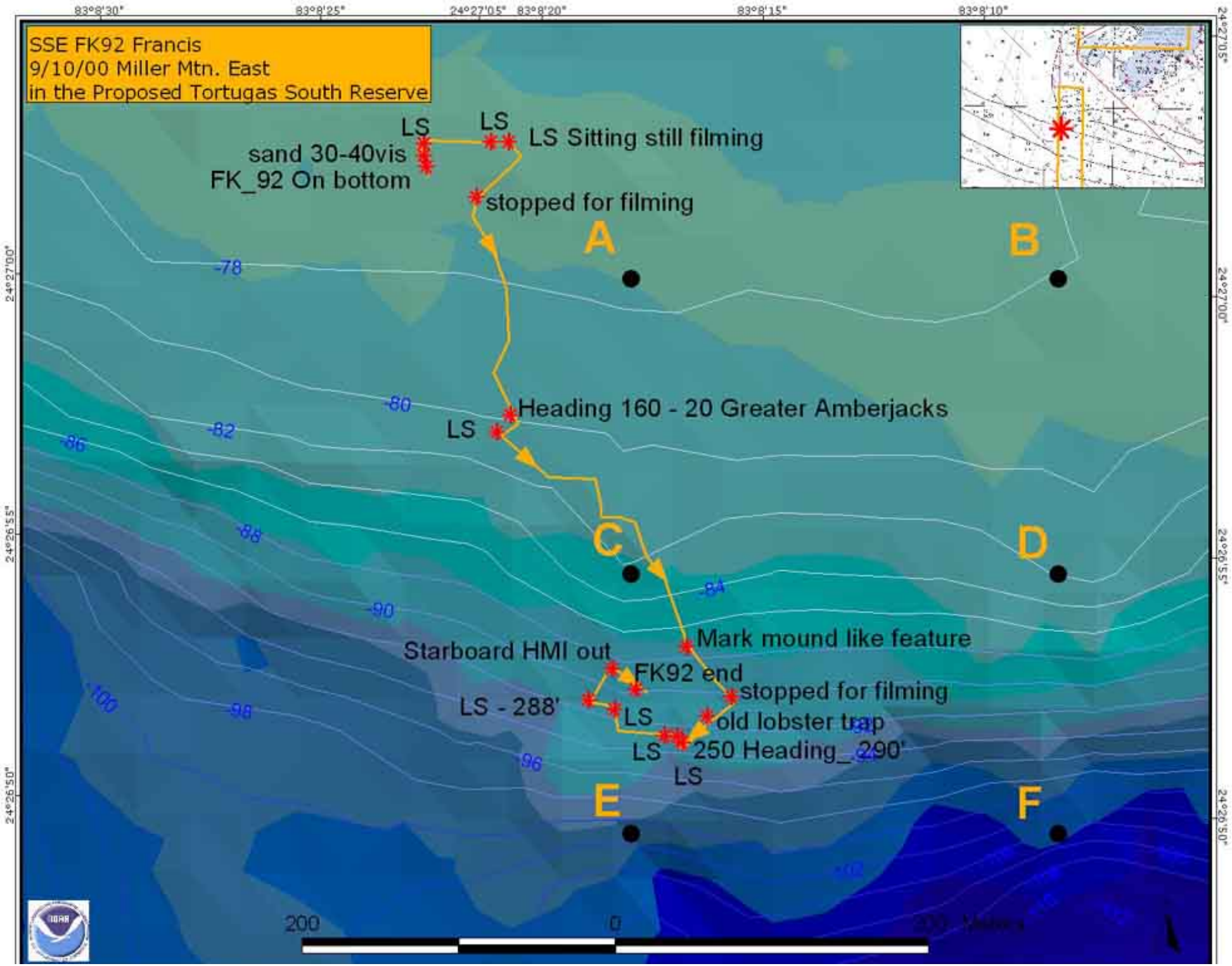

SSE FK89 Cava
9/9/2000 NW Sherwood Forest
83°3'50"
83°3'45"
83°3'40"
83°3'35"
83°3'30"
83°3'25"
83°3'20"
83°3'15"
24°42'05"
24°42'00"
24°41'55"
24°41'50"
24°41'45"
FK89_start_cava
L.S.
FK89 on bottom
Heading 240
L.S.
200 heading
L.S.
L.S.
Heading 180
FK_89 end
L.S.
sitting on botom
-32
-28
-26
-24
-22
-20
200
0
200
400 Meters
N


83°3'45"
83°3'40"
83°3'35"
83°3'30"
83°3'25"
83°3'20"
83°3'15"

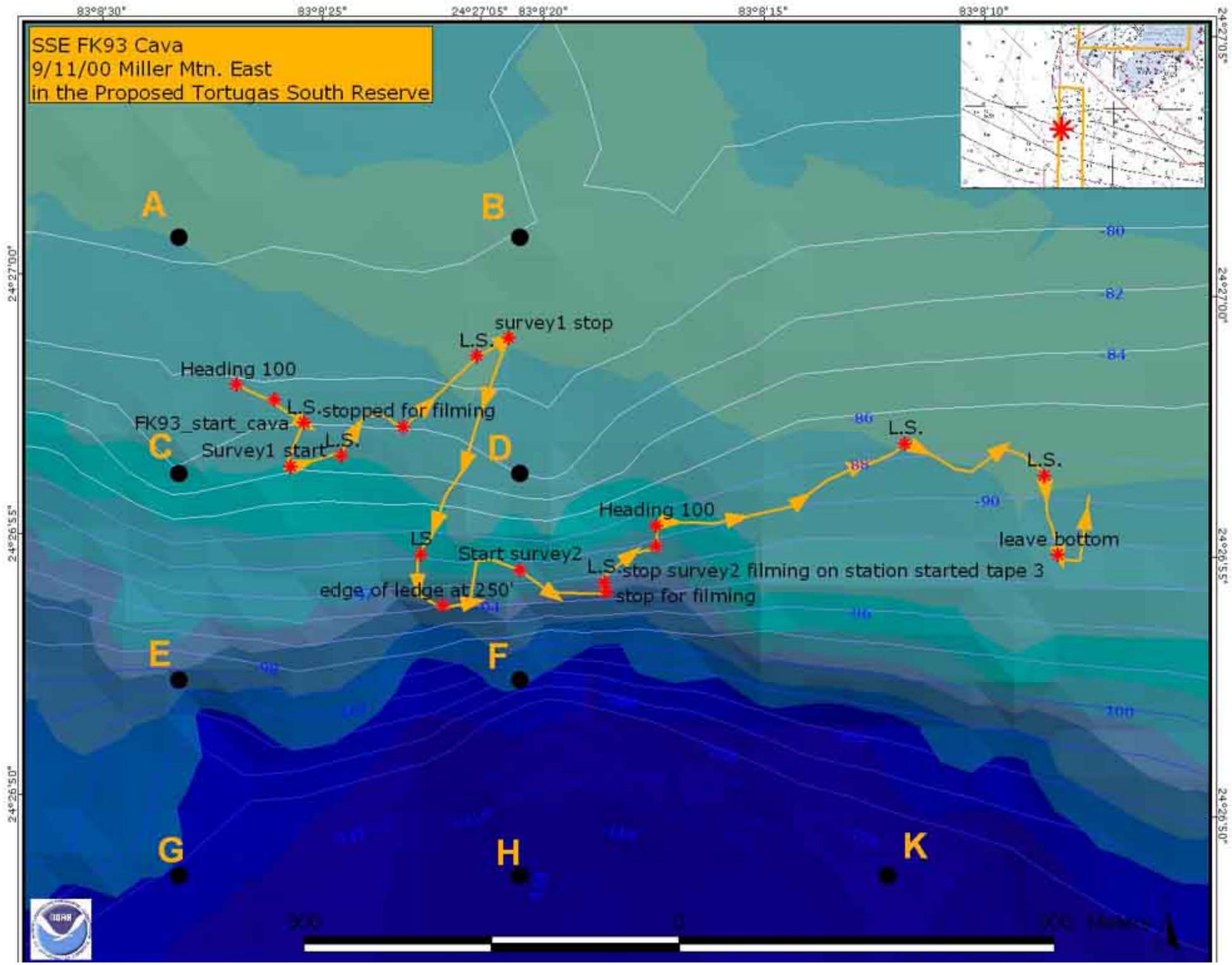

SSE FK90 Laddie Akins
9/9/00 NW Sherwood Forest Ledge
C
B
A
L S
150 Heading
FK 90 Dive End
Note E
L S black tipped shark
Point A starting fish count
Note C
L.S.
15 ft vis and sand bottom
L.S.
Note B
L.S.
FK90 on bottom
000 Heading
45 Heading
200
0
200
400 Meters
N


SSE FK91Tagliareni
9/10/2000 Sherwood Forest West Ridge
in the Proposed Tortugas North Reserve
FK_91_end
D
C
B
A
L.S.
Now heading 090
L.S.
L.S.
sitting still for silt - southern stingray
L.S.
Lots soft corals 12ft
Moving north to northeast
starting fish count
L.S.
Heading 030
L.S.
FK_91_mary_start on bottom
Spinning 360 to look for features
-50
-48
-44
-46
-42
-32
-30
-24
-26
-20
200
0
200
400 Meters
N

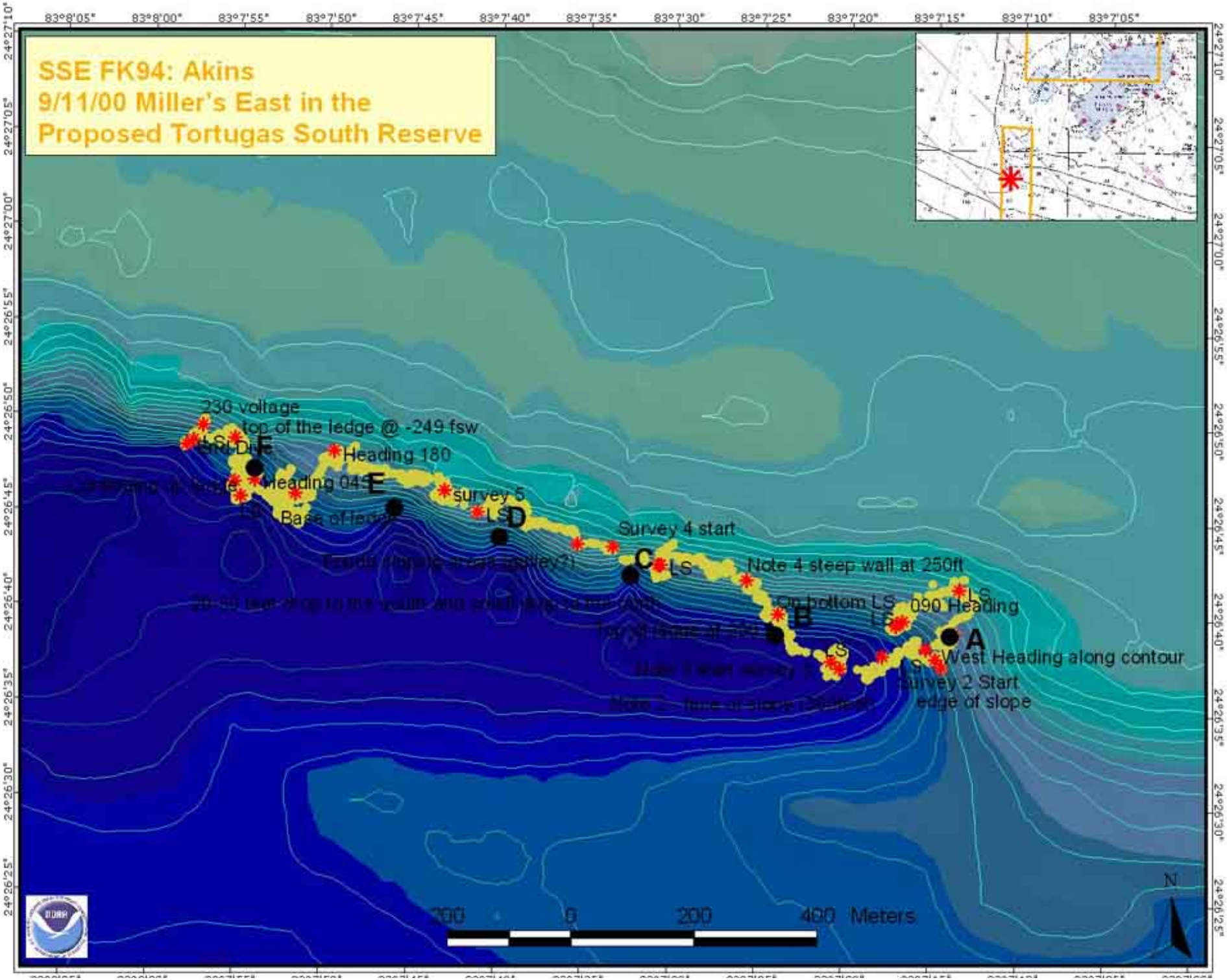

83°5'50"
83°5'45"
83°5'40"
83°5'35"
83°5'30"
83°5'25"
83°5'20"
83°5'15"


SSE FK92 Francis
9/10/00 Miller Mtn. East
in the Proposed Tortugas South Reserve
LS
LS
LS Sitting still filming
sand 30-40vis
FK_92 On bottom
stopped for filming
A
B
-78
-80
-82
-86
Heading 160 - 20 Greater Amberjacks
LS
C
D
-88
-90
-94
Mark mound like feature
Starboard HMI out
FK92 end
stopped for filming
LS - 288'
LS
old lobster trap
LS
250 Heading_290'
LS
-96
-98
-100
E
F
200
0

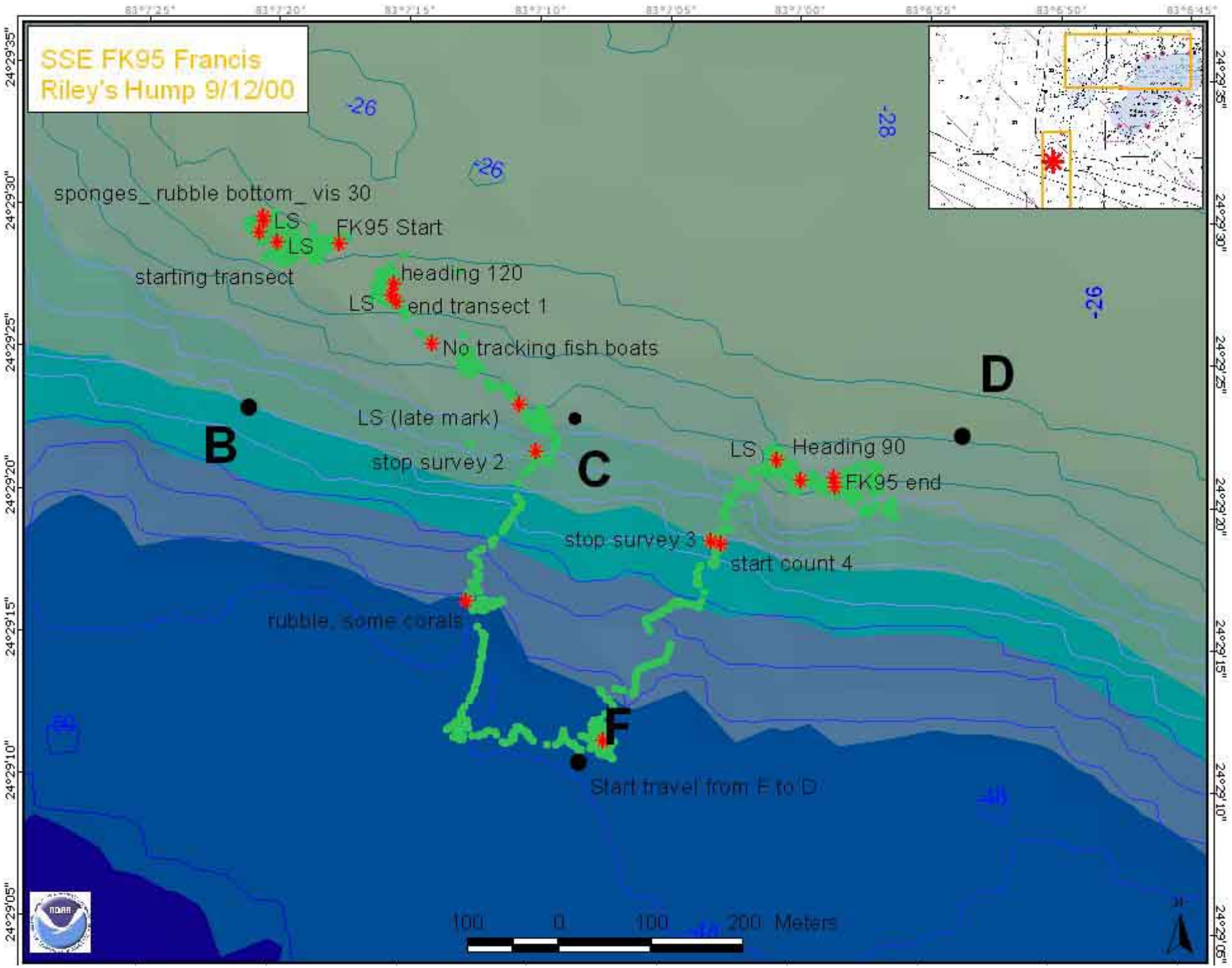

83°8'30"
83°8'25"
83°8'20"
83°8'15"
83°8'10"
83°8'05"


SSE FK93 Cava
9/11/00 Miller Mtn. East
in the Proposed Tortugas South Reserve
83°8'30"
83°8'25"
24°27'05"
83°8'20"
83°8'15"
83°8'10"
24°27'05"
24°27'00"
24°26'55"
24°26'50"
A
B
C
D
E
F
G
H
K
-80
-82
-84
-86
-88
-90
-94
-96
-100
survey1 stop
L.S.
Heading 100
L.S.
stopped for filming
FK93_start_cava
L.S.
Survey1 start
L.S.
L.S.
L.S.
Heading 100
LS
Start survey2
L.S.
stop survey2 filming on station started tape 3
edge of ledge at 250'
stop for filming
leave bottom

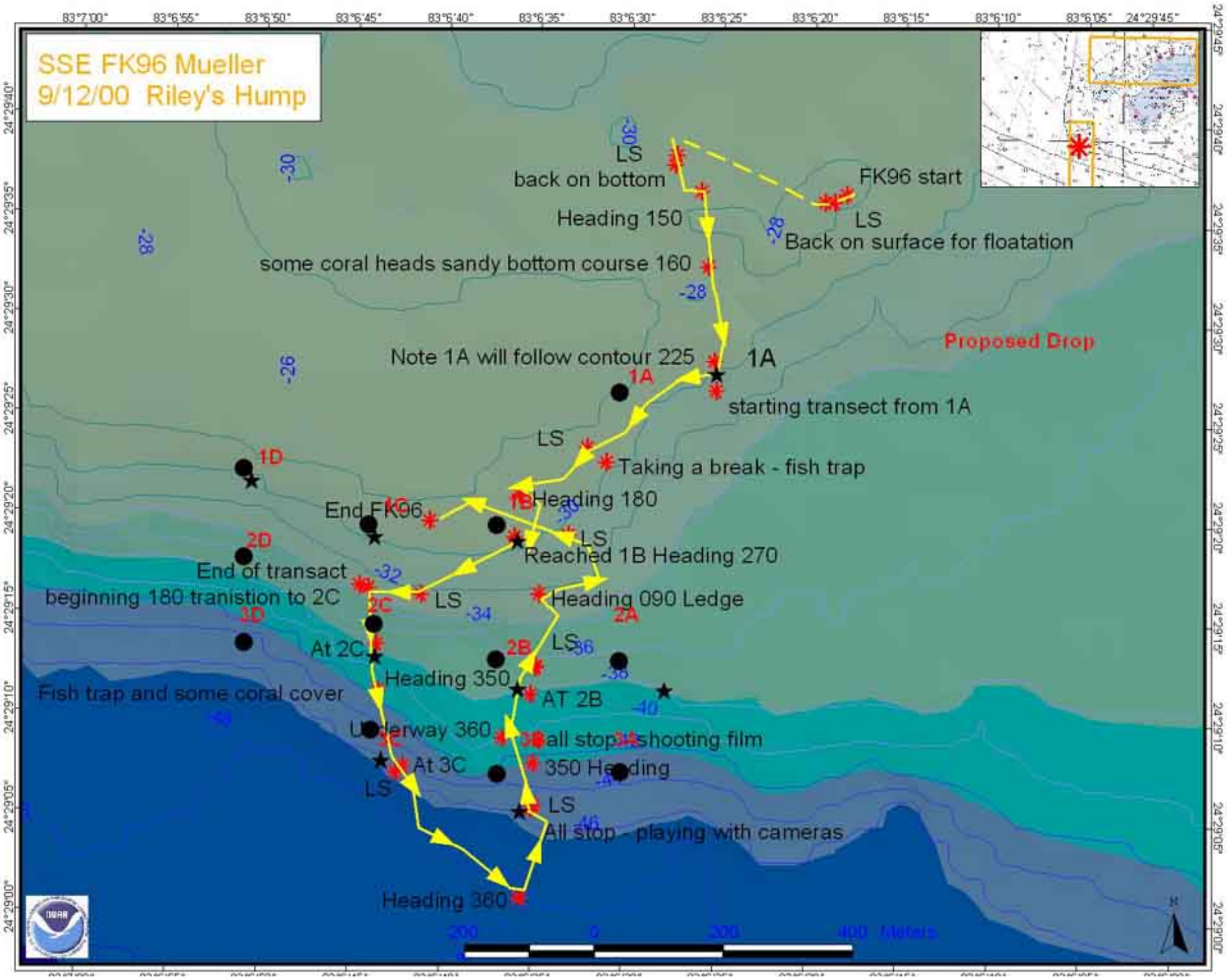

83°8'30"
83°8'25"
83°8'20"
83°8'15"
83°8'10"
83°8'05"


SSE FK94: Akins
9/11/00 Miller's East in the
Proposed Tortugas South Reserve
83°8'05"
83°8'00"
83°7'55"
83°7'50"
83°7'45"
83°7'40"
83°7'35"
83°7'30"
83°7'25"
83°7'20"
83°7'15"
83°7'10"
83°7'05"
24°27'10"
24°27'05"
24°27'00"
24°26'55"
24°26'50"
24°26'45"
24°26'40"
24°26'35"
24°26'30"
24°26'25"
230 voltage
top of the ledge @ -249 fsw
2nd Dive
F
Heading 180
Heading 045
E
survey 5
LS
D
Survey 4 start
C
LS
Note 4 steep wall at 250ft
On bottom LS
090 Heading
B
LS
A
West Heading along contour
survey 2 Start
edge of slope
N
200
0
200
400 Meters

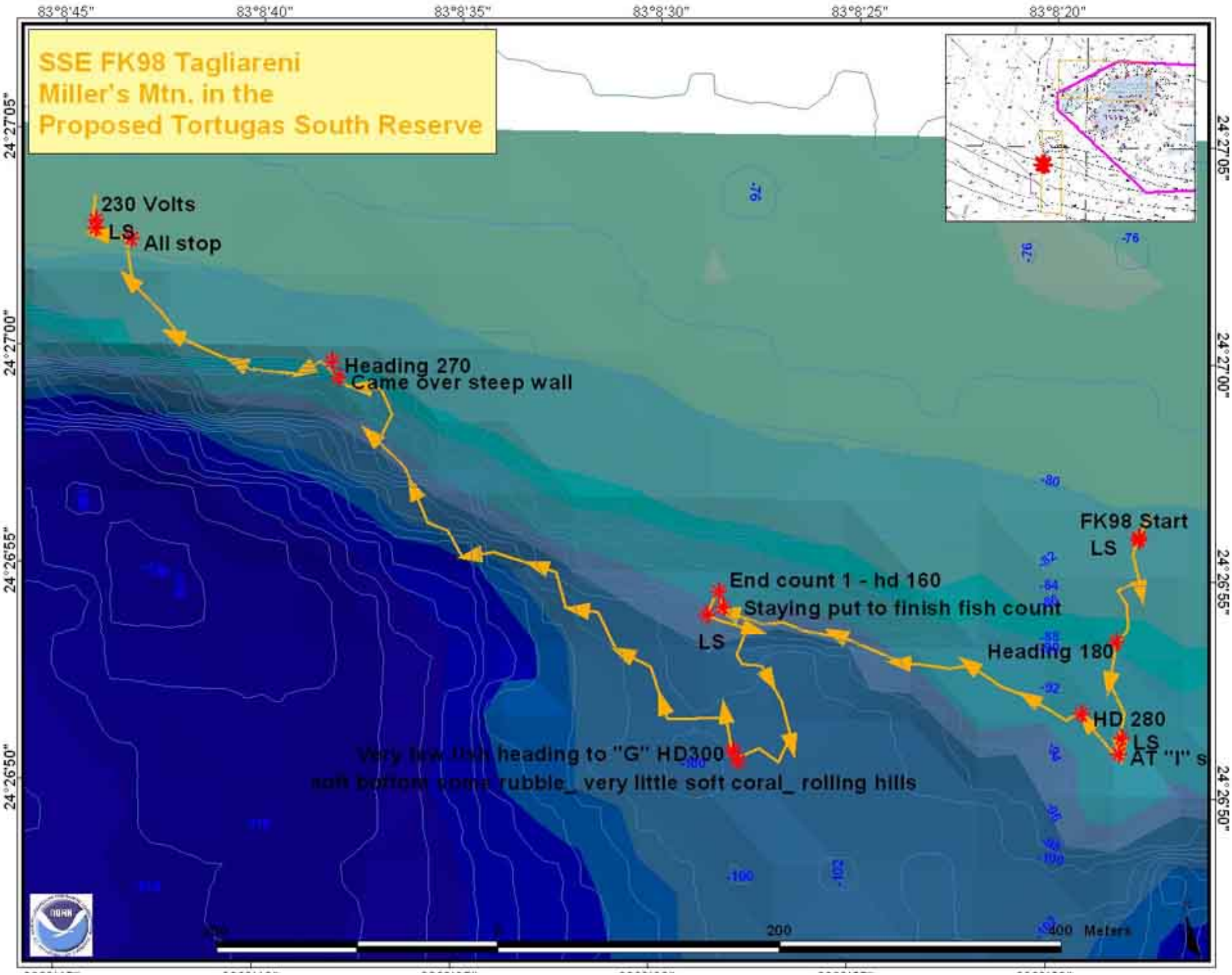

83°8'05"
83°8'00"
83°7'55"
83°7'50"
83°7'45"
83°7'40"
83°7'35"
83°7'30"
83°7'25"
83°7'20"
83°7'15"
83°7'10"
83°7'05"
83°7'00"


SSE FK95 Francis
Riley's Hump 9/12/00
-26
-28
-26
-26
sponges_ rubble bottom_ vis 30
LS
LS
FK95 Start
starting transect
heading 120
LS
end transect 1
No tracking fish boats
B
LS (late mark)
stop survey 2
C
D
LS
Heading 90
FK95 end
stop survey 3
start count 4
rubble, Some corals
F
Start travel from E to D
100
0
100
200 Meters
24°29'35"
24°29'30"
24°29'25"
24°29'20"
24°29'15"
24°29'10"
24°29'05"

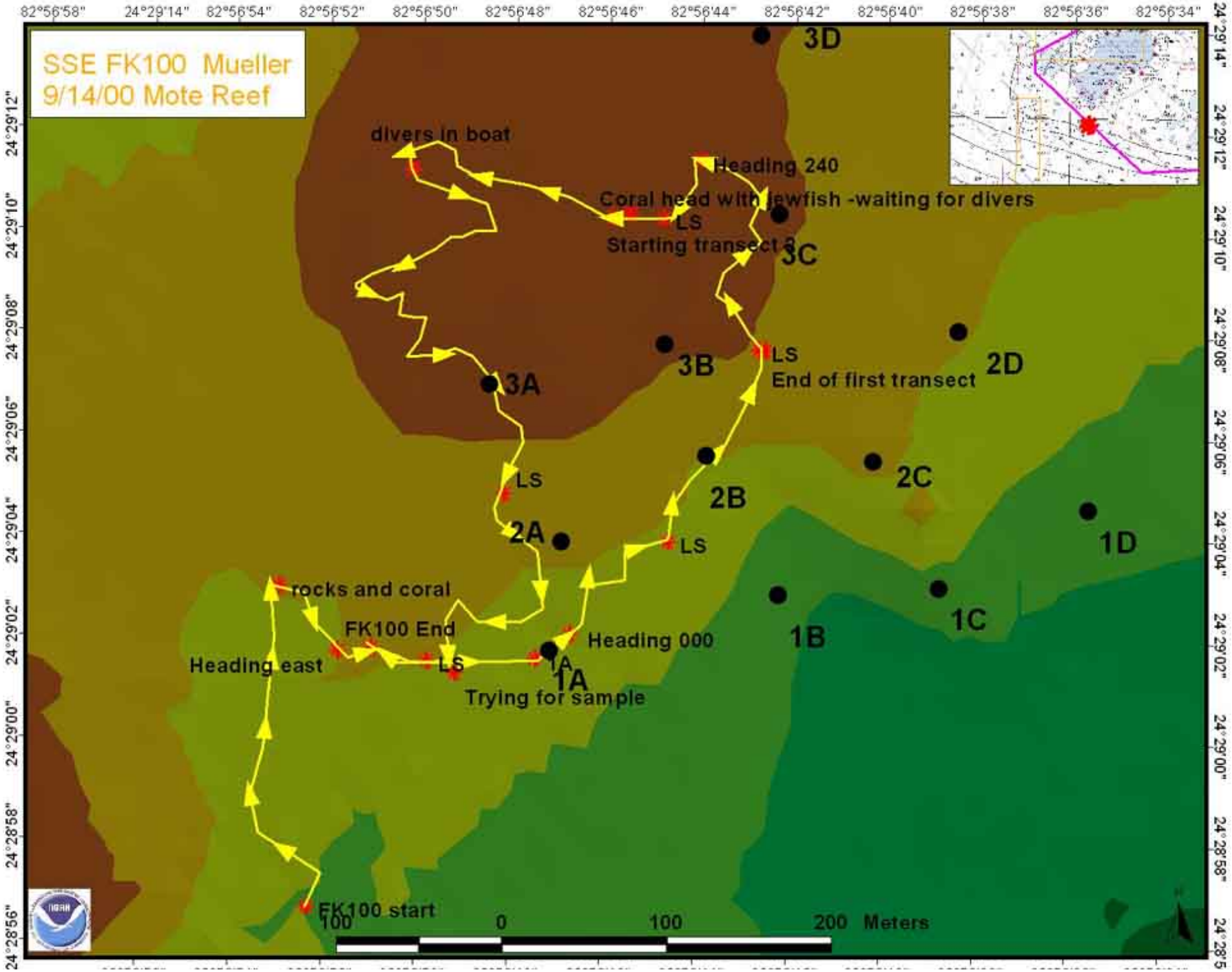

83°7'25"
83°7'20"
83°7'15"
83°7'10"
83°7'05"
83°7'00"
83°6'55"
83°6'50"
83°6'45"


SSE FK96 Mueller
9/12/00 Riley's Hump
LS
back on bottom
FK96 start
Heading 150
LS
Back on surface for floatation
some coral heads sandy bottom course 160
Proposed Drop
Note 1A will follow contour 225
1A
starting transect from 1A
LS
Taking a break - fish trap
1D
Heading 180
End FK96
LS
Reached 1B Heading 270
2D
End of transact
beginning 180 tranistion to 2C
LS
Heading 090 Ledge
2C
2A
At 2C
LS
Heading 350
AT 2B
Fish trap and some coral cover
Underway 360
all stop - shooting film
At 3C
350 Heading
LS
LS
All stop - playing with cameras
Heading 360
200
0
200
400 Meters


83°7'00"
83°6'55"
83°6'50"
83°6'45"
83°6'40"
83°6'35"
83°6'30"
83°6'25"
83°6'20"
83°6'15"
83°6'10"
83°6'05"
83°6'00"


SSE FK98 Tagliareni
Miller's Mtn. in the
Proposed Tortugas South Reserve
83°8'45"
83°8'40"
83°8'35"
83°8'30"
83°8'25"
83°8'20"
24°27'05"
24°27'00"
24°26'55"
24°26'50"
230 Volts
LS
All stop
Heading 270
Came over steep wall
FK98 Start
LS
End count 1 - hd 160
Staying put to finish fish count
LS
Heading 180
HD 280
LS
AT "I" s
Very low lying heading to "G" HD300
soft bottom coral rubble_ very little soft coral_ rolling hills
200
400 Meters

83°8'45" 83°8'40" 83°8'35" 83°8'30" 83°8'25" 83°8'20"


SSE FK100 Mueller
9/14/00 Mote Reef
82°56'58"
24°29'14"
82°56'54"
82°56'52"
82°56'50"
82°56'48"
82°56'46"
82°56'44"
82°56'42"
82°56'40"
82°56'38"
82°56'36"
82°56'34"
24°29'12"
24°29'10"
24°29'08"
24°29'06"
24°29'04"
24°29'02"
24°29'00"
24°28'58"
24°28'56"
3D
divers in boat
Heading 240
Coral head with jewfish -waiting for divers
LS
Starting transect 3
3C
3B
3A
LS
End of first transect
2D
2C
2B
LS
2A
LS
1D
rocks and coral
FK100 End
Heading 000
1B
1C
Heading east
LS
1A
1A
Trying for sample
FK100 start
100
0
100
200 Meters


82°56'56"
82°56'54"
82°56'52"
82°56'50"
82°56'48"
82°56'46"
82°56'44"
82°56'42"
82°56'40"
82°56'38"
82°56'36"
82°56'34"


SSE FK99 Evans
9/14/00 Ballast Pile
D
C
B
A
E
LS
Heading 190
Heading 270
LS
FK99 Start
ballast_center
Possible Ballast Debris
Continue filming
090 Heading
LS
Long Structure
Heading 270 200m
LS
Reef area sea fans
Heading NW
LS
Two lines on bottom with a 120 heading
FK99 End Mark
Depression
100
0
100
200 Meters

September 23, 2000 Summary Log

Mary Tagliareni, Education Coordinator
Florida Keys National Marine Sanctuary

The white-eyed goby posed for the camera during a deep dive in the Tortugas.

It's hard to believe that during the first two weeks of September -- the height of the Atlantic hurricane season -- day after day we had calm seas, beautiful sunrises, and glorious sunsets. One could not have asked for better weather for the Sustainable Seas Expeditions' mission to the Florida Keys. The perfect weather remained until September 16, when the outer squalls of Hurricane Debbie kicked up the wind and seas, and the skies became overcast, threatening rain. On September 17, Mother Nature won her battle with the NOAA ship *Gordon Gunter* at the Islamorada Hump, 20 miles off of the Upper Keys. The force of the waves caused damage to the port rudder, and the ship was forced to return to Key West for repairs, thus ending the 2000 field season of the Sustainable Seas Expeditions (SSE).

Prior to this quick and unexpected finale, the mission had gone well. The DeepWorker submersible pilots had completed 20 dives, some of which reached depths of 1,600 ft. The advantages of the DeepWorker were utilized in all of the dives, which were either deeper than scuba depths or for extended lengths of time.

These dives focused on the area of the proposed Dry Tortugas Ecological Reserve, which had been largely unexplored beyond scuba depths. The ability of the *Gunter* to perform low-resolution

Laura Francis, DeepWorker pilot and NOAA SSE Education Coordinator. (Photo: Mary Tagliareni/FKNMS)

bathymetric surveys enhanced the quality of the DeepWorker dives. The *Gunter* discovered features such as drop-offs, ledges, bottom cover, and fish congregations that the DeepWorker later explored in detail and documented on videotape.

While piloting the DeepWorker, Dr. Erich Mueller, of the Mote Marine Laboratory Center for Tropical Research, applied coral disease research techniques that he had developed while scuba diving.

This school of yellowmouth groupers in the Tortugas were tallied during the fish count. (Photo: Laura Francis/NOAA)

He conducted transects with two lasers at various depths to obtain quality video footage of the corals for further quantitative analysis. The health of these reefs in the Tortugas area is affected by water quality in the Gulf of Mexico. It is now known from extensive drifter studies that water travels from the Gulf of Mexico off the coast of southwest Florida to the reefs of the Florida Keys and the Tortugas. There is concern that nutrient-rich waters, produced during flood episodes on the Caloosahatchee River of southwest Florida and on the Mississippi River, will periodically threaten the coral reefs of the Florida Keys National Marine Sanctuary. These reefs normally thrive in an oligotrophic, or low-nutrient, environment. When nutrient-rich waters reach the coral reefs, the algae that normally grow on the corals can overgrow, because they thrive in nutrient-rich conditions. When this happens, the algae prevent essential sunlight from reaching the reef-building (hermatypic) coral colonies, and may eventually cause them to die.

Laddie Akins, Director of the Reef Environmental Education Foundation (REEF); Francesca M. Cava, Education Manager for the

Miller's Mountain

Sept. 14-16 National Geographic Alliance

Sept. 16 Open House

Sept. 2-14 Dive Maps

Sept. 23 Summary Log

Laddie Akins, DeepWorker pilot and REEF director. (Photo: Mary Tagliareni/FKNMS)

National Geographic Society's Sustainable Seas Expeditions; Laura Francis, NOAA SSE Education Coordinator; and I made up the "education dive team." Our task for five days of the mission was to pilot the submersible and survey fish populations in the deep-reef environment. A modified REEF roving-diver fish count technique was used to provide fish population data in the proposed Dry Tortugas Ecological Reserve. The data will be used in SSE-sponsored teacher workshops, and by students who will gain experience analyzing scientific data. Five fish-counting submersible dives were conducted along a ridge named Miller's Mountain at depths ranging from 200 to 400 ft. One fish count was conducted outside of the proposed reserve area. Prior to the SSE survey, no actual fish counts had been conducted in this area, even though resource managers were aware of its importance as a habitat and spawning ground for groupers. The abundance and variety of fish seen during the fish-counting dives confirmed the importance of setting this area aside as a "no-take zone."

The education and outreach components of the mission were very successful. In addition to our team that conducted fish counts, local high school students participated in fish-counting scuba dives, students from metropolitan areas discussed the state of the oceans with Dr. Sylvia Earle and Secretary of Commerce Norman Mineta, and more than 400 visitors toured the *Gunter* and the DeepWorker during the SSE Open House

in Key West.

The crew of the NOAA ship *Gordon Gunter* manned the controls during the launch and recovery of the DeepWorker. (Photo: Mary Tagliareni/FKNMS)

This year, Sustainable Seas Expeditions helped to further the goals of the Florida Keys National Marine Sanctuary, especially with the site characterization of the Tortugas area. Many thanks to the SSE crew, the National Geographic Society, the Special Projects Office of NOAA's National Ocean Service, the crew of the *Gordon Gunter*, the sanctuary staff, and all of the people who worked so hard to make this year's mission a success.

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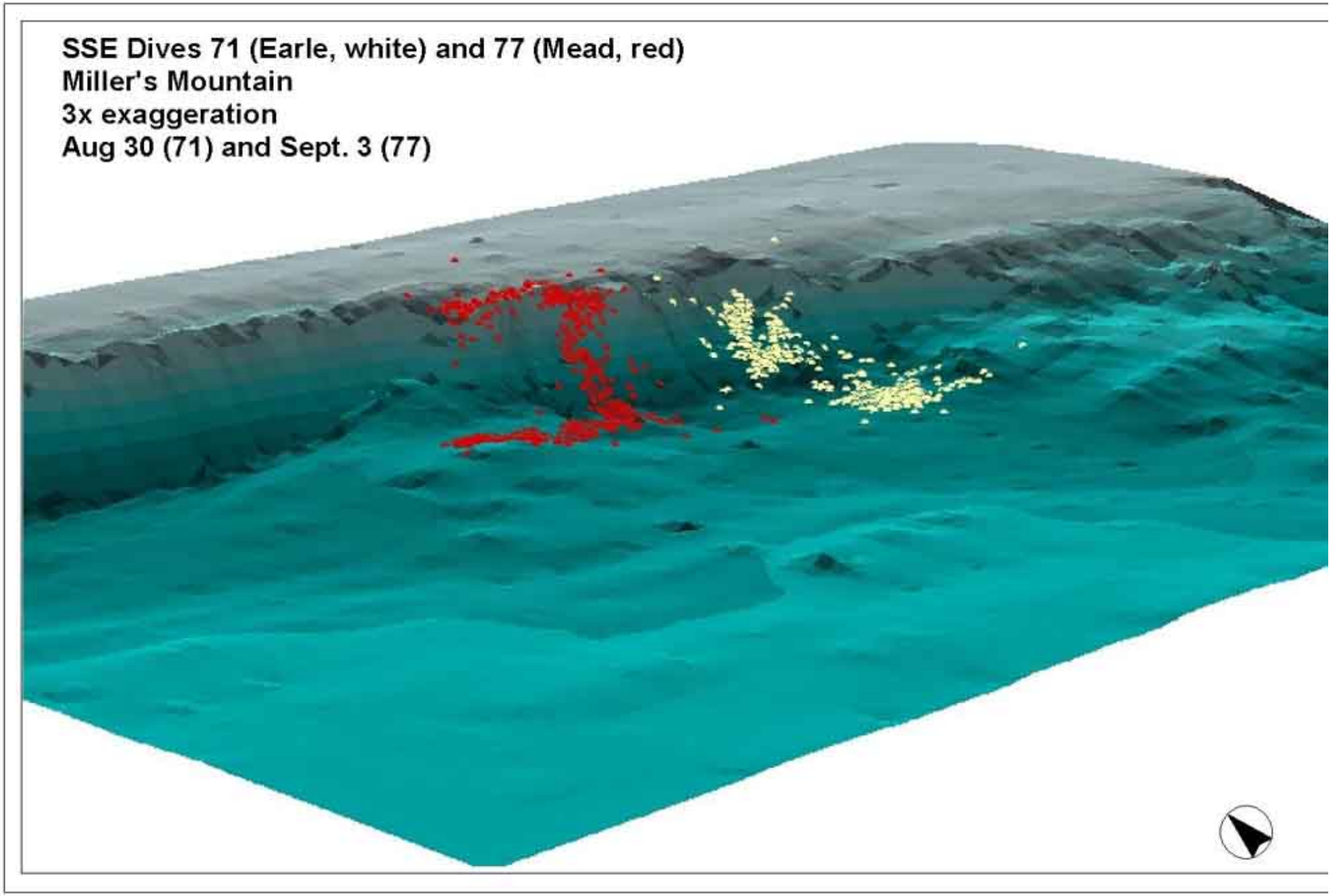
SSE Dives 71 (Earle, white) and 77 (Mead, red)
Miller's Mountain
3x exaggeration
Aug 30 (71) and Sept. 3 (77)

SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

September 26, 2000

2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific time)
NOAA's Florida Keys National Marine Sanctuary: Coral Reef Health and Diseases

Introduction

Join us on September 26 as we will take you to NOAA's Florida Keys National Marine Sanctuary. The program will take place in partnership with the **National Underwater Research Center** near the **Aquarius Underwater Laboratory** at Conch reef, about 4 miles from shore in the Florida Keys.

During the program we will explore coral reefs, a beautiful and mysterious underwater world. We will learn about many aspects of coral, their biology, some of the diseases effecting them, possible causes of the problems, what the Sanctuary is doing, and what you can do to help the health of the oceans.

So come meet some real-life "Reef Doctors," see how they repair and treat our amazing coral habitats!

You will be able to ask your questions live via an Internet chat room. To view the program you will be able to tune in via RealPlayer on the Internet or via direct satellite downlink using C-Band or Ku-band. **Visit the chat Web site**, or **enter the chat room**.

Preparation

As you prepare for the live event on September 26, we thought we could help by

providing some pointers to web sites that will help you learn more about where we are located, and hopefully help you to prepare some questions in advance.

First we challenge you to some questions! We hope that as you explore the suggested web sites for the answers, you will come up with some questions of you your own. You are invited to email your answers, leave your comments and questions in the chat room before the event, or ask them during the program.

Next we invite you to review some web sites that explore the marine life we might see during the broadcast.

Activity One

Challenge Question 1: Scientists have documented an increase in the number of coral diseases, the frequency with which they occur, and the number of coral species the diseases affect in the Florida Keys over the past several years. What are two possible, but different, explanations for why the number of diseases has increased so quickly in such a short time frame?

Challenge Question 2: One disease that affects sea fans, or soft corals, is caused by a fungus. Scientists have been able to identify this fungus as the same species as (or a very close relative to) a fungus that is found on land. Why is this discovery significant, in your opinion? Given your knowledge of coral reef areas, suggest three different hypotheses that would explain how this fungus of terrestrial origin might have come to affect marine organisms such as corals.

Challenge Question 3: One question that coral reef researchers struggle with is whether corals succumb to disease once a certain level of the pathogens that cause disease are present, or whether these pathogens/organisms are present all the time. In coral reef environments and the corals only become diseased when they are stressed by other environmental or human-caused impacts (such as increased sea temperatures, increased radiation, physical damage, etc.). Provide one argument for and one argument against each of these hypotheses, based on your understanding of humans and how we contract diseases and infections.

Look through the following web pages for the answers:

International Society for Reef Studies

The Coral Disease Page

The Journal of the International Society for Reef Studies

Florida Marine Research Institute: Coral Reef Research

Environmental Protection Agency: Coral Reef Protection

Environmental Protection Agency: Contiguous Zone of the United States

If you would like to get started early, we invite you to **email in your responses** to the challenge questions. You can also **leave them in the chat room**.

Activity Two

You may also want to explore these web sites in order to get a preview of the marine life we might see during the broadcast in the Florida Keys National Marine Sanctuary (FKNMS):

Florida Keys National Marine Sanctuary, Sanctuary Resources

REEF Fish ID and quizzes

Florida Keys Photo Gallery

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About the Video Broadcast

All broadcasts require the use of RealPlayer. If you do not have RealPlayer installed, please visit the **Advanced Features** section of this Web site to find out how to obtain it.

Internet Viewers: The view the archived event and view text from the chat room, **visit the chat Web site**, or **enter the chat room**.

For those of you with a satellite the corrdinates were:
Ku-band, Telstar5, Transponder 25
C-band, Telstar 5, Transponder 16
Event time: 2:00 pm - 3:00 pm Eastern time
Test time: 1:45 pm - 2:00 pm Easter time

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Web Chat Transcript

Claire - SSE Chat Host - Hello everyone! Should be an exciting live broadcast tomorrow as we discuss the Sustainable Seas Expeditions (SSE) and focus on coral reef health and diseases. Your questions will be answered by Laura Francis, SSE Education Coordinator, Mary Tagliareni, Education Coordinator for the Florida Keys National Marine Sanctuary and two coral reef experts, Laurie Maclaughlin and John Halas. We look forward to hearing from all of you and will do our best to make sure that all of your insightful questions get answered.

Laura - SSE Education - Welcome Everyone. In addition to John Halas and Lauri Maclaughlin, we are also very fortunate to have Joanne Delaney, Research Interpretor from the Key Largo Sanctuary office, join us on the chat!

Mary - FKNMS Education - I would like to extend a special welcome to a few groups joining us today. Mrs. O'Harra's class from Anchorage, Alaska; Mrs. Meraz's class in Texas; the Special Projects Team in Silver Spring, Maryland; and Mr. Diersing's 4-H club in Key Largo, Florida.

John - FKNMS Resource Manager - Hi, My name is John Halas and I am a Resource Manager for the Florida Keys National Marine Sanctuary working on resource management issues out of the upper region office in Key Largo

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Lauri - FKNMS Resource Manager - Hello, I'm Lauri MacLaughlin, a resource manager with the Florida Keys National Marine Sanctuary. My work involves field surveys of seagrass and coral communities that are injured due to vessel groundings, anchor damage, and of habitats that might be impacted by aquaculture, artificial reefs or scientific permitted projects. We also work to restore injured seagrass beds and coral colonies.

John - FKNMS Resource Manager - RE: Androsko/BishopVerotHS We will have our 29 student marine biology class online for your chat!!! The DeepWorker 2000 spent about 5 days off Naples coast- we found out it was here from a Ft Myers Newspress article the day the ship left for the Keys. We look forward to your chat! Welcome to you and your students! We are looking forward to an interesting chat session.

Lauri - FKNMS Resource Manager - Welcome to the Sustainable Seas Chat room. I will be here to answer questions that you may have relating to resource protection and management of coral reefs, seagrass beds and Florida's coral reef ecosystem.

Joanne - FKNMS Research Interpreter - Hello everyone. My name is Joanne Delaney, I work for the Florida Keys National Marine Sanctuary as a research interpreter. I hope to be able to assist with the chat today by answering your questions and explaining some of the exciting research that is happening in the Sanctuary related to corals and coral diseases.

Q1: Joanna - Did you survive the latest tropical weather systems? How long will it take to repair the Gunter's rudder?

A1: SSE Expert - Thankfully, we have survived the recent weather systems. It appears this hurricane season has not been as bad as originally predicted! The Gunter's rudder should be fixed within the next month.

Q2: Kelly and Catherine - Who funds your research?

A2: Joanne - Sanctuary research is funded in part from base funding allocated to the National Marine Sanctuary program, and also by some special funds given to agencies in South Florida that work on ecosystem restoration. Many researchers that come to the Sanctuary fund their own research through grants or university funding.

Q3: Micah - If the reefs in the Flordia Keys are so fragile, what can regular snorklers like me do to preserve them?

A3: John - Hi Micah, Good to see you all are on line from North Carolina and survived your little weather system. The main thing all snorklers can do is make sure you keep you body floating above the reef at all times. Many reefs are so shallow that you may harm both yourself and the coral if you don't do so . Thank You.

Q4: Ryan - Where are you in the florida keys?

A4: Joanne - The three offices of the Sanctuary are in Key Largo, Marathon, and Key West.

Q5: Dane - What's it like underwater? Is there a pressure difference? Is it cold?

A5: Lauri - Being underwater is like being on another planet! There are pressure effects on your body which you mostly feel in your ears and sinuses. Depending on where you are in Florida, the water temperatures are 84 degrees or so at present. It is refreshing and comfortable right now, but it will get cold this winter (70's) and we'll be whereing wetsuits then. Still this is really warm compared to most locations in the

United States. We're tropical...

Q6: Ryan - Do you feel that lobstering has a significant impact on the coral reefs that they live? What exactly do lobster bring to their environment?

A6: Joanne - Lobsters, like many marine invertebrates, play a critical role in the environment as part of the food chain. They eat detritus and other items, keeping the sea floor clean. Lobstering has some impacts because the lobster traps can damage coral reef areas and lobster trap line may entangle certain other organisms.

Q7: Bethany - When I was studying about sea life in my science class in my home school, we learned that often in very deep waters there were "weird" creatures down below. Have you seen any?

A7: John - Hi Bethany, Glad to hear you are learning such things in your home school. Yes that is very true. Since we don't get to see things down deep very often, compared to shallow water, they can appear very strange. The low light levels found at those depths are a major factor in adaptation and animal form. While participating on the SSE in the Tortugas we got to see on video footage that Sylvia Earle shot on a 1600 ft dive. See you later. Say Hi to Mom and Grandma. Thanks, U. John

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Q8: Kimberly - Could humans bring the fungus from the land to the ocean when they visit the coral reefs? is this type of fungus harmful to different kinds of species?

A8: Lauri - Some scientists propose or suspect that fungal spores are transported by way of our atmosphere and are being introduced into the oceans. Here in the Florida Keys, a scientist by the name of Dr. Drew Harvell has identified a fungus responsible for a disease affecting sea fans. She is at Cornell University, and I'm not sure I will spell this right but the disease is call "Aspergillosus." You might check the coral disease website by Esther Peters and McCarthy.

Q9: Julia and Ashley - What are the main causes of coral disease?

A9: Joanne - Coral diseases are caused by a variety of factors, including bacteria and fungi. Not all causes of diseases have been identified. Many corals are also affected by coral bleaching, which is not exactly a disease but a stress response that appears to be due to high temperature water, among other things.

Q10: Julia and Ashley - Where is your next destination after the Keys?

A10: Claire - The Florida Keys National Marine Sanctuary Sustainable Seas Expeditions (SSE) mission was the last for the second field season of SSE. The SSE

cruise planning team is working on next year's expeditions with the DeepWorker 2000 submersible, keep posted on the SSE Web site for more information on next year's mission. http://sustainableseas.noaa.gov

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Q11: Chelsea - What effect has the sponging industry had on the survival of coral reefs?

A11: Joanne - It is unclear exactly what effect sponging has on the coral reef, but scientists know that there are connections between many organisms that live around and on sponges and those that live on the coral reef. Sponges play a role in providing habitat for many small organisms.

Q12: Matt and Jenn - In the picture gallery you have a picture of a spotted eagle ray (Aetobatus Narinari)..how big do they get it looks mighty big!

A12: Joanne - Spotted eagle rays can get quite large. I'm not sure exactly, but I've seen ones as large as several feet across ("wing span")!

Q13: Matt and Jenn - BVHS Are there Flat worms located down in the keys?

A13: Joanne - There are flat worms in the marine environment of the Keys. There are also some other beautiful invertebrates, such as nudibranchs, which look like delicate and flowery worms.

Q14: Matt and Jenn - What is the most unique fish you have seen?

A14: John - Flashlight Fish are kind of unique in that they have adapted to the low light levels of deep water by developing a flashing luminescent patch beneath each eye, we think to both communicate with one another and find their way around. Sylvia Earle saw them at 1600 feet and interestingly I have seen them as shallow as 30 ft. on a dark night in the Philippines. A very wide range for a single fish.

Q15: Kimberly - There was an article in the newsletter of the Florida Marrine Education Association that gives the procedure for replacing corals that have been broken off from their main branches. do you recommend that we do this? what is the chance that we will introduce some fungus/disease when the pieces are restored?

A15: Joanne - Coral transplantation is a pretty tricky matter given the fragility of some branching corals. If you live somewhere where corals have broken, perhaps you could contact a local reef expert to see if they have experience in transplanting methods.

Q16: Williams - What is the relative age of the coral found in the keys?

A16: Lauri - Coral bank reefs in the Florida Reef tract started developing 7-10,000 years ago, which means that the shallow reefs we dive and snorkel took approximately that long to develop. Individual coral colonies, say 8-10 feet in diameter can be hundreds of years old, say 500-700 years. Different species of corals grow at different rates, for instance star corals may grow 1 cm per year whereas branching corals such as elkhorn or staghorn may grow 5-10 cm per year. Your averge basketball sized boulder coral may be perhaps 50 years old. Hope this answers many of your questions.

Q17: Julia - I was in the bahamas a little while ago... I heard about artificial reefs being created with plastic cubes. Is this project pending? What is the success rate of such reefs? Is this occurring any where else?

A17: Joanne - There are many artificial reef projects in the Florida Keys, Florida east coast, and elsewhere in the Caribbean. The placement of artificial reefs is controversial to some, as it is not quite clear what benefits they provide. Ultimately, our priorities should lie in protecting and preserving natural reefs!

Q18: Ms. Bridget's class - Since we live here in the Florida Keys, what should we look for on the reefs to tell if it is dead or alive?

A18: Joanne - A healthy reef will have lots of fish, invertebrates, and hard and soft corals present. Look for a diversity of organisms and coral that has nice, uniform polyps. Lots of algae may indicate signs of imbalance, but may also be a temporary phenomenon caused by nutrient-rich upwelling events.

Q19: William - What is the relative age of the coral found in the keys?

A19: John - The Upper Keys Islands are formed from ancient coral formed during the Pliestocene age approximately 100,000 yrs. ago. The living large coral heads that can be found today can be 300 to 400 years old and attaining a height of 2 to 3 meters growing at a rate of approx. 1 cm. per yr.

Q20: Team Tallywaker - What kind of corals are down there?

A20: Joanne - There are over 35 species of hard corals and 50 species of soft corals in the Florida Keys. Some frequenty seen corals are sea fans, star corals, brain corals, and branching corals such as elkhorn and staghorn coral.

Q21: Team Sea - Have you ever been effected by fire coral?

A21: Joanne - Fire coral has gotten me before when I accidentally brushed up against it! It's sort of like a mild bee sting, but thankfully the sting doesn't last very long. Just Mother Nature's way of saying "don't touch!"

Q22: Mellie - Two summers ago Jewfish were spotted off the bow of the Duane and in deep water (90 ft.) off the bow of the Benwood. This past summer, in checking both locations the fish were not there. Have you seen any evidence of Jewfish this summer? Thanks.

A22: John - Yes, Although you did not see them again at those locations they seem to be on the rise and efforts to better understand them are underway through a strong tagging effort in the Keys

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Q23: Julia - Will there be any research projects in the New England area? I will be in college there soon, and I am interested in an internship. Thanks.

A23: Joanne - Be sure to contact Stellwagen Bank National Marine Sanctuary in Massachusetts when you are in the New England area. Stellwagen Bank is an offshore underwater feature that supports a rich diversity of marine life, including many whale species.

Q24: Mekka - Is there a way to track the number of visitor on Looe Key per day? is there any plan to limit the number of dive/rec boats that visit each day?

A24: Lauri - When Looe Key was first designated as a marine sanctuary, our officers would conduct daily counts of visitor use. Off course holidays would be our busiest time with over 100 boats a day visiting the site. Now with the new Florida Keys National Marine Sanctuary, we don't have this luxury. Some visitor use studies have been done by aerial photography. The one tool that we can use to limit visitor use is the mooring buoy program. Although we don't do this at present, we may someday want to limit one boat to a buoy with no anchoring, even in the sand. This would be one way to establish a carrying capacity for a particular reef, such as Looe. We don't have any plans to do so at this time.

Q25: Kelly and Catherine - What made you go into this field of study?

A25: Joanne - I knew from a young age that I was interested in the marine environment. Every time I went to the beach, I found myself looking in the tide pools and searching underwater for neat critters. What I didn't know was what my career would eventually wind up being! My advice to anyone interested in coral reefs and

marine biology is to study hard and take advantage of neat opportunities such as volunteer programs, internships, and shadowing to get some practical experience in marine careers.

Q26: Mekka - Where do you think that the disease called White Band Disease came from and why?

A26: Lauri - We are not certain of the cause of white diseases at this time, but there is research that is being conducted for the past two years to look at the quality of water on Keys reefs and the penetration of light (UVa and UVb). Dr. Deborah Santavy of the EPA Gulf Ecology Division, Gulf Breeze Florida is leading up these efforts. There is research being done by Dr. Laurie Richardson at FL International University that indicates it may be caused by a bacteria, however what causes the infection by this or any other pathogen remains to be determined.

Q27: Bekah - If we build artifical reefs won't that take some of the pressures off the natural reefs? wouldn't humans fish/dive either type if the same species are present?

A27: John- There is an ongoing socio- economic study to determine diving activities on both natural and artificial reefs to help answer your good question. Certainly artificial reefs provide good alternate dive sites that can be equally as interesting as natural reefs. A question to be answered is if artificial reefs bring a greater number of divers that will also dive the natural reefs on a second dive thereby increasing the pressure on natural reefs rather than reducing it.

Q28: Mast Academy - Is someone currently studying the fungus, Aspergillus?

A28: Lauri - The research is being done by Dr. Drew Harvell at Cornell University, with Kiho Kim.

Q29: Kelly and Catherine - How did the pollution of the industrial revolution and the later shipping industry pollute the seas and affect the marine life?

A29: Joanne - The marine waters of our nation have been affected for generations by human activities, including shipping. Some of the greatest threats that shipping poses are pollution and damage to reefs by groundings. Since the industrial revolution, many other changes have occurred in our environment which have stressed natural environments.

Q30: Kimberly - Is there a relationship between changes in temperature and the increase of coral diseases?

A30: John - Yes, there appears to be a relationship between temperatures and coral diseases. Scientists have documented a higher incidence of coral disease during the very hot summer months in the Florida Keys. If the threshold of approximately 87.5 degrees F. water temperature is reached and maintained over several weeks of calm weather we also begin experiencing coral bleaching whereby the commensial zooxanthellae algae are expelled from the coral polyps leaving the coral weakened and more susceptible to disease. However, temperature is not the only cause of coral diseases and studies are on-going.

Q31: Bekah - What kind of impact does silting have on the reefs? is most of the silt a result of filling in wetlands for building?

A31: Joanne - Siltation can be a serious problem for coral reef ecosystems. Siltation is caused, as you suggested, by dredging and filling activities in nearshore areas. It can also result from terrestrial runoff in areas that have been deforested for farming or development. Silt affects the coral reef by smothering coral polyps and obstructing sunlight from reaching the coral's symbiotic algae.

Q32: Bekah - Are these diseases just a cyclic occurance? could it be just a "phase" they are going through?

A32: Lauri - Are the disease cyclic? Well, I've been working in the keys for 17 years, and for 14 of those I have seen coral diseases. Other scientists have described the these same diseases and observed them since the 1970's. The increase in incidence of disease is certainly something new within the past 4-5 years, and if we can correlate it to global warming affects - perhaps this is the canary in the coal mine. Whether this is a normal, geologic time flux is still the big question to be answered. There does seem to be a seasonality of diseases here in the Lower Keys as we see them disappear in the summer time, so that's possibly the only phase I can explain.

Q33: Ms. Bridget's class - We have heard that in Looe Key, there was a black paste put on and around the black ring coral. Did this help with the disease? What was the disease? What was the paste made from?

A33: John - This disease is appropriately called "Black Band Disease" and can occur upon several species of head corals (usually during the warm summer months). Harold Hudson/FKNMS biologist developed an underwater aspirator to remove the black band (cyano bacteria algae infection) and infected coral tissue. The paste you see is actually modeling clay (a grey-green color) that is placed down after the band is removed to help heal and protect the diseased area from further infection. If successful, which is most of the time, the infection is arrested and no further deterioration of the coral will occur.

Q34: Ryan, Alyson, and Team Tuna - Could a giant squid ever attack a sub? I have heard that they do exist. Why do sharks attack people? some one told it is b/c they look like seals? What is ur opinion?

A34: Joanne - I suppose a giant squid could attack a submarine, but I suspect it would not try! Most ocean animals are pretty wary of human beings. Sharks do occasionally attack people, and the best reason I have heard is that they do mistake us for seals. But did you know that the chances of getting attacked by a shark are less than the chances of getting hit by lightning? In other words, sharks are just one of many fascinating components of the marine environment, and don't purposefully harm humans.

Q35: Kimberly - We have a coral reef about 100 miles offshore; with it being so far away, do our actions on shore still affect the life of the coral?

A35: Lauri - Here in the Florida Keys, due to cirulation patterns of the oceans in the Gulf of Mexico, we are "downstream" of the Mississippi river, and do on occassion see obvious affects of the out flow of that river. Several years ago (1996?), when the Mississippi floods occurred, we had brown water with weird (not local)critters floating through the Florida Keys. This water affected our area for about a week, perhaps two. I cannot say what the direct affects on the reef have been, but this is about the same time that we had begun seeing an increase in the incidence of coral diseases Keyswide. So, yes - even events or inputs into the oceans from hundreds of miles away can have some effect downstream and offshore.

Q36: Kimberly - Can coral grow in controlled environments so that we may restore lost reefs?

A36: Joanne - Many scientists, including Dr. Erich Mueller who participated in the live video broadcast, have had success rearing corals in captivity and transplanting them back to damaged reef areas. Some public aquariums have also had success in this venture. Elsewhere in the world, some folks are trying to raise coral for this reason. I am not aware of any large scale coral "farming" in the US at this time, however, due to the relative difficulty of this task and the space and expense involved to raise one colony. Perhaps we'll see innovations in this field in the future!

Q37: Ryan, Alyson, and Team Tuna - On you way back up the coast of the Gulf of Mexico, will you be visiting the Naples/Fort Myers coastal region? It would be fascinating to see you expedition in progress. Maybe we could take a field trip to watch and learn:)

A37: Claire - The Sustainable Seas Expeditions (SSE) are complete for this year. Browse the SSE Web site for an archive of mission logs and fancinating images from this year's expeditions with the NOAA ship Gordon Gunter in the Florida Keys and Florida Middle Grounds. Hopefully we will see you next year!

Q38: Bekah - How has the health of the reefs been improved since there has been regulations about the taking of "live" rock?

A38: Joanne - Yours in a great question! The prohibition on live rock harvest has most definitely benefitted reef health. The "live rock" not only provides habitats for all sorts of marine invertebrates, plants, and fish, but also serves as an attachment place for newly settled corals (coral "recruits"). Suitable habitat is a key component of any healthy ecosystem, whether it be terrestrial, aquatic, or marine.

Q39: Ryan, Alyson, and Team Tuna - How many people are working with you on the expedition? What does a normal day consist of?

A39: John - There are many people working with the Sustainable Seas Expedition at sea. These can be grouped into the officers and crew of the NOAA vessel Gunter to sustain 24-hour operations for extended days at sea, the submarine technical crew responsible for safe operations of the two onboard one-person submarines, scientists and scientist-pilots conducting research, other technical support people. Altogether this could number to as many as 50 people at any one time. A regular day begins at 6:30 am with breakfast. At 7 submarine preparations begin for the morning dive. If things go well, the sub could be in the water as early as 8:30 - 9 am. The length of a dive averages 3 to 4 hours. Then post-dive operations and preparation for the second dive begin after surfacing from the first morning dive. Depending on the site for the afternoon dive, the second sub dive may begin around 2 to 3 pm. for another 3 or 4 hour dive. Sometimes, two subs may be deployed depending on the mission or either by design or unforeseen delays, the afternoon dive may easily terminate as a night dive and recovery. The swimmer (which I participated as from time to time in the Dry Tortugas) must attach the sub for pickup at whatever time the dive ends. More than once, this has been as late as 10pm.

Q40: Dana - I know they are all interrelated but what priority (%) do you think are the reason for coral disease. Pollution, warm water, alge, etc.

A40: Lauri - The obvious answer is temperature being the most visible cause, as summer seems to be our peak time of the year. However, we do not know enough about the water pollution input and radiation (Ultraviolet light) inputs to answer your question. It would be very difficult to place percetages on these causes. A blue green alga is responsible to for black band disease but what factor contributes to it's presence and, which corals are infected while others are not, are not well understood.

Q41: Bekah - Do the corals spawn in the same manner as the corals in Flower Gardens...all at the same time, at a specific time..

A41: John - Not quite! More species have been documented to spawn simultaneously in the Flower Gardens NMS as opposed to here in the FKNMS. Perhaps as many as four species at the same time. However, interestingly, the timing for spawning in these two locations occurs (when adjusted for time zone changes) at the very same time (usually during a three to four day period about 8 days after the full moon in August for the "head" corals.) In the Florida Keys, we have also documented spawning of the branching (Elkhorn and Staghorn corals) which do not occur in the Flower Gardens approximately a week before the head corals.

Q42: Kelly and Catherine - Where is the most interesting location that you have researched marine life?

A42: Lauri - In the FL Keys, probably the "Sherwood Forrest" located at the West end of the FL Keys Sanctuary and north of the Tortugas Banks.

Q43: Brady - What factors would be needed before we begin to limit access to areas such as Looe Key? It seems that there are some limits to land based parks such as the Grand Canyon. Limited permits are available for camping, riding a mule in etc.

A43: Joanne - Generally, national marine sanctuaries work to preserve special habitats and species while still allowing "compatible use" of the marine resources of the area. Recall that the marine sanctuary program is administered under NOAA, which is part of the US Dept. of Commerce. Our legislation specifically instructs that marine sanctuaries not limit use just for the sake of doing so. However, your point is an excellent one in that many areas, marine areas included, suffer from overuse such that "carrying capacity" limits should be considered. Any changes to visitor use of the FKNMS would have to be considered as other regulatory changes would, through the management plan review process every 5 years (we're due for ours in 2002). Please continue to stay involved in your local marine community by making such suggestions to local officials. Together we can ensure the protection of important marine ecosystems.

Q44: Dane, and TeamTuna - Is it illegal to collect sea turtles from a near by beach?

A44: John - Yes! All species of turtles are protected no matter where they are and none should be collected or handled. If an injured turtle is found, the Marine Patrol should be contacted and they will respond so the turtle can be safely removed to a place where it can be cared for.

Q45: Kimberly - Is there a relationship between changes in temperature and the increase of coral diseases?

A45: Joanne - It seems that here in the Lower Region of the Florida Keys National

Marine Sanctuary, it appears that there is a coral disease "season" and this generally is the summer during our warmest water temperatures (80-90 degrees). Outbreaks of blackband disease seem to be most productive and prominent during this season. It may be a combination of factors including warm water temperatures, clear water that allows high penetration of Ultra-violet light, and doldrum sea conditions that does not provide for good mixing of the water column. We also suspect that low dissolved oxygen levels during these doldrum conditions may also be a contributor. There is much we still need to study and discover....

Q46: Dana - What is the best advice for the students in perserving the coral reefs. what can they do?

A46: Joanne - Students can do many things to preserve coral reefs. Mostly, any thing you can do around your home, no matter where you live, to protect the environment will eventually help the coral reef. Reducing pesticide use and chemical fertilizers in yards prevents contaminated runoff from reaching sewers and streams (which eventually reach the ocean). Recycling reduces waste in landfills and trash overall. If you are on the ocean or a lake, you can pick up trash you see floating and bring it ashore for proper disposal. Encourage your friends and family to fish responsibly by obeying size limits, not taking more fish than they plan on eating that day, or by practicing "C" (catch and release) fishing. When you visit beaches and other nearshore areas, be sensitive to the multitudes of plants, insects, invertebrates, and other animals that live there. All organisms are part of complex, interconnected systems that we oftentimes know little about. Remember to take only pictures and leave only footprints (or bubbles!), and this will go a long way toward protecting coral reefs and marine species everywhere.

Q47: Kimberly - We have a coral reef about 100 miles offshore, with it being so far away do our actions on shore still affect the life of the coral?

A47: John - Yes, although the 100 mile distance from shore and water depth (60 ft. and greater) creates a more stable environment for Flower Garden corals and thus there tends to be less coral disease in the Flower Gardens than in the Florida Keys.People's activities on shore can affect water quality (and, thus, the corals on the Flower Gardens) since, for example, water quality studies in the Keys have documented the presence of Mississippi River water which may have carried over the Flower Gardens as well. Run-off, nutrients, sediments, chemicals and other man-produced contaminants would or could affect reefs in both locations.

Q48: Dane, and Team Tuna - I have sea horses. How do i take care of them?

A48: Joanne - Well, I'm afraid I don't have much practical advice to offer on caring for seahorses in captivity. Perhaps your best resource would be a local aquarium or pet shop? There may be information on line as well, if you do an internet search for "seahorse". Seahorses are interesting fish that are unique in their reproductive

strategy. See if you can find out which seahorse, the male or female, cares for the seahorse eggs and how.

Q48: Christina - I need some info on species and the habitats they are found in as well as if they are endangered\protected\no designation.

A48: Joanne - A great place to get some information on species and habitats in the Florida Keys is our Sanctuary website, which can be found at www.fknms.nos.noaa.gov

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Q49: Kelly and Catherine - Is there anything we can do on land that can prevent the spread of coral disease?

A49: John - Possibly. Excess nutrients in the coral reef environment can cause algal blooms, macro-algae overgrowth, and stress in the corals which can lead to a weakened state and allow them to be more susceptible to disease. Preventing the run-off from storm water, effluents, and nutrients from agricultural activities would help. Also, people on land can help educate others about the importance of coral reefs and caution reef-goers about proper activities to protect reefs like not touching living organisms and anchoring boats properly.

Q50: Ryan - Hello, I was just wondering on what the rate of mitotic replication was on growing coral.

A50: Joanne - What an interesting question! I'm not sure I can quantify the rate of mitotic division in corals. You may be able to find some information from a coral expert such as Dr. Erich Mueller or Dr. Steven Miller, who participated in the live video broadcast. There are several researchers studying coral physiology and reproduction in Florida through the University of Miami and Univ. of North Carolina at Wilmington. Perhaps each of these University websites has information specific to their coral research programs. Another option to find the answer to this question is to do an internet or library literature search on the topic of coral reproduction and cell division. Good luck!

Q51: Mike - Do you know of any locations around the Ft. Myers area that would a good place to study and collect sea specimins?

A51: Joanne - Perhaps a good place to start would be local aquariums, parks or county programs with a marine component. Depending on the types of organisms you are looking for, someone with local knowledge of the area should be able to advise you on where to go. Be sure that you check collecting rules with the agencies in your local region and with the State of Florida Fish and Wildlife Conservation Commission. Many invertebrates are regulated species.

Q52: Dane, and TeamTuna - I have sea horses. How do I take care of them?

A52: John - Hi Dane - Good for you to take on the responsibility of your sea horses. I have kept many species of fish in aquariums but never sea horses but I do know that you will have to provide the proper habitat as sea horses are fond of using their tails to hold themselves in place. They will need to be fed with either natural or artificial food - often artemia (live brine shrimp) may a good meal. As with all aquarium organisms, water quality should always be kept to a high standard through normal filtering practices. Salinity and temperature should be checked regularly. In the Florida Keys, we don't find sea horses out on the reef but they are often seen near shore on the Gulf side in Florida Bay. Good luck!

Q53: Mike - Do you know of any locations around the Ft. Myers area that would a good place to study and collect sea specimins?

A53: John - I am not that familiar with the area around Ft. Myers but you can examine all kinds of marine life just along the waters edge of your beautiful beaches and inland waterways. Some areas and species are protected so be sure to check any regulations that may be in effect before you collect specimens. North of you, in Sarasota, you may enjoy visiting Mote Marine Lab where you can learn more about the marine life on the west coast of Florida. Also, the University of South Florida in Tampa/St. Petersburg is a good source of information and may have a satellite location in or near Ft. Myers.

Q54: Dane, and Team Tuna - Is it sufficient to maitain an aquarium containing several "sea squirts"?

A54: Joanne - Sea squirts, or tunicates, should be fairly easy to maintain in an aquarium. Be sure to feed them artemia (brine shrimp) or other small plankton regularly. If your aquarium uses fresh seawater (not recirculated or artificial seawater such as "Instant Ocean") then the tunicates might be able to fend for themselves without addition of artemia.

Q55: Kimberly - When does the FKNMS do their next management plan update?

A55: Joanne - The next (and first) management plan update for the Florida Keys NMS will be in the year 2002.

Q56: Chelsea - Is it possible to seed the water with zooanthellae in order to stimulate the growth of the coral?

A56: Joanne - Yours is a very thought-provoking question. Zooxanthellae, the symbiotic algae that live within individual coral polyps, aren't exactly what cause coral recruits (new corals) to settle. The coral animals pretty much do that on their own if they find the proper substrate. A few researchers are looking into what it might take to enhance coral settlement, and have created a sort of coral "fly paper" that is supposed to encourage corals to settle on it. Other researchers are trying similar experiments to see if they can increase the rate at which corals settle by altering water chemistry with electric currents. This is a very innovative field of coral science, and I encourage you to search for more answers through the internet and library research.

Q57: Williams - Does the presence of coralline algea Halimeda damage the coral in the keys?

A57: Joanne - The algae Halimeda is one of many important reef species that plays a role in a balanced, healthy coral reef ecosystem. Halimeda actually contributes a significant amount of substrate to reef areas because it is one of only a few algae that calcify, like corals. Some areas are overgrown by Halimeda if coral colonies die, but the Halimeda itself is only being opportunistic, taking advantage of new space to grow. Halimeda itself rarely, if ever, out competes coral animals for space on the reef.

Q58: Brady - Why do you think the diseases disappear in the summer? If global warming is contributing to the increase incidence of disease, this seems contradictory. I'm curious to what hypotheses you have . . .

A58: John - Maybe there is a misunderstanding since we usually see an increase in stresses on corals and reef organisms during or after the warmest weather of the year. So it looks like you are on the right track to question this.

Q59: Kimberly - Are there signs of black band disease and other coral diseases at the Flower Gardens in the Gulf of Mexico? We are concerned about how these diseases affect us in Texas.

A59: Joanne - I'm not sure about the status of coral diseases on the Flower Garden Banks. However, you are fortunate to have many coral reef experts in your backyard, at the Flower Garden Banks National Marine Sanctuary. Contact their headquarters in College Station, TX (or see them on the internet) to find out the latest in coral diseases and coral reef research in your area.

Q60: Bekah - How will the coral disease affect How will the coral disease affect the other animals in the ocean? Is there anything that we can do to prevent the spreading?

A60: Joanne - Coral diseases affect other organisms in the ocean by reducing the health of reef environments overall. The loss of coral tissue and healthy living coral colonies can result in decreased habitat and food for other species, and an imbalance in food webs. We can best prevent the spread of coral diseases by not handling or touching corals that are diseased, but more importantly, we can work to improve water quality, reduce pollution, and reduce overfishing. All of these other pressures cumulatively can affect the health of individual coral colonies, and therefore make them more susceptible to diseases in the long run.

Q61: Brady - Why do you think the diseases disappear in the summer? If global warming is contributing to the increase incidence of disease, this seems contradictory. I'm curious to what hypotheses you have . . .

A61: Joanne - Yours is an interesting observation. I am not aware of a decrease in coral diseases in the summer months, in fact, we generally see increases in disease incidence that time of year (see response #169 from resource manager Lauri MacLaughlin, also). Many scientists hypothesize that these increases in the warmer summer months are due to increased sea temperatures, which would be exacerbated by global warming. Some great coral disease literature and links can be found through the CHAMP website at www.coral.noaa.gov.

Q62: Joanna - Did you paint the aquarius yellow because it is the size of a school bus?

A62: Joanne - I'm not sure why the Aquarius is yellow! But, I suspect that it is like a school bus in more ways than one.... there are generally "students" inside (students of marine science), and it serves an important function in education. Check out the Aquarius website at www.uncwil.edu/nurc/aquarius for more neat Aquarius facts.

Q63: Joanna - Did you paint the aquarius yellow because it is the size of a school bus?

A63: John - Hi Joanna! This is an interesting question and you have made a good "connection"! I think that the Aquarius habitat is painted yellow for the same reason that a school bus is that color and that reason is visibility. Divers who are living underwater in the habitat need to be able to find their way back from their excursions and that bright yellow is much easier to see at a distance. Of course, divers have other means of reference to return to the habitat as well such as their compasses and travel lines which help guide aquanauts back from their distant research sites.

Q64: Joanna - How many tropical storms/hurricanes do you experience in one year?

A64: Joanne- It depends on the year, but most years we have several tropical

storms. Not all of these hit the Florida Keys, however, and some years more storms progress into hurricanes. Those of us that live in the Keys are very thankful for the accurate predictions and watchful eye of the National Weather Service's hurricane center in Miami, FL. See our FKNMS website's "links" page for more weather links: www.fknms.nos.noaa.gov

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Q65: Mekka - How did the fish counts go? is there a difference in the numbers/species from the counts done durnig last year's count?

A65: John - Right now I really don't have access to the fish count data, however, while I was participating on the SSE Tortugas leg of the expedition, several dives were made on the deeper portions of Riley's Hump (the proposed southern portion of the Tortugas 2000 no-take ecological zone). Dives in this area had not been conducted before and we found along a ridge, particularly at the 300 ft. depth, a great number of grouper, primarily yellow mouth grouper and scamp. Also, several schools of large amberjack were documented as well as a variety of deepwater tropical fish including the Bank Butterfly fish which is only found in deeper waters and never on the shallow coral reefs. Dr. Sylvia Earle, on her 1600 ft. dive, video-recorded a variety of deepwater fish (adapted to the dark environment) in addition to a very large isopod and other crustaceans including a deepwater golden crab which is being sought as a commercial sea food product. The inclusion of this deepwater habitat as an ecological no-take zone will help ensure the preservation of this unique environment.

Q66: Mike - What were your experiences with the numerous cold water seeps located in the gulf of Mexico, especially near the coast of Naples, Fl.

A66: John - Hi Mike - Currently no one here at this chat participated in this research so we don't currently have that information. However, your question will probably be forwarded to Dr. John Ogden of FIO/St. Petersburg or Walter Jaap/FMRI who were on the Middle Ground and West Florida Shelf portion of the expedition cruise. I am sure they will be able to provide some answers for you. Interestingly, we do have fresh water "seeps" in shallow waters offshore along the Florida Keys (probably artesian flow from deep aquifers under the seabed).

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SUSTAINABLE SEAS EXPEDITIONS

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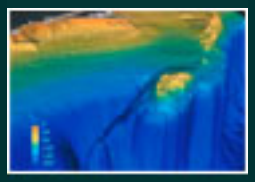

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EXPEDITION UPDATE

April 27 - May 8, 1999

Cordell Bank is a virtually unexplored submerged island off the California coast near San Francisco with an incredibly diverse, rich, and beautiful assortment of flora and fauna. But weather conditions in the waters off San Francisco make for frequently rough seas and hazardous diving, especially in springtime, and especially out here, at Cordell Bank.

Officially, the expedition moved to Cordell Bank from the Gulf of the Farallones on April 27. The Sanctuary brought on some other staff and researchers, and we started working on completing their checkout dives in the subs. An ROV (remotely operated vehicle) was added to our bag of tricks, and we've been making use of that as an additional research tool. Weather conditions, especially the gale force winds, continued to make our work more difficult, but we were determined to make the most of every chance to dive we got.

Ultimately, the weather won out. We got some more dives in on the subs, and ran some ROV ops, but primarily at Drakes Bay, not at the Bank. May 5 gave us the kind of diving conditions in Drakes Bay that we'd wanted all along. Relatively calm seas and very little wind enabled us to get seven pilots in the water that day. Unfortunately, the sea state at Cordell was still too rough to make diving there an option.

Cordell remains shrouded in mystery. We look forward to next year's opportunities to revisit Cordell Bank, and move on to the beginning of our Monterey Bay mission on May 8.

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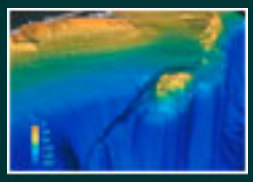

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Interview

Interview with Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary
On location at the sanctuary administrative offices in the Presidio of San Francisco
February 1999

What is the most important part of your job as Assistant Sanctuary Manager??

Click here for audio response. (RealAudio), for help see About this Site

Dan Howard

A very important part of my job is assisting people, so my title as Assistant Manager is pretty appropriate. I see the sanctuary as a clearinghouse of information, so when people in the community or other agencies aren't exactly sure where to turn, they often give us a call. In addition, because of current fiscal realities, a lot of our projects need to be cooperative in nature, and an important part of my work is getting along with people so that we can see these projects through. All of our field work is also a critical part of my job -- keeping in touch with sanctuary resources and uncovering new information that allows us to better understand what's going on. This, in turn, allows us to make more informed management decisions.

What are some examples of what is known and unknown about the resources of the Cordell Bank sanctuary ?

Click here for audio response.

One example relates to the annual migration of humpback and blue whales that arrive at the sanctuary each summer and fall to feed. We are well aware that the Cordell Bank area provides critical habitat for these whales to forage, and we also know that they come here to feed on the eupahusiid shrimp, or krill, which is their primary prey, and, in the case of the blue whale, their only prey. What we don't know is how many krill are out there, what their population densities are, and how these populations vary from one year to the next. We are in the process of gathering some of this information through our annual research cruises, but many questions still remain.

(top)

What are some of the major challenges for research in the sanctuary?

Click here for audio response.

One of the major challenges of working around Cordell Bank is just getting there. Because the Bank itself lies about 25 miles from the closest harbor, and sea conditions are typically rough, it can be a very difficult place to work. We're fortunate here to have access to the NOAA vessel McARTHUR, which is big enough for us to stay out at sea for extended periods of time, and also allows us to work in rough sea conditions. Also, the tops of the pinnacles out at Cordell Bank are about 120 feet (deep), but most of the bank is 150 to 180 feet deep, which is a little beyond scuba depths for any regular studies.

How do you think the Sustainable Seas Expeditions and the use of the DeepWorker 2000 will affect the sanctuary from a management perspective?

Click here for audio response.

Having the DeepWorker will put us in a much better position to manage our resources. With the DeepWorker, we will be able to collect basic information about some of the deep-water

communities in the sanctuary. Once we have established baseline conditions on some of these resources, we will have a benchmark for measuring change over time. From a management perspective, having this resource information allows us to operate from a much stronger position if we see changes in the future, if these changes are caused by human activities, and if we need to act.

(top)

What are your objectives for the Sustainable Seas Expeditions in the first year?

Click here for audio response.

Our primary objective at Cordell Bank National Marine Sanctuary this first year will be to explore and describe the habitats that make up Cordell Bank. We will be assessing algae cover, estimating abundance, and documenting the distribution of both benthic invertebrates and fish. We will be doing this using video and still photographs as we move along transect lines in different areas of the Bank. Another goal of this first year will be to bring back video and still images for our education and outreach programs. That will help us to convey the majesty and spectacular beauty of Cordell Bank to the public.

What are some of the obstacles in management that you hope the Sustainable Seas Expeditions will help overcome?

Click here for audio response.

Often times in management, we are required to make decisions without having all of the information. There is an incident or catastrophe where we have to act on a short-term basis. I think the Sustainable Seas Expeditions provides an incredible opportunity to collect information so that we can make more informed decisions. For example, we often hear of irresponsible fishing practices, like damaging the fragile reef habitat on Cordell Bank, but there is no way for us to check this out. The Sustainable Seas Expeditions will provide a tool that allows us to see firsthand if there is truly any cause for concern.

(top)

Dan Howard, Assistant Manager of Cordell Bank National Marine Sanctuary, prepares for the expedition.

Do you think there has been a shift in our perspective towards ocean management in the last 50 years?

Click here for audio response.

I think the major shift in ocean management over the last 50 years has been the realization that the oceans are finite or have limits, and instead of managing the oceans like a refuse disposal site, we are now starting to think of the ocean in terms of a wilderness area. Remnants of the old way of thinking are still all around us, though, as sewer districts and dredge disposal projects consider the ocean a convenient place to get rid of waste. Our biggest challenge is going to be changing old habits, in an economical way, to protect the marine environment for future generations.

In managing the Cordell Bank National Marine Sanctuary, what other agencies do you work with, and how will these groups benefit from the Sustainable Seas Expeditions?

Click here for audio response.

Since the sanctuary is a clearinghouse for information, we end up cooperating with most agencies that have anything to do with the coast. In our area, that includes local and state agencies like the county open space districts, the U.S. Marine Reserves, the State Department of Fish and Game, and the Coastal Commission; and many federal agencies like the National Park Service, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the U.S. Coast Guard. We also work closely with nonprofit organizations like the Gulf of the Farallones Marine Sanctuary Association. The Sustainable Seas Expedition will provide important and useable information for most of these groups dealing with coastal issues.

(top)

What do you personally hope to see beneath the waves when you are piloting the DeepWorker?

Click here for audio response.

The first thing that pops into my mind is a mermaid or a giant squid. Either of those would be pretty spectacular. But what I am really looking forward to seeing are the commonplace things -- what goes on down there, how this community functions. I'm hoping to see a healthy, thriving underwater community with patches of zooplankton drifting through schools of fish that are hovering over carpets of colorful invertebrates on the bank. For several years now, I have been sampling this environment from a boat with plankton nets and instruments trying to figure out what's going on. It's incredibly exciting to think that now I'm going to have the opportunity to go down there and observe this world firsthand. To me, it's like going to Yosemite and trying to experience the backcountry without ever getting out of your car, and then one day someone opens up the door and offers you a backpack. In the end, it is going to make us much better stewards of the sanctuary, having had the opportunity to see our resources firsthand and to truly appreciate what we have.

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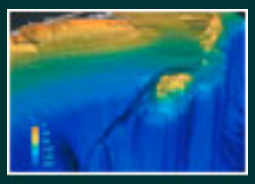

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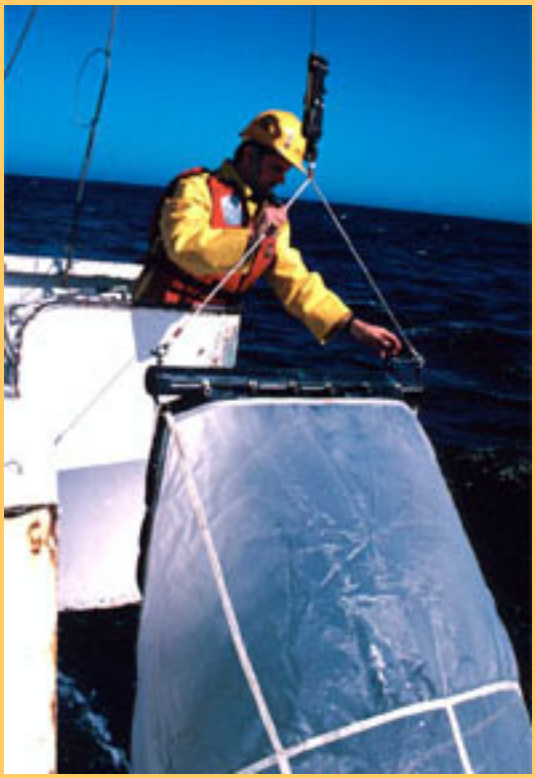
Natural Setting

The Natural History of Cordell Bank
by Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary

The first time someone mistook Cordell Bank for a financial institution, I missed my cue. I should have waxed on about margins, productivity, and the incredible wealth of resources protected at this Bank. I could have described the difficulty accountants are having calculating the true value of our assets. Estimating the total value of sport and commercial fisheries can be accomplished with difficulty. But how much is a lunging humpback worth, or the swarms of krill that attract the feeding whales and support vast populations of foraging sea birds, fishes, and marine invertebrates? How much is a bow riding Dall's porpoise worth, or clean water? I could have informed them about the diversity of our portfolio and how futures are protected by consistent productivity.

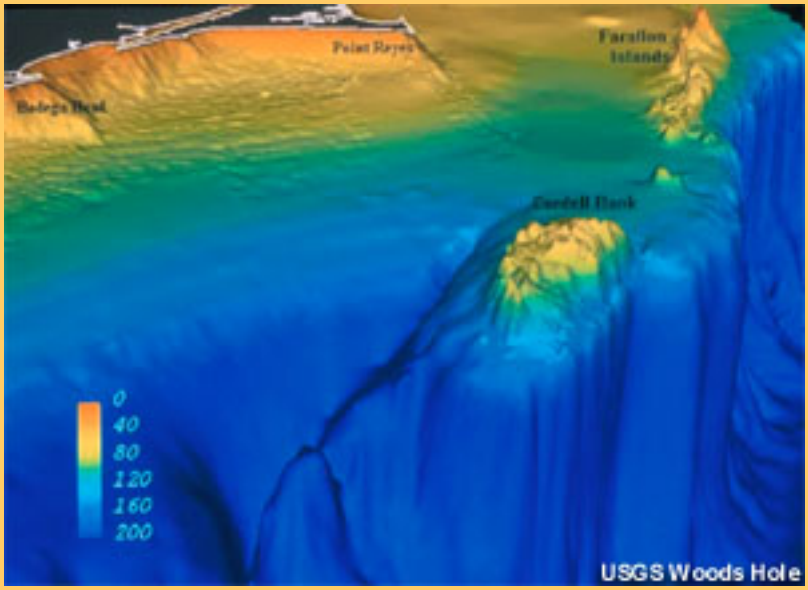


Dan Howard conducting research.

Cordell is a very special Bank. The walls and columns are solid granite and all of the finishing materials are natural. The highest point is located about 18 nautical miles west of the Point Reyes Lighthouse. Cordell Bank is a 9.5 by 4.5 mile bathymetric anomaly--a solid granite mountain rising abruptly from the soft sediments of the continental shelf. The Bank rises from the depths to within 120 feet of the ocean surface. Perched on the very edge of the

continental shelf, the bottom to the west drops precipitously. In about half the width of the Bank, the bottom drops from 150 feet to over 3000. This location, combined with undersea topography and prevailing oceanographic currents, makes the Cordell Bank area an extremely productive environment supporting a rich and diverse marine community that is protected as one of twelve Marine Sanctuaries in the National Marine Sanctuary Program.

(top)



Computer imagery shows the topography of Cordell Bank, the proximity of the Farallon Islands, and the steep drop-off of the continental shelf to the west of the Bank.

Many studies have documented increased productivity associated with seamounts and banks. The reasons for this are often explained by either transportation and concentration of resources from elsewhere, or local production and subsequent retention of these resources. Cordell Bank is blessed with all of these: 1) transport of resources from elsewhere, 2) local production and 3) preliminary data and field observations that suggest that there is some type of retention mechanism concentrating food over the Bank.

Transportation of Resources from Elsewhere. The west coast of the United States is one of five major upwelling regions in the world. Maximum upwelling values for the west coast system consistently occur to the north of Cordell Bank along the Sonoma and Mendocino coast. This seasonal process pulls nutrient rich water from the deep ocean into the sunlit surface layers near shore. As this happens each spring and summer, an explosion of life

occurs. The photosynthetic phytoplankton are the first to benefit from the influx of nutrients and the lengthening days of spring. This phytoplankton soup then stimulates growth of organisms at all levels of the marine food web. As populations of phytoplankton and zooplankton expand, they are transported south by one of the dominant oceanographic features in the eastern Pacific Ocean, the California Current (note a point of confusion: the eastern Pacific is the west coast of the United States). This meandering, north to south current washes over Cordell Bank bathing it with the products of upwelling emanating from miles and miles of upstream production.

As the California Current moves south teeming with life, it passes over Bodega Canyon approximately twelve miles north of Cordell Bank. The Canyon is a deep groove slicing into the continental shelf. Studies along the west coast have demonstrated increased productivity on the south sides or the down-current sides of submarine canyons. This results from an interaction between the animals' natural behaviors and the prevailing currents. For reasons including energetics, predator avoidance, feeding, or reproduction, many organisms in the ocean migrate from near bottom during the day into the upper portions of the water column at night. When organisms migrate out of the Canyon at night, they are transported south by the California Current. When they descend at the first hint of daylight, they are trapped on the continental shelf instead of returning to the depths of the Canyon. Many of these organisms become easy targets for predators waiting on the down current side of the Canyon. One animal demonstrating this type of behavior is the euphausiid shrimp (krill), a major prey for many fishes, sea birds, and marine mammals. The consistent replenishment of food resources, particularly krill, moving out of the Canyon each night contributes to the productivity associated with Cordell Bank.

(top)

Krill - primary prey for many species around Cordell Bank.

Local Production. Local upwelling and Bank topography are additional factors increasing production and prey availability. In addition to upwelling products from the north, local upwelling moves nutrients from the deep ocean directly into the Cordell Bank area. As this deep water moves onto the continental shelf, its nutrients can be passed on to phytoplankton residing in sunlit surface layers over Cordell Bank. Physical mechanisms that retain water over the Bank increase residence times and cause tremendous plankton. Energy from this increased primary productivity is eventually transferred into the higher trophic levels of the marine food web. In June, 1869, Edward Cordell finally relocated this elusive Bank by investigating large numbers of birds and mammals that were aggregating on the ocean's surface. Over one hundred years later, the abundance of food at Cordell Bank is still attracting large numbers of foraging seabirds, and marine mammals.

Bank topography makes prey more available to these birds and mammals by compressing the water column as it moves over the Bank. Organisms that spread out in water depths between 500 and 3000 feet deep in the open ocean are suddenly compressed into a water column that is 150 feet deep as it passes over Cordell Bank. Concentrating prey and moving them up in the water column increases their availability to seabirds, marine mammals and resident fishes. This compression of the water column also can set up circulation patterns or eddies that further concentrate and retain prey.

(top)

Upwelling of nutrients and the abundance of food in the waters around Cordell Bank draw legions of foraging seabirds.

Retention. Where seamounts act as obstacles to current flow, the resulting difference in flow velocities can set up eddies or retention zones. The size and strength of these eddies depends on current velocities, temperature stratification in the water column, and topography. Data on currents around Cordell Bank from five oceanographic cruises indicate some level of retention over the Bank. At times, currents on the western edge of the Bank are moving to the south while currents near the southeastern portion of the Bank are moving north. This counter-clockwise water motion is consistent with circulation patterns described for gyres or eddies that retain materials over banks and seamounts. Some level of retention, concentrating food from upwelling centers to the north, Bodega Canyon, and local upwelling could explain the incredible productivity and biological activity synonymous with Cordell Bank.

Conditions of geology, oceanography, and biology come together in an exquisite combination to create a wonderfully productive environment around Cordell Bank. Conditions that are perfect for phytoplankton production in May eventually lead to ideal foraging conditions for whales in September. This Bank was open 24 hours a day long before ATMs were a part of our vocabulary. The balance between withdrawls and deposits comes naturally. So, the next time someone asks, "What kind of financial institution is Cordell Bank?" I'll be ready to tell people about this multi-billion dollar institution.

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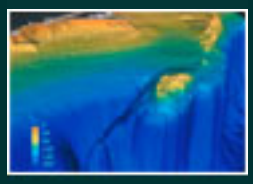
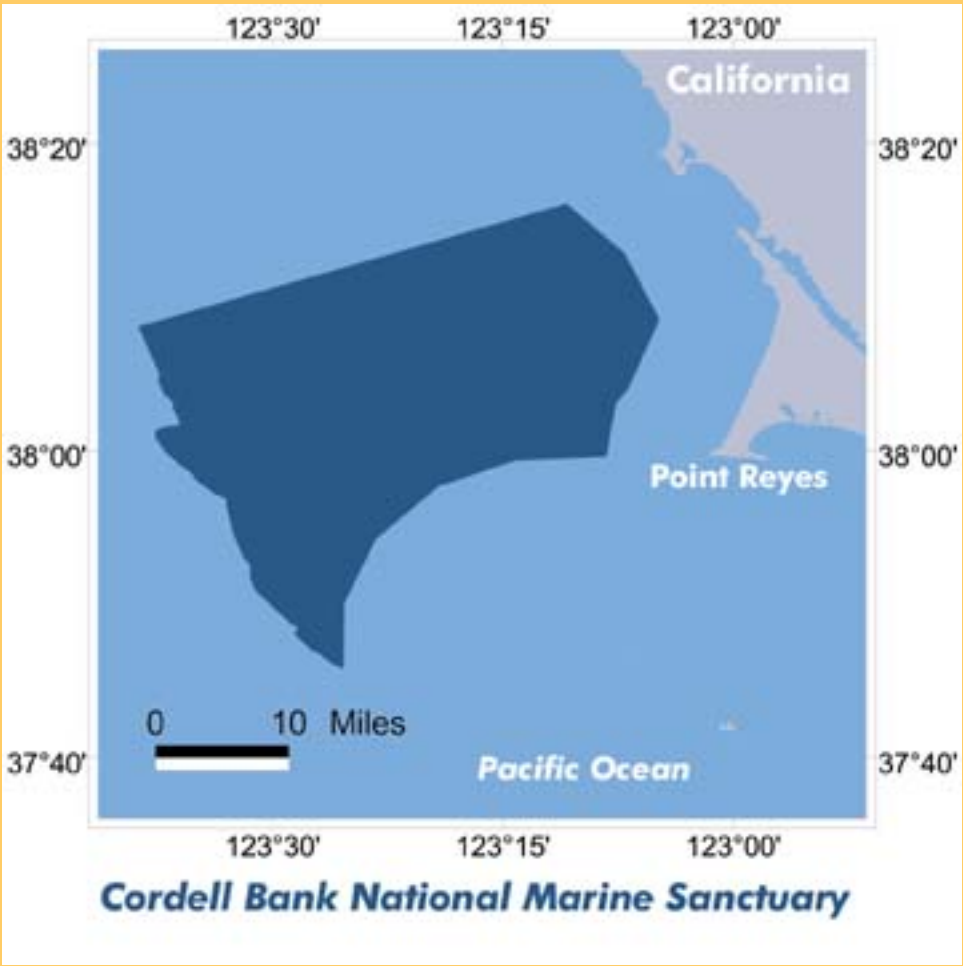


Maps

The Sanctuary



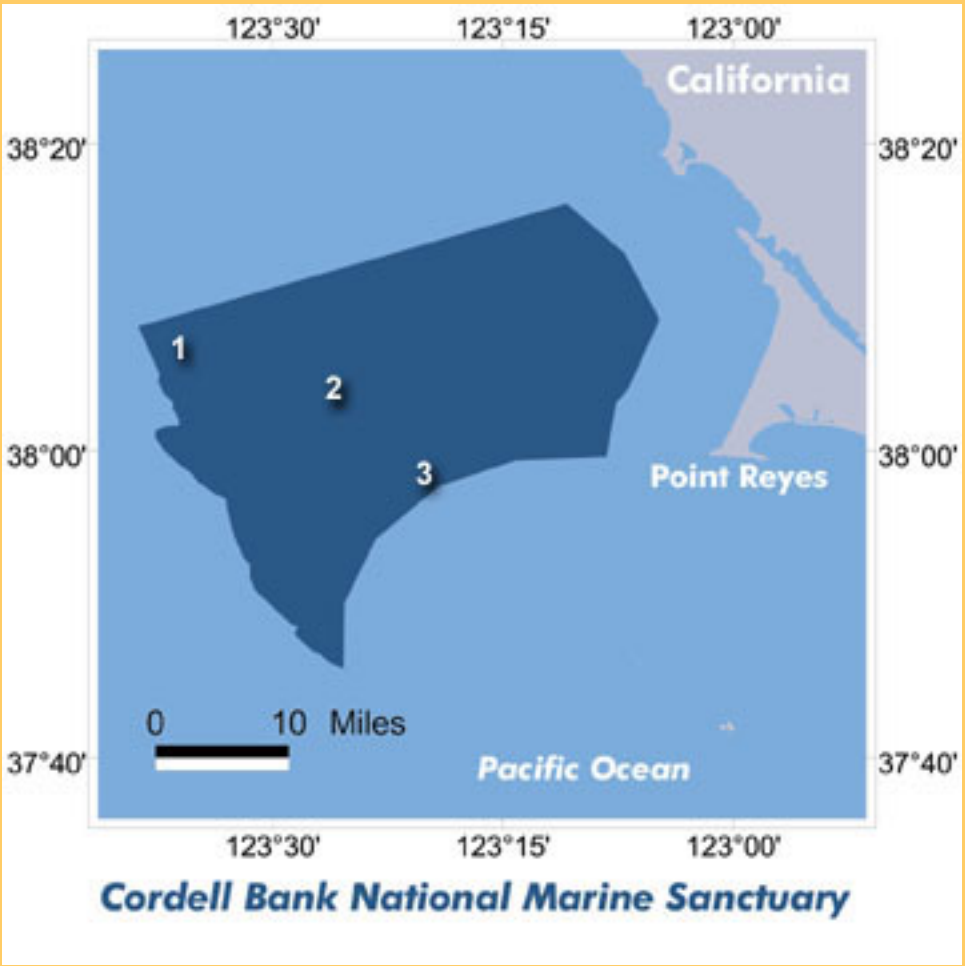
About 52 miles (45 nautical miles) northwest of the Golden Gate Bridge, at the edge of the continental shelf, Cordell Bank rises from the seafloor. Over most of it, the water is about 200 feet deep. Along a few of its ridges and pinnacles, this submerged island rises to within 120 feet of the ocean surface. Here,

upwellings of nutrient rich ocean waters and the bank's topography create one of the most biologically productive areas on the West Coast.

The significant value of this marine habitat was officially recognized in 1989 when 526 square miles (397 square nautical miles) of Pacific Ocean including and surrounding Cordell Bank were designated as a national marine sanctuary.

(top)

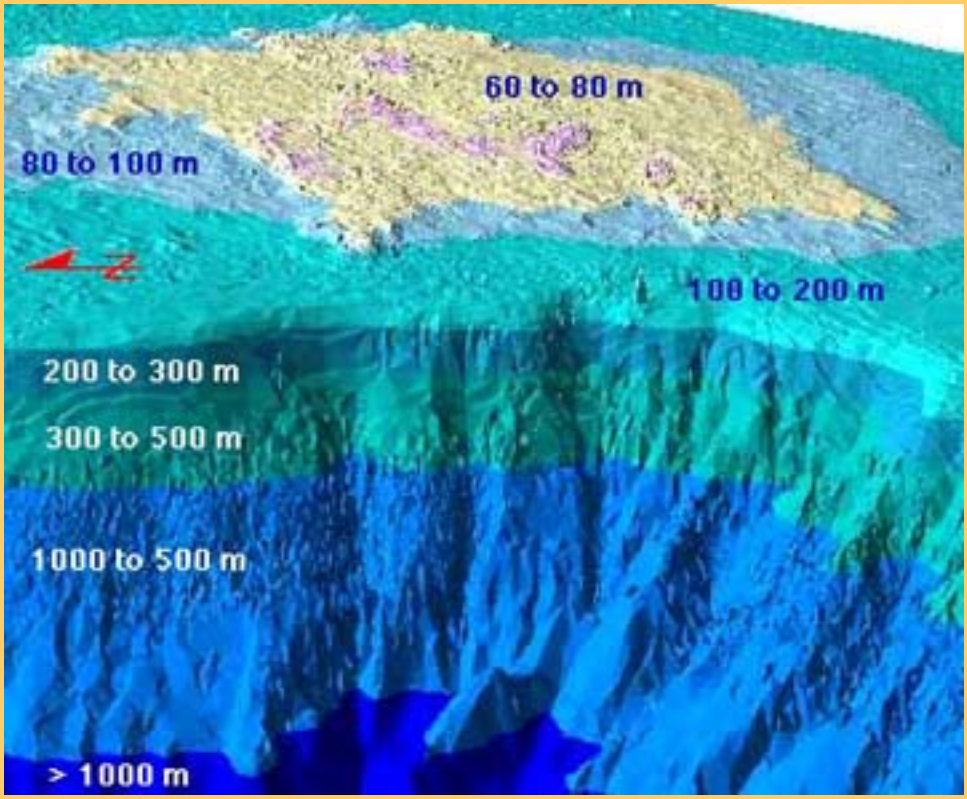
The Mission



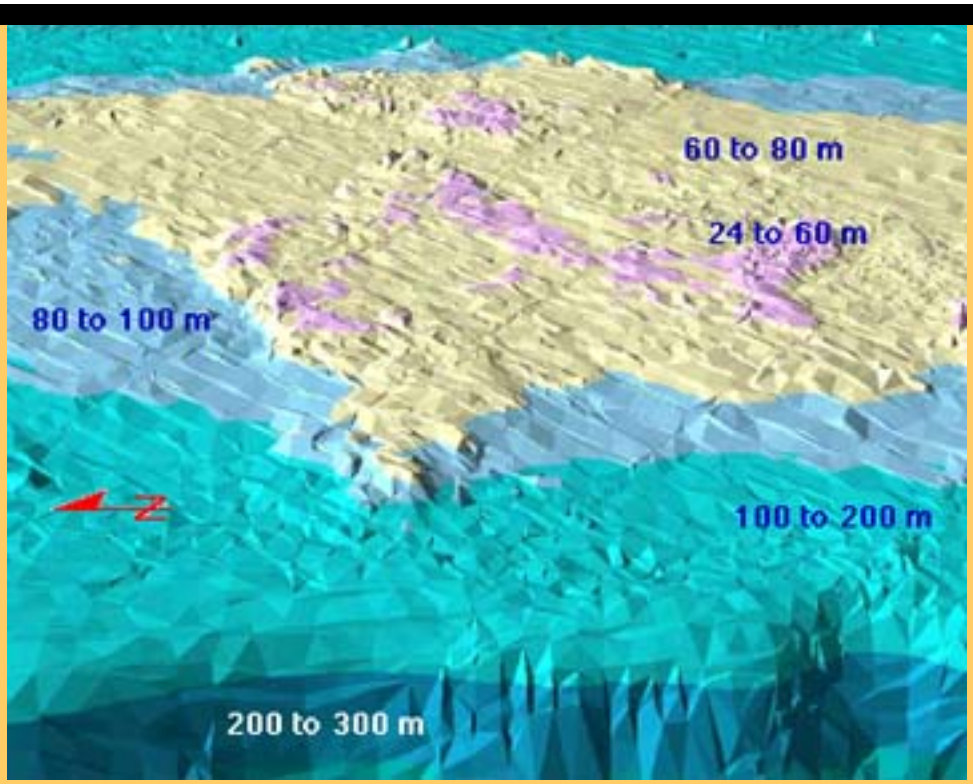
Proposed dive sites for the Cordell Bank expedition are: 1) in the northwest area of the sanctuary, there will be an estimated five to six dives, 2) in the middle grounds of the sanctuary, there will be an estimated six dives, and 3) in the southeast, the DeepWorker will be making an additional two to three dives.

(top)

The Sea Floor



Three dimensional, west-to-east view of the sea floor around Cordell Bank. Note the steep drop of the continental slope just west of the Bank. An upwelling from these deeper waters provide nutrients that support the rich biological community on the Bank. (Source: based on NOAA's hydrographic survey data collections)



Close up of three dimensional view of the sea floor around Cordell Bank. Note the highest point in the bank is 24 meters below sea level. (Source: based on NOAA's hydrographic survey data collections)

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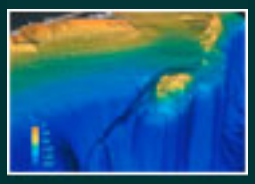

Research

Usefulness of DeepWorker in Studying Cordell Bank
by Tom Laidig, Fisheries Biologist
National Marine Fisheries Service

Tom Laidig

Cordell Bank is an underwater island off the coast of central California, about 75 km northwest of San Francisco. It is surrounded by the Cordell Bank National Marine Sanctuary. It rises to within 36 m of the sea surface, but most of the bank is below 50 m. Conventional methods of studying this area, such as SCUBA, are limited due to the depths involved. The first study completed on the bank was conducted using SCUBA, and the study was restricted to the topmost sections of the bank. With the use of the one-person submersible, DeepWorker, scientists can study this diverse and important area without the risk of decompression sickness, nitrogen narcosis, running out of air, or being compressed by the pressure. Whereas a regular scuba tank can last around an hour, DeepWorker has enough oxygen for 72 hours.

(top)

Due to DeepWorker's long submersion time, scientists can study different aspects of Cordell Bank that other methods cannot. In particular, the submersible can be set on the bottom and the organisms, particularly the fish, will become accustomed to it. Then, the scientists can make behavioral observations, such as species interactions, habitat associations, movement patterns, feeding methods, etc. The data gathered here will allow scientists to better understand and test hypotheses because they can physically watch the results themselves. These types of observations are limited when diving in a time restricted manner, as with SCUBA. For Cordell Bank, we are hoping to see some interactions among species and to determine specific microhabitats that the different species will be occupying.

DeepWorker will also allow scientists to collect data while piloting the submersible themselves. Pilots who are studying a certain species can follow individual fish wherever the fish travels by maneuvering the submersible. In most submersible dives, the scientist does not pilot the craft. Therefore, when following an individual animal or seeing something noteworthy, the scientist must explain what and where it is to a pilot who then has to maneuver the submersible there. This uses up valuable time and the fish may have left the area or the event may have ended. We will be examining juvenile rockfish and looking for areas they may settle. The use of DeepWorker is invaluable in these studies.

(top)

The DeepWorker is hoisted from the deck of the McARTHUR to explore the mysteries beneath the surface.

The DeepWorker also allows an almost 360 degree viewing opportunity. This is in contrast to an ROV and other submersibles where you see on a video image or view out one small porthole. In completing our main objective of assessing the abundance and habitat associations of the different organisms on the bank, this increased perspective permits scientists to film one area and look at another.

Using DeepWorker will enable scientists studying Cordell Bank to analyze the species of the bank and how they interact with the

habitat. If conditions are good, we will determine species abundance for many different fish and invertebrates in four different areas of the bank. Also, habitat associations of these species and bottom topography maps will be used to expand the species abundance's over the entire bank to get a total abundance for each species. Determining the number of juvenile fish that settle on the bank would help predict how the species abundance will change in the future. With a tool like DeepWorker, science could become a lot easier.

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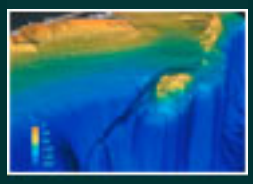
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Education

Revealing Cordell Bank National Marine Sanctuary to the Public

by Maria Brown, Executive Director
Farallones Marine Sanctuary Association


Maria Brown

The Sustainable Seas Expeditions provides me a once-in-a-lifetime opportunity to experience and see the Cordell Bank National Marine Sanctuary underwater. Very few people have ever dove on Cordell Bank. The highest pinnacles of the Bank reach 115 feet below the water's surface. An expert SCUBA diver would only be able to spend a few precious minutes exploring the lush spires of the Bank. Even then they would be risking a deep ocean dive in strong currents and cold water.

With the DeepWorker 2000 submarine, educators, researchers, and managers can now see what they have dedicated their lives' work to protect. Sustainable Seas not only allows educators to visually experience the Bank, but it will also begin to educate us about life on a submerged island in cold water. Educators have had to interpret Cordell Bank based on experience above the water--similar to interpreting a mountain forest by flying over the trees. DeepWorker 2000 allows us to travel down the water column to see what is living at different depths and encrusting the ancient granite pinnacles, to observe how the animals interact in their habitat, and to discover what threatens this unique submerged mountain.

The surface of the sea reveals nothing of what lies below.

As marine interpreters and educators our job is essential to the protection of Cordell Bank. As interpreters of the sanctuary we must reveal the meanings and relationship of the underwater world through firsthand experience and illustrative media rather than simply to communicate facts.

(top)

Karina Racz, an exhibit designer, will study the habitat and collect images and video. Since very few people in the world will ever see Cordell Bank in person, her daunting task will be to visually recreate Cordell Bank for the public. She will work with a design team to build a tactile replica of one of the pinnacles and design exhibits that stimulate awareness of Cordell Bank. The exhibits must encourage the public to want to learn more, to convey that this is their sanctuary, and that Cordell Bank is a vital link in the chain of life--it is one of the most productive marine environments in the world.

Exhibits and Visitor's Centers, like the one in the Presidio of San Francisco, are a means of bringing Cordell Bank to the public.

Amber Mace, an interpreter for Cordell Bank and Gulf of the Farallones National Marine Sanctuaries, will use her experience in DeepWorker to provoke and inspire the public. Through informal settings such as the Gulf of the Farallones and Cordell Bank National Marine Sanctuary Visitor Centers, Bodega Marine Laboratory exhibits, and the Farallones Marine Sanctuary field programs, Amber Mace will deliver interpretive programs that build upon the story captured in the exhibits. Through slide shows, boat trips to Cordell Bank, and presentations, she will help the public create their own Cordell Bank experience increasing the public's awareness of the importance of Cordell Bank and inspiring the public to become active stewards of the marine environment.

(top)

The Assistant Manager pretends to "dive" on Cordell Bank using the mural in the Visitor Center in San Francisco. Exhibits are a method of bringing this Sanctuary to the public.

As for myself, diving in a submarine on Cordell Bank will inspire a vision for protecting the sanctuary. If a picture is worth a thousand words, then experience is worth a million. As the Executive Director of the Farallones Marine Sanctuary Association and an educator, my goal is to develop an education program that increases awareness and knowledge, reinforces values, and provides experiences that enables individuals to solve present and future problems. Before, during, and after the expedition, I will be working with a high school teacher to develop materials, activities, and lesson plans on the Sustainable Seas Expeditions. I will also be working with students to design a research project for the following years of the Expeditions During the explorations at Cordell Bank students will come together for a summit on April 26, 1999 at the Bodega Marine Laboratory to meet the pilots, learn more about the Expedition, and exchange research project ideas. During the summer, I will bring the Sustainable Seas Expeditions to inner-city, low-income youth through Sea Camp. Sea Camp youth will become explorers and learn the thrill and exhilaration of discovery. In the following years, I will use the information gathered during the expeditions to develop a teacher institute. Teachers from around the San Francisco Bay Area will be invited to participate in a two-week workshop about the sanctuaries and the Sustainable Seas Expeditions.

(top)

Maria Brown diving in DeepWorker.

To successfully protect our marine ecosystems, researchers,

educators, and managers must work together. As Dr. Sylvia Earle likes to remind us, "the ultimate success will be in the project's overall impact on dispelling ignorance about the sea. With knowing comes caring, and with caring there is hope that an ocean ethic will arise that will secure a sustainable future for ourselves, and for the sea." Managers and researchers can not protect the sanctuaries by themselves. Everyone plays a part from the youth in the inner-city to the farmer in the midwest, and it is our job as educators to reveal the meaning of our relationship to the underwater world and cultivate an ocean ethic. For humans to survive, the oceans must survive.

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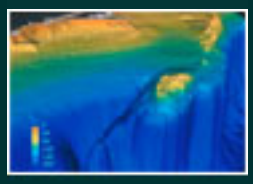


Wildlife at the Surface

by Rich Stallcup, Naturalist

Following are excerpts from logs of Rich Stallcup's past expeditions at Cordell Bank, in 1996 and 1985.

Out on the Water

Sketch of Albatross by Karina Racz.

2 November 1996

It is 0915 when we shut down the engines of the New Sea Angler at Cordell Bank, where the highest point is 18 nautical miles west of the Point Reyes Lighthouse. We are purposefully adrift in fog so

thick you could take a bite out of it. Except for the squealing of shearwaters and fulmars quarreling above krill towers, there is only silence.

Suddenly everyone aboard is stunned by a loud and abrupt noise followed closely by a second. It is the sound of powerful blasts of escaped air-they are the sounds of exhalations from close but unseen great whales-in this case, humpbacks.

As the fog lifts we begin our slow transects above the Bank and see wonders that can never be seen from shore. Today there are many whales-at least 28 humpbacks, 18 blues, and two minkes. They, too, are feeding on krill which are abundant here because of a unique combination of geologic and oceanographic features...

The Gulf of the Farallones and Cordell Bank National Marine Sanctuaries entreasure some of the finest oceanic resources on Earth. Plant and animal diversity below, on, and above the surface-of-the-sea easily rival that of any marine environment, anywhere. Cetaceans, pinnipeds, and seabirds (as well as an occasional large sea turtle) are usually present and observable in large numbers and dazzling variety.

(top)

As we gently pass the feeding whales, avoiding as much as possible any disturbance to their peace, a group of Dall's porpoises are spotted and identified by the "rooster-tail" crests of white water cast up as the speedy little mammals break the surface to breathe. Soon, as is often the case, they have joined us - 15 to 20 of them. They are beautifully black-and-white, shining like porcelain sculptures. We peer down at them from the bow rail and see every detail of their wild energy. They are gone as quickly as they appeared.

Animals from far to the south as well as the arctic are attracted to this special place because huge amounts of food are supported by nutrients pumped to the surface by upwelling and because mammals and birds in these sanctuaries are currently protected from harm. Predation and survival here are in a classic episode of "big fish eat little fish," as food webs abound with microscopic single-celled organisms up to top predators like skua and orca.

It is early afternoon and we are crossing Bodega Canyon with only two hours left of this outrageous trip when someone screams "killer whales." We see splashing, and distant black dorsal fins-some large and sharply curved, some huge, triangular and sail shaped-Orcas! A limp California sea lion is tossed 40 feet in the air by the whales

and another appears on our starboard side looking as though it wants to come aboard. It is no wonder! There are at least 54 orcas - more, we think, than have ever been seen together in the northeast Pacific south of Puget Sound. The sea lions that usually fish these offshore waters without much worry (even from commercial fishermen from whom they pilfer meals) have been caught off base. There is nowhere for them to haul-out...nowhere for them to hide. Orca's schedule of seasonal presence is not available for human scrutiny and is largely unpredictable. For those that love the excitement of magnificent wildlife sightings, it is worth the wait. Encountering the big hunter in its oceanic empire is an entirely different adventure than watching one doing its tricks in the pond at "Water World."

(top)

Orca

Each year legions of seabirds spend their winters in the Gulf of the Farallones NMS and at Cordell Bank NMS, and in spring many thousands of birds (12 species in all) attempt to nest on the South Farallon Islands. Hundreds of thousands, even millions of birds, annually pass unmolested through the sanctuaries during their seemingly endless pageant of migration.

The species list of true seabirds documented from this region is exceptionally long. Trips to this wild place are the envy of birders worldwide and cause amazement to distributional biologists. Four species of albatrosses have been photographically documented here, more than at any other place north of the equator.

(top)

3 November 1985

Then it happened. There it was. About 200 yards away and coming straight at us. I was so excited I could barely breathe. It rose to miss the boat and went so closely over me that I could feel its wind. I came unglued. The screams must have been deafening, causing the skipper to have "done something" to his transmission and causing 40 birders (who had been watching dolphins on the bow) to come stampeding aft. I snapped-off a couple of panic photos and dragged three sick people out of the cabin. Later all was forgiven. After all, we were the first naturalists to be gifted with the presence of a short-tailed albatross (Diomeda albatrus) in the eastern Pacific in more than 80 years.

The huge bird passed again, made a large, arcing slow motion wheel, lowered its big pink, webbed landing gear and water-skied to a halt. Those who knew the significance of the event were alternately crying and laughing, babbling incoherently and missing "high-fives." The others were at least amazed-with the unraveling story about the near extinction of this species and with the vision...this thing made the black-footed albatross look small.

Albatrosses, shearwaters, storm-petrels, puffins, auklets, murrelets, phalaropes, pelagic gulls and terns, jaegers, and skuas are often seen on the same one-day trip. All this, in addition to pinnipeds and cetaceans, blue sharks, ocean sunfish, and, rarely, a green or leatherback turtle, make the excitement of a journey into these Sanctuaries hard to contain.

(top)

Compare the wingspan of the albatross to the gulls in the foreground.

Back on the Coast

On the mainland , the sanctuaries encompass several pristine lagoons and estuaries that provide shelter and refuge for many more kinds of birds than those of the open ocean. Each winter, especially during herring runs, Tomales Bay alone may contain 15,000 ducks-mostly Greater Scaup, Buffleheads, and Surf Scoters, and hundreds each of loons, grebes, cormorants, and gulls. In late winter and spring, up to 5,000 Brant are present foraging eel grass at Limantour Estero, on the Walker Creek Delta, and around Hog Island. Bolinas Lagoon, Limantour Estero, Abbott's Lagoon, and Tomales Bay are vital foraging spots for passing migrant shorebirds that need refueling. Thirty-five to forty shorebird species are recorded here annually. Ospreys fish waters of the Sanctuaries during summer. Snowy Plovers and Black Rails, rare birds in North America, nest within the Sanctuaries as do four species of egrets and herons. Large groups of harbor seals that haul out on sandbars in these protected waters to molt and give birth number more here than anywhere else in the state-a sure sign of healthy aquatic environments, both onshore and off.

The natural resources of Cordell Bank and the Gulf of the Farallones National Marine Sanctuaries are infinitely diverse and complex. For curious scientists there are innumerable mysteries needing solutions and stories in want of closing chapters. For naturalists, birders, whalewatchers, anglers, kayakers, and tidepoolers there are many great adventures to be had in this place of refuge and beauty.

(top) **RETURN**

April 27, 1999

Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary

Jan Roletto, Research Coordinator
Gulf of the Farallones National Marine Sanctuary

Dan Howard writes:

The morning greeted us with sunny skies but marginal conditions for diving. The winds continued through the night and by 7:00 a.m. had stabilized at 20-25 knots from the northwest.

Phycologist (marine botanist) Natalie Cosentino has joined us for the next leg of the cruise, and ran through her predive check first thing this morning. Natalie has been monitoring intertidal algae around the Farallon Islands for five years, and is excited about the opportunity to continue these surveys into the subtidal.

This will be the first quantitative assessment ever of subtidal algae on Cordell Bank. The prospects of new discoveries at unexplored depths are very real with the DeepWorker and an experienced eye. As she neared the end of her predive, winds began to exceed 30 knots -- the maximum wind speed for dive operations. We contacted the marine forecast office, and learned that predictions call for these conditions to hold for the next couple of days. After considering all options, it is decided that we will in port the ship tomorrow and dive on May first, our scheduled in port day.

(top)

Bill Sites, the captain of the McARTHUR, has been bending over backwards to do anything he can for the mission. Phone calls are made to reschedule fueling, garbage pickup, water, and berthing -- things that are normally scheduled weeks if not months in advance. The dive supervisor and mission coordinator make calls to reschedule changeout days for their crews.

All the logistics required for a successful mission are daunting. The silver lining as we surf on the building seas from Drakes Bay towards the Golden Gate is that these

springtime winds initiate the annual cycle of productivity necessary for sustaining the incredible biomass and diversity that makes this area one of the richest ocean environments in the world. We are only visitors, inconvenienced by conditions that are necessary to produce the spectacular underwater world that we are here to document and explore.

Jan Roletto provides an overview on a daily bird and mammal transect:

This morning we had to turn back to San Francisco. The wind is expected to blow +40 mph, creating sea conditions that will cancel our sub launches. So the captain has decided to wait it out in San Francisco Bay. We decided to count a few birds on the way in, just to see how our new bird and mammal survey program is working.

The program is very simple. A Macintosh laptop is connected to a GPS (global positioning system) so that every time we enter a sighting our location is automatically downloaded onto an Excel spreadsheet and our location is plotted on a chart. Typically we do these surveys with two observers, one person watching for birds and mammals and another person counting only mammals, in milder sea conditions.

Two Common Murres.

(top)

We've set our observation zone for birds to be 350 meters (410 yards) from the ship. Using this systematic way of counting, we can later calculate the density of birds within the survey area. If we do enough of these surveys, we can tell how many birds and mammal are in the Sanctuaries, where they like to concentrate, what the habitat is like in their favored areas, and the abundance and distribution of their food (such as krill and juvenile fish). Ultimately, this helps us better understand the dynamics of the Sanctuary's ecosystem.

Sea conditions we not favorable for a typical survey, but we got in some good practice and worked out a few of the bugs in our system. During this one-hour transect, we were able to observe:

1 alcid
1 Black-legged Kittiwake
44 Brandt's Cormorants
460 Common Murres
9 other cormorants (species unclear)
1 Double-crested Cormorant
143 gulls (unsure of specific species)
4 Pacific Loons
48 Sooty Shearwaters
120 Western Gulls

3 Western Grebes
1 gray whale

Total Number of Sightings: 133
Total Number of Birds: 841
Total Number of Marine Mammals: 1

Sooty Shearwaters on the surface at Cordell Bank.

The ship transited through the commercial shipping channel during the transect. Birds were counted from both sides of the ship, using three observers. Several patches of crab pots were noted. We passed directly through the San Francisco Bay fresh water plume about half through the survey. Species diversity (taxa richness) was low, 8 species of birds and one species of mammal. One patch of drift algae, Nereocystis sp., was noted near the fresh water plume.

While we are a little frustrated to see so many potential opportunities to dive the sub ruined by the season's typical high winds and unpredictable sea state, we are gratified to have the opportunity to continue our work in observing and studying the other inhabitants of this sanctuary. And tomorrow is another day.

(top) **RETURN**

SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

CORDELL BANK

SITE INDEX

April 28, 1999

Thomas La Pointe, Web Project Manager
NOAA, National Ocean Service

A View from the Home Team
Silver Spring, MD

Tom La Pointe

6 pm and time to go home. Our Sustainable Seas Web site continues to grow. Today, we had two more Mission Log entries, seven new photos and annotations, a fairly major change to the "Schedule of Events," and revisions to several items on the Home Page. We have done a number of major Web sites, but this Web site is a very different beast, entirely. We feel more like we are in the newspaper world, than our normal world of a communications office in a scientific agency.

The day began around 8:30 am. We had received two more log entries from Gale Mead, our Mission Log editor from the National Geographic Society. Gale is the one-person Away Team. That is a tough job. Besides her own writing, she must gather and edit all log entries, and suggest and coordinate new log entries from expedition participants. Gale is the hub of our wheel. From the McARTHUR, we also had received six photographs, shot on the days of the two log entries.

(top)

At 9:30 sharp, the team filters into my office. Mike is first. Mike Shelby is our Webmaster. He is really the one responsible for all aspects of the site. The stress is pretty high on Mike. But Mike is one of those enviable people who remain completely unflustered, especially when the going gets tough.

We have come to rely on Mike's ever-even temperament and exceptional competence. Susan Holliday Buda is next. Susan has been doing a great job on the mission calendar and technology section. And she has had to balance her work on

Web team uploading mission log entries.

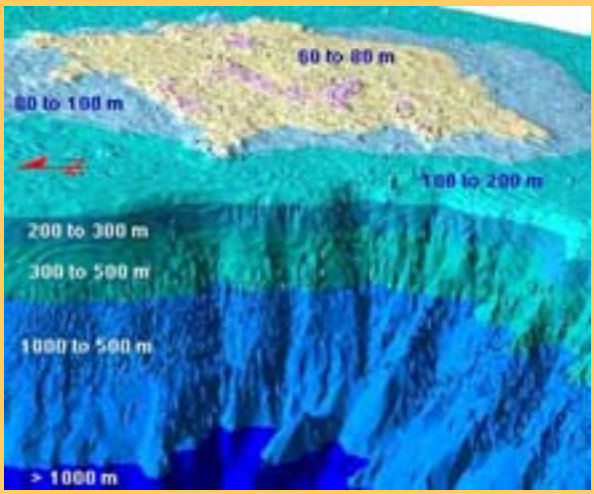
several other important projects, such as being the project manager for the National Ocean Service's Web site. Hers has been a real feat of juggling. Alison is on Susan's heels. No, I did not misspell her name. Alison (Hammer) is continually ribbing me about putting in that second "l." Alison is the Webmaster for the Cordell Bank mission log. In our office, we have assigned a staff member to each mission. We are very fortunate to have Alison. She is very versatile, and a real can-do person. As usual, Brian Johnson, our Mission Log coordinator, arrives last. Brian is really making it happen. He is the one who has to work with all of us and the sanctuary people in the field, and the SSE staff. His daily to-do list starts long in the morning and ends long in the evening as new tasks continually come to replace those items he's completed during the day.

Today we discuss a news item, the two new logs we have received, a new idea for the calendar, and how we will respond to a change in mission focus from the ship. Then discussion turns to additional work. NOAA's National Weather Service has offered to give us a special daily forecast for the actual expeditions. We are excited about working with the Weather Service and discuss how to include the forecast on the Web site.

(top)

I return to my work. Alison has added the 3-D Sea Floor maps to the Cordell Bank offering, and I have to review these with Peter Grose, my colleague and one of the National Ocean Service's foremost bathymetry experts.

Every day I see Peter totally focused on his computer screen as he works in 3-D with millions of data points and 3-D models. Peter is developing these maps for all of the sanctuaries, a very tough job. Peter approves the maps and its on to selecting photographs with Brian. We have to do this before noon, so that we can get the material to Alison.



At 3 pm, we all gather in Mike's office. We do not update the real Web site. We have a working version of the site on one of our other servers. When our revisions are completed, we review them in Mike's office before uploading them to the NOAA central bank of Web servers. Every revision is viewed

by the group. Lo and behold, our collective eyes catch a few minor problems. Details, details, endless details!!! Mike fixes these with dispatch and uploads the new version.

3-D, west-to-east view of sea floor around Cordell Bank.

(top)

At 5 pm Brian informs me that the Monterey Bay background pieces are ready for my review. I know what that means. Brian will print them all out for me to read on the subway on my way home and on my way to work tomorrow. I like this part of my job. Tonight I will learn much about the Monterey Bay National Marine Sanctuary. I am curious about what Bill Douros has to say in his interview about his goals for the Sustainable Seas Expeditions in Monterey. I know I will learn a good deal about the Monterey Canyon and the biological community it supports.

A Chumash tomol.

I enjoy history, and look forward to the special piece Bill's father has written on the history of exploration in the central California area. I am also taking home the Chumash Perspective piece by Roberta Cordero for the Channel Islands offering. I have already read this once in my "site reader" capacity, but now I want to read it again, just to read it.

So, here I am at 6 pm finishing my log entry and getting ready to walk out the door. When we began this Web project five months ago, I had no idea what we were getting into, and my gang is very experienced at these types of projects. It has been more (and much different) than I imagined. I remind myself how lucky I am to be blessed with a wonderful staff. But, despite the toll, I know that the Home Team is participating in something special and something new, and how fortunate we are to be serving as the public's window into the adventures, explorations and discoveries of the Sustainable Seas Expeditions.

(top) **RETURN**

April 30, 1999

Natalie Cosentino
Gulf of the Farallones National Marine Sanctuary

Jan Roletto, Research Coordinator
Gulf of the Farallones National Marine Sanctuary

Karina Racz, Exhibit Designer and Educator
Farallones Marine Sanctuary Association

Natalie Cosentino writes about her first dive:

I arrived on the McARTHUR on the night of the 27th and unfortunately, because of the winds and swell, we were forced to stay in port in San Francisco until this morning. We got a bit of a break, but the weather was still too harsh for the Farallones and Cordell bank. So it was off to Drakes Bay we go. I had been waiting for this day since the thought of even being involved in this amazing project. The conditions at Drakes Bay were perfect. A slight wind, a sunny day, and an inviting sea.

I prepared myself mentally for the dive by reviewing the basic operations of the Deep Worker and reading up on emergency procedures. We started our pre-dive at 1500hrs and this is when the nerves kicked in. The nervousness was not so much of fear, but of excitement and much anticipation. At 1500 hrs the hatch was closed and I was ready to be lowered into the bay. The sunny conditions made it quite warm in the sub, but as soon as I was in the water it was very comfortable. The water was an azure blue, and I could no longer hear the noise of the ship's generators. Instead the sounds of the carbon dioxide scrubber and the water lapping up against the hull took over. My nervousness went away and I was ready to see the bottom.

(top)

I was told to back away from the ship and to proceed to a set course of 60degrees. When I was far enough from the ship I was told to dive. Within the water column, ctenophores and hydromedusae, *Beroe sp.*, *Pleurobrachia sp.*, and *Polychoris montereyensis* floated by amazing me with their delicateness yet complex structure. At 40ft I arrived at bottom. The bottom of Drakes Bay is composed of soft, fine particulate sand. The most dominant organism inhabiting the bay was a burrowing

clam, which could only be recognized by its occasional projecting siphons. There were also significant numbers of the tube dwelling polychaetes, *Pistia pacifica*, and the sand dollars, *Dendraster excentricus*.

Other echinoderms that were present were the pink bay star, *Pisaster brevispinus*, and *Evasterias troschelii*. While flying along the bottom I noticed a patch of sand that looked different. As I approached I could see a partially buried fin. Suddenly, a 3ft long California halibut, *Paralichthys californicus*, swam frantically away. I think I startled it as much as it did me. I tried to take some photos during my dive, so we will have to wait to see if they come out. Tomorrow we shall see what the weather brings; hopefully we will be able to get out to Cordell Bank or the Farallones.

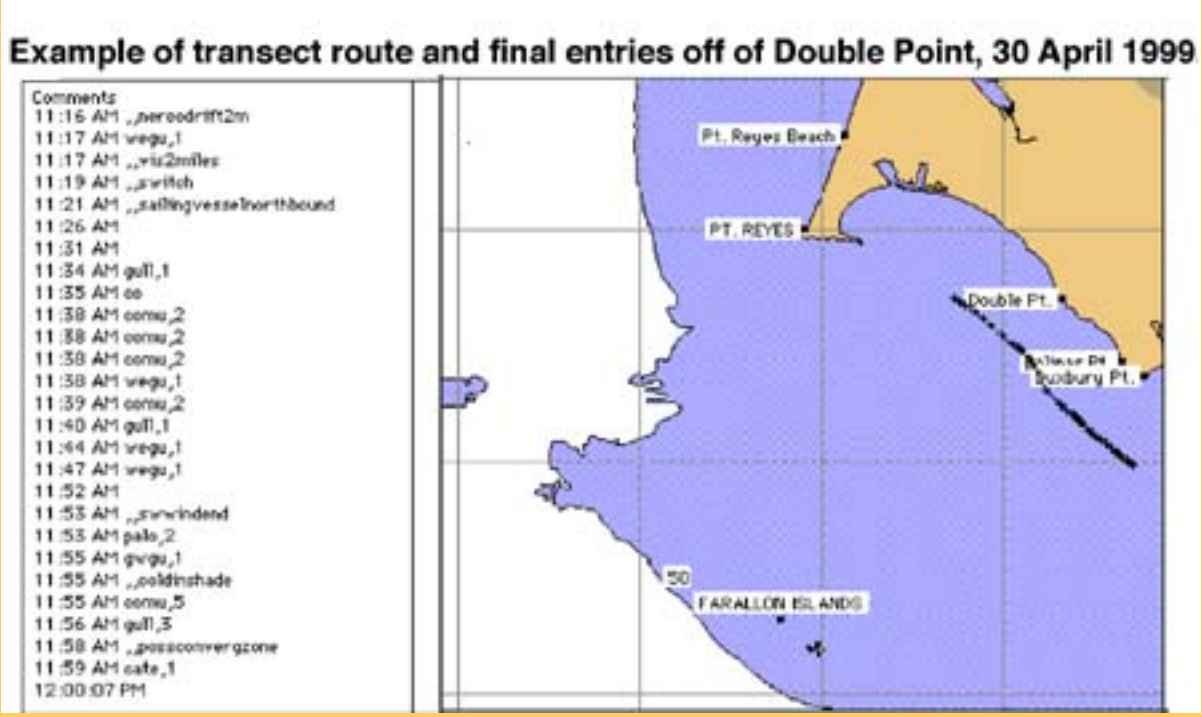
(top)

Jan Rolettto provides an overview of bird and mammal transects from Shipping Channel to Drakes Bay:

Today, we were able to complete another bird and marine mammal transect. Our transect began at the west end of the shipping channel to Drakes Bay.

A California sea lion relaxes at the surface.

We had surveyed this area a few nights ago, for plankton and larval and juvenile fish. The samples collected from those plankton tows were minimal. The lack of food (plankton, krill and juvenile fish) could be why we had so few sightings of birds and mammals during this strip transect. Taxa richness for birds was 8 and 1 for marine mammals. Numbers were also low: a total of only 28 sightings, with a total of 46 birds counted. Very few birds were sitting on the water (5 Common Murres) and none were observed feeding. All animals were transiting through the area. Common Murre sightings did pick-up when we were near the murre nesting colonies at Double Point.



Species Count

Brandt's Cormorant 2
Caspian Tern 1
Common Murre 14
Gull 7
Glaucous-winged Gull 1
Pacific Loon 2
Red Phalarope 1
Sooty Shearwater 1
Western Gull 17
California sea lion 1
Drift algae: seven patches. All were Nereocystis with no birds associated.

Total Sightings: 28
Total Birds: 46
Total Mammals: 1

The weather forecast continues to give us little reason to hope for another fabulous diving day like last Sunday, but in the mean time, there's other ways we can make good use of our time, and gather important information about the sanctuary and its inhabitants.

(top)

Karina Racz describes her experiences with today's mission activities:

After being kept at Pier 45 in San Francisco by winds that would not subside, we were

finally back out again to resume diving at Drakes Bay. The past couple of days have been used to fine-tune equipment being used on the sub. Routine maintenance checks were done, as well as improving the video recording capabilities and rewiring certain electrical components.

The sea state has been typical of this time of year off the California coast but we are now hopeful of another window of calm seas. Surrounding those of us on the fantail of the ship are the dramatic white sand cliffs of Drake's Beach and Point Reyes National Seashore. One can see how the elements have carved away at this stretch of the coast, wind and sea sculpting the land back to its most rugged. A bright green layer of pasture carpets the rolling hills as cows graze in the historic ranchlands, blue skies and cumulus clouds overhead.

At 22:30 I arrived back on deck again after a very short evening dive. All the routine checks went without incident on the surface, but when I reached the sandy bottom of Drake's Bay at 42 feet, both the video recorder and the sonar system went out. In comparison to the abundance of life and color I had seen at the Farallones, I was thinking that there did not appear to be much to film here anyway.

As if to prove my thoughts wrong, a flatfish scudded by and disappeared into the sand once more as I fiddled with the video screen. All around me were small molehills with openings - indicating clams buried in the sand below. Maybe this habitat was not as devoid of life as I had thought - it was just not within plain view. In an area with few features to provide cover, I could see how camouflage would be advantageous to the species living here, in the sand dunes of the seafloor.

(top)

After 45 minutes of hanging out on bottom trying to fix the technical problems with assistance from topside, we had gotten nowhere. At that point the winds decided to pick up again to 25 knots. Dive Supervisor Ian Griffith made the call on deck to get me out of the water as soon as possible since winds and surface currents make retrieval of the sub even more challenging.

When I arrived on the surface, a nearly full yellow moon had risen in the east while the rosy blue glow of sunset still lingered in the west over the hills of Point Reyes. Through the acrylic dome of the sub I could see the first stars appearing overhead. This is my favorite time of day out at sea. Called the "gloaming," this is the time when it's possible to use a sextant to measure the angles of known stars from the horizon and get a fix on one's position out in an otherwise featureless realm. Relating oneself to the position of celestial bodies has a way of putting things into perspective like nothing else.

Through the water, the headlights of the DeepWorker created a surreal green glow in the lower half of my dome as the skylight glow above began to fade. Gooseberries, small floating orbs of translucent, rippling light drifted by, feathered arms extended to catch minute particles suspended in this universe below, as more and more minute sparkling stars appeared in the expanse overhead.

The weather forecast continues to give us little reason to hope for another fabulous diving day like last Sunday, but in the meantime, there's other ways we can make good use of our time, and gather important information about the sanctuary and its inhabitants.

(top) RETURN

May 1, 1999

Karina Racz, Exhibit Designer and Educator
Farallones Marine Sanctuary Association

Weather: Sunny, 25-30 knot winds, seas 4-6 feet

Well, it's been another day of wind along this stretch of the California coast. Wind and high seas, and the weather report keeps calling for more of the same. Even in the protected alcove of Drake's Bay the winds have churned the water so that deployment of the subs is not possible.

The McARTHUR heads for calmer seas in the haven of Drakes Bay.

Those of us stuck on the ship have been making the best of it by catching up on laptop computer work, sleep, and, of course eating well. The galley crew here aboard the McARTHUR are famous for their delectable meals.

If nothing else, these past few days have given us insight into what so many expeditions of this nature must encounter. For the few minutes of exceptional footage, or that rare moment observing an animal's behavior in the wild, countless hours are spent waiting for conditions to be just right. This is especially true when it comes to exploring the remote areas of the ocean. These areas have remained a mystery for good reason: it is extremely difficult and expensive to have everything be just right. And when you think you've covered all bases in preparedness, nature proves who's really in control by throwing high seas your way. It's humbling and frustrating, but in a weird way reassuring, that there ARE forces still out there that we cannot control.

For all the reasons that we treasure it, Cordell Bank still remains a mystery. Five days into the leg of the Expedition allotted for Cordell, we have yet to even come close to it. Rugged, beautiful, hidden, and wild, Cordell remains elusive and an even greater challenge for exploration than we had thought.

(top) RETURN

May 2, 1999

Jan Roletto, Research Coordinator
Gulf of the Farallones National Marine Sanctuary

Dan Howard, Assistant Manager
Gulf of the Farallones National Marine Sanctuary

Location: Drakes Bay
Just Another Day at the Office

Jan relates her experiences with a troublesome sub:

Well, while waiting for Dan, our Mission Coordinator and Chief Scientist, to return to the vessel, we hoped we could get in another dive today. My name was up on the roster, so I started my pre-dive check of the submersible only to power up the on-board computer and find that it would not boot-up. We have had several electrical and software conflicts for the last several days, possibly stemming from a new data and digital video recorder and the ever changing software in the computer. Our wonderful Nuytco technicians and dive supervisor opened up the internal electrical panel and ran a quick diagnostic test. They were able to quickly find the problem, do some re-wiring, and I was able to resume my pre-dive check.

Once we got to checking the underwater communications we found more problems. You just can't dive if you can't talk to the surface, so we waited while the Nuytco crew tried to find the problem. They finally decided to take a hammer to the comms battery and hammer it in place. This actually worked! Underwater comms were working great. By early afternoon, I was launched off the back of the McARTHUR. Then...EEE-GADS!!!! The intake valve for the hard ballast system was jammed opened and the hard ballast water was freely (and coldly I might add) flowing into the sub and on top of me and my sonar laptop. My immediate response was to try to crimp the over-flow tube and turn off the hard ballast hull stop. Crimping the tube was useless and the seat was blocking the hull stop. I tried to lift the seat (which I was sitting on and had several pounds of water in it; there's no standing in DeepWorker) and close the valve, but that only made everything that was on my lap fall down into the leg tube, where the mouse to control the sonar laptop wedged itself under a thruster pedal.

(top)

With the thrusters engaged, the sub doing doughnuts on the surface, my oxygen monitor alarm went off because I was exerting myself a little too much and I consumed more oxygen than what was flowing into the sub. So I had to re-adjust by bellows, thus immediately increasing oxygen into the cabin and increasing the rate at which oxygen was dispensed into the cabin. Words of wisdom came from Topside, "Place the over flow tube in to the leg tube of the sub, there's nothing you can do. The seat will just run out of water." Which it did. There was about two gallons of water in the sub and the only way to get it out was to abort the dive, return to Topside and vacuum out the water.

I was never in any real danger and I felt confident that I could still control the sub, remain calm, and deal with the minor emergencies. If nothing else it was a good learning lesson. Tomorrow I may dive at the Farallones or if the weather gets worse I'll return to Drakes. Either way, it's just another day at the office.

Dan Howard describes the rest of the day:

We decided to run to the islands while cleaning up the sub. We got underway from Drakes Bay at 1515 hours, with high fog, and a northwest wind at 10 knots. We arrived at the Farallones at 1730 hours and set the anchor off the east side near Shubrick Point in about 40 m of water. We deployed the ROV at about 1940 hours and ran transects along a mixed sand boulder habitat. We observed six species of rockfish - Quillback, Rosy, Blue, Yellowtail, Vermillion, and Copper. The rockfish, along with lingcod, greenling and a dead halibut of all things kept the gallery entertained.

The electronics tech had routed the video feed to channel 40 on all the ships television sets. White anemones swaying in the crew's lounge, ward room and instrument lab for all to enjoy. Sea cucumbers littered the bottom for most of the dive, along with multiple species of stars. Ornate sponges that rival the most elegant of corals in the Caribbean grace the tops of rock ledges and boulders. Everyone had a chance to operate the ROV, and after two hours we reeled it back in with the event recorded on VHS.

The rocky habitat at 40 m around the island is complex and intriguing. High relief rock ridges run through areas of mixed boulder and sand that lay adjacent to large open sand channels. The diversity of the habitats supports a rich biological community. A great ending to the day. The weather seems to be moderating. We only hope it holds.

(top) **RETURN**

May 3, 1999

Ed Ueber, Manager
Gulf of the Farallones National Marine Sanctuary

Weather: Cool, wind 10-15 knots, seas 1-3 feet, swell 3-5 feet.
Time: 11:00 pm

Well, Earlier today, higher winds (20-35 knots) and higher seas (8-12 feet) prevented us from diving the sub. We were eventually able to use the ROV to get some good images of Southeast Farallon Island's subtidal habitat, in depths of about 140 feet. Later, anchored again in Drakes Bay, two attempted dives were scrubbed due to minor technical problems. No submarine is allowed to dive unless everything is perfect. Safety first, last, and always. Seemingly insignificant errors can cause fatal problems down the line, and subs are expensive.

After dinner, a dual dive (two subs in the water) is approved. I will be piloting the primary DeepWorker, while the other sub is piloted by Nuytco's technician, Steve Drover: A wonderful smile and 50,000 jokes (one or two of which are fit for mixed company) are all part of this fine, intelligent young man.

At the last minute, the decision was made to let Kip Evans, SSE's official photographer, and Dave Bowden, the ship's chief cook (but also a working SCUBA diver), get in the water to film my and Steve's antics with the two DeepWorkers. As the predive check progressed, the sun set slowly in the west (or, if you want to get technical about it, about 250 degrees W). This means the dual dive was a dual night dive.

Launching went smoothly, with me in the water around 19:30. I moved to about 200 feet off the port side of the "Mac." Once all was clear, I dove to the bottom and tested my equipment. Cameras, both video and still, seemed to be OK, but one of my halogen lights shorted out, so I was limited to only my starboard halogen light and my two HID (high intensity discharge) lights.

(top)

Unfortunately, my oxygen percentage was climbing, and my cabin pressure was dropping. O2 percent 21, 21.1, 21.4, 21.8, 22.1, 22.3.... I had opened my bellows and tried to unstick the purge valve with a few good purges, but still I watched it climb:

22.7, 23.4, 24.1.... At this point I closed the oxygen hull stop, notified topside, and waited for my respiration to use up the excess oxygen in the cabin. All this time, because of the excess oxygen bleeding into the cabin, the cabin pressure had continued to climb, going from 1000 feet above sea level to 400. I could switch to my backup o2 system, but if I did, I'd have to abort the dive, something topside and I agreed was unnecessary at that point.

After a few minutes of heavy breathing, my oxygen percentage had dropped to 23.9, and cabin pressure had gone to 700 feet, so all was under control.

Using the sub's sonar, I located and maneuvered towards Steve, who by this time was on bottom in the other sub. Steve and I surfaced within 5 feet of each other, and then I dove and he followed, with our two scuba divers right with us. The next 25 minutes were spent with bright lights from divers and DeepWorkers all around. It ended when DeepWorker 2 asked me to write and show the divers a note asking them to get a benthic sample and go to the surface.

I had pencil and paper, but only heard the part of the message which said to have the divers go to the surface. I wrote them a note saying "GO UP," and they did, so we did not end up with a bottom sample.

Steve and I danced a slow Lindy to a slow beat for another 15 minutes, and I sat and watched mysid shrimp, euphausiids, and rockfish glide across my HID light beam. It went all too quickly, and at 21:20 I was told to surface, and come up close to the stern of the Mac.

Matt hooked up the lines and lifting bridle in under two minutes, and the Boatswain and deck crew had me safely on board by 21:28. My feet were cold and wet, but I would gladly have stayed another two hours, if I'd been allowed to. The RHIB (rigid hull inflatable boat) is needed in order to go pick up Dana Wilkes, Gale Mead, and Amber Mace at the fishing dock in Drakes Bay. We will be glad to see them again. Unfortunately, Karina Racz and Peter Jung will be leaving us at this point. And my next dive in the DeepWorker will probably not be until April of the year 2000. Bring on the new millennium!

(top) **RETURN**

May 4, 1999

Dan Howard, Assistant Manager
Cordell Bank National Marine Sanctuary

Day 8 - SSE, Cordell Bank National Marine Sanctuary

06:00, rise and shine! We started the day mixing concrete and cutting and bending rebar to fabricate cluster weights for the ROV. Our priority is to get out to Cordell, and we want to be ready for anything. At 07:40 we poked our nose around Pt Reyes. Winds remained down - 10-15 knots, and we were thinking (hard). Maybe today's the day we'll make it to the Bank - payday.

The groundswell from the previous day was still with us. Seven to eight foot seas greet us around the corner - marginal for any dive or ROV operations at the Bank. We got two miles offshore and winds were steady at 15 with a rolling sea. Marginal. These are the tough calls. We wallowed outside and weighed all our options - check the buoys - Farallon Buoy 7 feet every 11 seconds, Bodega Buoy 10 ft every 12 seconds; we contacted the islands and get "it looks pretty good in close to the island on the lee side."

The captain, Ian and I decided conditions were not conducive for operations offshore. It's reassuring to have two other people to bounce options off of. We decided to try live launches in Drakes Bay and continue to increase our repertoire. We steamed into Drakes Bay and I started my predive at 0930. Winds were increasing to 15-20 knots NW - too much for live launch and recovery. Back on the hook. By the time we finished the predive at 11:00 hours, winds were blowing 20-27 knots with gusts over 30. Dive operations were suspended while we waited for a window.

Nuytco started wiring up the 999 video camera on the ROV. At 15:00 winds were steady around 20 knots and we went for launching the sub. Flooding soft ballast and descending to the floor of Drakes Bay, the visibility was less than 5 feet. I've been in conditions like this many times before using scuba, but this is so much different. I'm an observer looking in on another world from my capsule. Maybe it's the bucket seat or the fact that I'm talking with people while I'm down - it seems so incongruent with work underwater.

Back topside at 1645 hrs, I was hoisted back to reality. An hour later, the ROV with the 999 camera was over the side and cruising along the sandy bottom of Drakes

Bay. The camera image was crystal clear, and about an hour and a half of video was recorded on VHS. Dungeness crabs scampered along and burrowed into the sand when the strange intruder got too close. Clam burrows and polychaete worm tubes were abundant throughout the dive.

Again, everyone had the opportunity to operate the vehicle. I missed my chance as I chose to watch the Drakes Bay show on the "big" screen in the wardroom. Another day closes. Another day moving onward and downward.

(top) **RETURN**

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May 5, 1999

Maria Brown, Executive Director
Farallones Marine Sanctuary Association

Weather: Blue skies and calm seas. Today was a good day.
Time: 19:56

We woke to bright blue skies and calm seas within the shelter of Drakes Bay, but learned that the swells were still too high to dive at Cordell Bank or the Farallon Islands. We would dive in Drakes Bay today.

Some of the Cordell Bank team: divers, pilots, crew, writers, and photographers.

I was the first diver of the day. Anxious and excited, I helped prepare the submersible. My mission was to work with Kip Evans, the National Geographic Society photographer, and to continue to improve my submersible skills.

As I was floating on the surface preparing to descend, a Coast Guard helicopter buzzed the submersible. It was quite a view of the underside of the helo. On the ship, the CO radioed the helicopter pilot, who agreed to overfly Cordell Bank to verify what the sea state was. His observations confirmed the weather buoy's report of 8 to 12 foot swells, so there would be no chance of diving at the Bank today.

I continued my descent into the murky green water of Drakes Bay. At the bottom the visibility was poor: only about 5-8 feet. I saw the familiar clam siphons and worm holes. Soon the two SCUBA divers, Kip Evans and the ship's Executive Officer, Wade Blake, joined me, and we began our project. The divers documented the dive as I operated the submersible. Using sign language, they kept asking me to smile for the camera - I smiled until my face hurt! I also video taped them

Sunset from the deck of the McARTHUR.

and took still photos. The photo shoot soon ended, and I continued alone on my journey exploring the sandy bottom of Drakes Bay.

(top) RETURN

May 6, 1999

Gale Mead, Expedition Log Editor
Matt Hovelman, McARTHUR crew

Swimmer Matt Hovelman enjoys getting off the McARTHUR and into the water.

Today, the McARTHUR is in port, and we're essentially in between missions. The Nuytco crew is busy doing maintenance on the DeepWorkers, while the crew of the McARTHUR completes needed maintenance on the ship, and the SSE management team meets to discuss the upcoming mission to Monterey Bay.

Throughout the first two missions, you've seen mention of the "swimmer," Matt Hovelman. A member of the McARTHUR crew, Matt was designated early on as the person responsible for getting into the water for each launch and recovery of the sub, in order to remove, and later reattach, the ropes and straps used when the sub is lifted by the crane. Usually, his job is basically the same as the other deck hands, but as an experienced SCUBA diver, he was the logical choice for this task. I asked him to describe his perspective on working with SSE in this capacity.

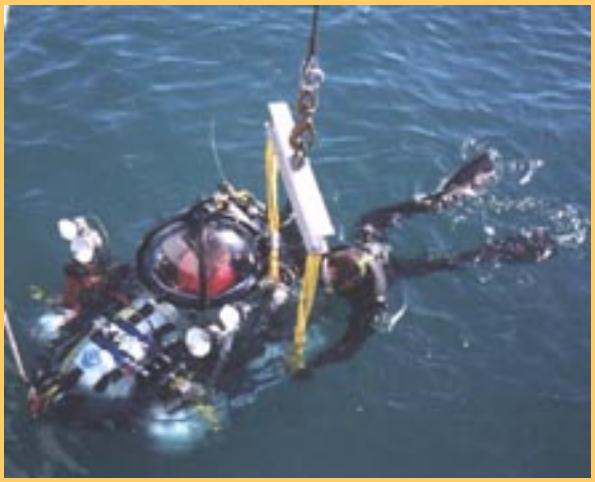
He writes: A day in the life of a swimmer brings to mind worn out cliches about being shark bait, which pierce one's mind faster than a hot knife through an overused metaphor. Basically (and fortunately) all fears evaporate once one jumps into the water. Focusing on the task at hand overcomes any potential paranoia about shark attack, and confirms what Samuel Clemens was quoted as saying: "I've been through some terrible things in my life, some of which actually happened."

I guess the most tense situations I've experienced so far would include:

- When Francesca Cava had the tracking float wrapped around the the transducer pole and it looked like she might have gotten entangled on the McARTHUR.
- When Maria Brown was getting blown away at night and required extensive and laborious towing up-weather back to the McARTHUR. It was dark, and my fingers weren't cooperating because they were cold, and there were all sorts of

lines streaming everywhere which I was getting tangled up in.

So far so good though: Matt 15 - sharks 0. The risks sound worse than they are, given how unlikely they are to happen: the possible danger of losing digits in the thrusters, or a zero-sum game with a white shark. The only real and persistent irritant is being out on the RHIB (rigid hull inflatable boat) for extended periods with no restroom break!



Matt Hovelman assists in bringing DeepWorker back onto the McARTHUR after a dive.

The job is a welcome break from the monotonous routine of being a deckie on the McARTHUR, and I'm happy to do it. If only to get off the darn ship for a short time.

The McARTHUR will be in port until Saturday night, then we're on our way to Monterey, with a new group of scientists, and hopes of weather conditions more conducive to getting the sub in the water so we can get some real science done!

(top) **RETURN**

SUSTAINABLE SEAS EXPEDITIONS
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May 8, 1999

Claire Johnson, Project Team Member
Sustainable Seas Expeditions

Location: Pier 32, San Francisco, CA
Time: 11:00 am - 4:00 pm

Claire Johnson

There was not a cloud in the vibrant blue sky as Farallones Marine Sanctuary Association (FMSA) and Sustainable Seas Expeditions (SSE) employees, along with volunteers and NOAA ship McARTHUR officers and crew kept busy to complete the final set up of the first SSE Marine Sanctuaries Ocean Fair.

The McARTHUR deck crew hung flags and 40 foot banners across the ship, adding the finishing touches to the transformation of Pier 32 into a fair-like atmosphere. Many local organizations, including the Marine Mammal Center, and the Oceanic Society, set up information booths.

On this hot day in May, children and adults could wander around the booths and learn about not just SSE and the sanctuary program, but also a diversity of other projects established to help protect the marine environment and broaden the public's knowledge of issues related to the oceans. The FMSA activity booth was popular with children, who had fun sculpting DeepWorker submersibles out of play dough and crafting construction paper sea anemones and mussels.

Another hands-on activity was designed to help kids understand how blubber keeps arctic dwelling marine mammals warm. The demonstration consisted of placing your hands into a bucket of ice water, one bare, and the other in an insulating mitten made of plastic bags and a thick layer of Crisco.

Other booths provided displays and activities that dramatized how watersheds affect our oceans. Marine environment motivational speaker, Andrew Aguillan, supplied a 3-dimensional mock up of a watershed, depicting a miniature city and the various ways we inadvertently pollute our oceans. A dab of black paint dropped into a mini street drain showed visitors how and where pollutants travel when they go into storm drains, and helped bring the point home: even if you don't live near the ocean, your everyday actions can and do impact on the health of the marine environment. Children watched aghast as this murky, toxic water flowed down into the tiny ocean.

Another demonstration had children wide-eyed with dismay and shock, as they watched how a spray bottle 'rain storm' washed toxic fertilizer, pesticides, and herbicides from the farm lands and yards down into the same water, significantly impacting the health of the marine mammals and other sea life depicted.

(top)

Moving on to another booth, visitors could see the opportunities made available at The Marine Science Institute. These friendly instructors provide children, ranging from pre-school to high school students, hands-on experience with marine science activities, and provide interdisciplinary science programs to help students develop a sense of responsibility for the natural environment and our human communities.

The day was filled with a constant flow of people meandering around the converted parking lot and touring the NOAA ship McARTHUR. Families mingled with DeepWorker pilots on the fantail of the ship, listening with rapt attention to the details of the life support, camera, and electrical systems on the submersible.

A high point of the day for me was a chance to visit with young Davey, a six year old visitor who was wandering curiously around the sub. This intelligent character offered some very perceptive observations about the submersible, and readily grasped the information I gave him about the submersible.

He was fascinated. Later, this six year old admitted to me his immense dilemma: When he grows up, should he be a detective, or an ocean explorer and dolphin researcher? I have a feeling that standing on the battery pod of the DeepWorker and peering in through the acrylic dome at the internal systems of the sub may have helped sway his future career choices more than a little bit.

Those who made their way onboard the McARTHUR were treated to a tour which led them from the fantail of the ship into the Oceanographic Laboratory (a.k.a. Oceo Lab) where samples of marine life, bottled for

research and educational purposes, were on display. Winding their way through the deck of the ship led them to the cool interior of the wardroom to relax and watch video footage of sub operations from our National Geographic Expedition Photographer, Kip Evans. In the Officer's Lounge a continual slide show ran, illustrating submersible operations at the South East Farallon Islands and Drake's Bay, along with images of the many National Geographic Society and NOAA personalities within the SSE project.

Visitors explore the NOAA ship McARTHUR during the first SSE Marine Sanctuaries Ocean Fair.

As the day slowed down and the fair was packing up, the ship began its metamorphosis back into a research vessel. The McARTHUR deck crew donned their hard hats and moved swiftly about the fantail preparing the crane to put one of the subs back onto the ship from the pier. SSE banners were lowered and folded to be stored until the next big Open House and Ocean Fair, and state rooms began filling with researchers and educators about to embark on their journey of exploration and research with SSE in the Nation's largest marine sanctuary, Monterey Bay.

(top) **RETURN**

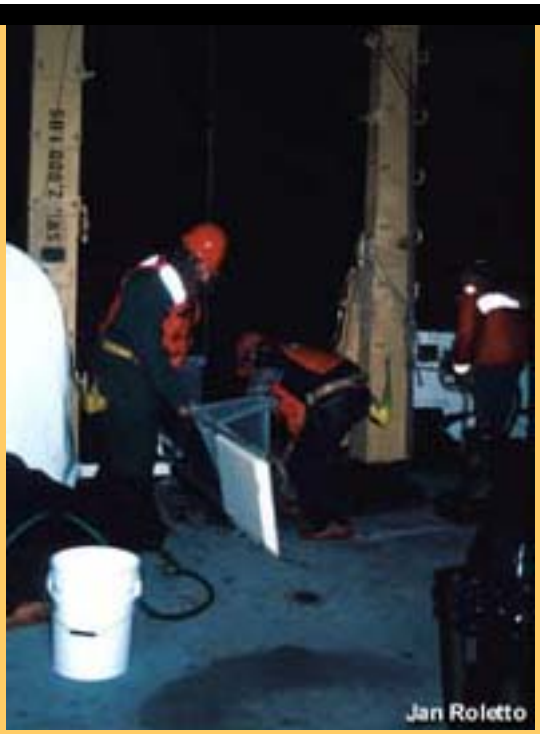
Summary of Investigations

The second leg of Sustainable Seas Expeditions was set to investigate Cordell Bank National Marine Sanctuary. High northwest winds and eight to ten foot swell prohibited dive operations at the Bank. Fourteen dives were completed at the contingency site in Drakes Bay with operations designed to increase pilot proficiency. Navigation exercises and dives using the tracking system, submersible sonar, cameras, and other auxiliary equipment helped DeepWorker pilots increase operational proficiency. Additionally, the operations in Drake's Bay provided an opportunity for planning a complex operation using two submersibles, a remotely operated vehicle (ROV), and two scuba divers, with a complex series of tasks. Such multi-vehicle operations will prove useful in the future for assessing any influences of DeepWorker, scuba divers, and the ROV on fish and invertebrates.

Braving sharky waters, Matt Hovelman makes the plunge to free the DeepWorker from the A-frame.

Nighttime operations included plankton tows. Plankton nets were deployed at night whenever possible to make use of every precious moment of ship time. Data gathered from these nets will contribute to a long-term ecosystem dynamics study being conducted by the Cordell Bank and Gulf of the Farallones National Marine Sanctuaries.

The Cordell Bank Expeditions wrapped up with a Sanctuaries Fair and Open House on the NOAA



Technicians deploy plankton nets at night to gather data for a long-term ecosystem dynamics study.

vessel McArthur. Dan Howard, the mission coordinator participated in the second NASA sponsored Web chat focusing on sanctuaries and Cordell Bank.

(top) RETURN

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EXPEDITION UPDATE

July 9 - 15, 1999

The Stellwagen Bank National Marine Sanctuary Expedition will be undertaken from July 9 - 15.

Surprising color and fascinating faces greet visitors to the deep boulder reefs of the Stellwagen Bank Sanctuary.

The Stellwagen Bank portion of the Sustainable Seas project was launched, auspiciously enough, on the 4th of July, accompanied by fireworks and a 19-gun salute from the USS Constitution. After several days of preparation, launch and recovery exercises, and technical tinkering, we set out to explore this special sanctuary off the Massachusetts coast.

July 9 found Sylvia scuba diving in the sanctuary, while students on the sailing ship Mimi conducted whale acoustics studies and the crew of the Ferrel worked with the scientists and Nuytco technicians to fine-tune launch and recovery procedures.

On the 10th, James Lindholm completed his checkout dive in the DeepWorker, and tested some new through-water communications equipment.

On July 11, Sylvia dove the sub to 252 feet in rocky habitat, while other scientists on board took samples to study microbial life at the surface, in the water column, and on the sea floor.

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On the 12th, Peter Auster and James Lindholm both completed science dives, studying fish distribution, abundance, behavior, and interactions within rocky habitat.

July 13 marked a change to dreary weather to accompany James' morning dive, and high winds that prevented a dive in the afternoon. Tomorrow, we are hoping for improved conditions to dive at the next site selected by our scientists.

The last two days of the mission were a huge success, with a full day of ROV operations on the 14th, and two perfect dives on the 15th with Peter Auster at the helm. The mission to Grays Reef starts July 26. See you there!

Gale Mead, Expedition Log Editor

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Interview

Interview with Peter Auster and Anne Smrcina, Mission Coordinators

Peter Auster #1. Humans had reached the highest peak and the deepest part of the ocean decades ago. How is it that we understand so little about the ocean?

Click here for audio response. (RealAudio), for help see About this Site

Anne Smrcina & Peter Auster

True we, and I mean the global we --humans--, reached these points on the globe in the 1950's and 60's. However, briefly visiting a place does not imply understanding the what's, why's and how's. Suppose we studied life on land the way we traditionally study life in the ocean. It's as if we flew over the land during a thick fog and could not see anything on the surface directly. We might be able to describe the life histories of the animals living on the surface. We could toss a net out of the plane and drag it in many spots and collect our samples. In some areas the net would get hung up and lost in thick forests. We might get samples of birds and bugs, bushes and flowers, but we would not necessarily have gained a whole lot of information from this study. Knowing where things are is important. Knowing what they do, how they interact with their environment, what are the habitats they need to survive and prosper is a whole different story.

Peter Auster #2. How will use of DeepWorker contribute to your understanding of the Stellwagen Bank National Marine

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Click here for audio response.

A drop camera system allowed scientists to photograph this northern red anemone and shy lobster.

The ocean off of the northeast coast of the United States is perhaps one of the most well-studied parts of the ocean world. But there have been limitations. Going to observe life in the oceans is not as simple as working on land -- you need to take your environment with you, as well as all your scientific tools. For our work on the ecology of fishes, DeepWorker is the newest of a wide range of research submersibles we have used in the Sanctuary. The tens of hours we will have underwater during the current expedition will allow us to make the types of primary observations that Darwin made during his voyage of the Beagle, that Beebe made in his bathysphere one-half mile down off Bermuda, and that my colleagues and I make every time we go to work under the waves in any part of the world. But here, the goal is more than just the thrill of exploration or the satisfaction of academic curiosity. The imperative is to gain an understanding of an ocean ecosystem that has been altered by human activities. There is an urgency to understand how the world works so we can better balance human needs with the needs of all of the creatures that inhabit the earth with us, and we should never forget that 99 percent of the world is underwater.

(top)

Peter Auster #3. Has working at Stellwagen Bank National Marine Sanctuary changed your view of the ocean?

Click here for audio response.

This haddock uses a rock as shelter from currents and predators.

Yes, both professionally and personally. This Sanctuary is rather unique in that most of its seafloor is deeper than can be accessed with traditional scuba diving. Given that most people have never seen the "underwater landscape" in this region, I think I have a rather unique perspective of the sanctuary having spent hundreds of hours underwater here, using research submersibles and tethered robots (called ROV's). When most people picture the sanctuary, they see a whale showing it's flukes, or hauling a fish to the surface with a rod and reel, or landing a trawl net full of fish on the deck. I see different pictures, ones that are reminiscent of hiking through a forest, but this forest is one of burrowing anemones and branching sponges. Stellwagen has a wide range of habitats that are representative of most habitats in the Gulf of Maine -- colorful boulder reefs, gravel ridges, sandy plains. It's hard not to have a personal interest in protecting the health of the ocean in general and the sanctuary in particular, having spent the past five years working in these waters. As I sail over these spots on a map, I can see, in my mind's eye, the unique and magnificent vistas on the sea floor. I want them to look wild and pristine 10, 20, 50 years from now.

Anne Smrcina #1 What are the most difficult issues relating to management of the Stellwagen Bank National Marine Sanctuary?

Click here for audio response.

The waters around Stellwagen Bank were popular even before there was a sanctuary. For centuries the area has been a magnet for commercial and recreational fishing. The area has become a major Massachusetts ecotourism attraction, achieving the distinction of being listed as one of the top whalewatching sites in the world. Shipping lanes to Boston pass right over the Bank, adding another level of vessel traffic that could impact sanctuary resources. The great concern of the sanctuary is how to balance these often

A boatful of whalewatchers get a ring-side view of a breach. The sanctuary is working with the industry to assure safe boating around whales.

competing uses with the overarching and primary goal of protecting the resources, including the critically endangered northern right whale and other endangered species.

(top)

Anne Smrcina #2 How does the sanctuary adjust to changing resource needs and advances in our understanding of marine systems?

Click here for audio response.

As required under federal law, the Stellwagen Bank Sanctuary has started a management plan review. We are the first of all the sanctuaries to proceed with this process -- a process that involves a significant amount of public input. The sanctuary's present management plan was issued shortly after the 1992 designation with the goal of ensuring the integrity of all 638-square-nautical miles of this rich marine habitat. Since then we have made great strides in understanding how this ecosystem functions -- and the levels of human impacts on resources. But there are still so many unknowns. This management plan review process will determine where and how the present plan succeeds or fails, and to pinpoint what adjustments must be made to keep the plan current with the latest scientific discoveries, marine management policies, and resource protection issues.

(top)

Anne Smrcina #3 How do you educate people about an area they cannot easily get to?

Click here for audio response.

Kids know about tropical rainforests and coral reefs even though many of them have never been and probably never will get there.

Why do they know about these places and why do they care? Because they were taught. The significance of these environments to the global ecosystem has been addressed. They have learned -- and with this understanding comes caring. Our sandy banks and deep boulder reefs are just as important for their wealth of resources and biodiversity. Perhaps their proximity has been part of the problem -- the old axiom that the grass is always green on the other side of the fence. And then there's the adage -- out of sight, out of mind. Vessels can bring students out to see surface activity like feeding birds and breaching whales -- and that's a good first step. But we can also bring them to deeper depths vicareously through imagery and state-of-the-art educational technologies. There's a world of wonder out there just off our own shore.

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Natural Setting: Voyage to Stellwagen Bank

Anne Smrcina, Education Coordinator
Stellwagen Bank National Marine Sanctuary

My first trip out to Stellwagen Bank was to see the whales -- this must have been about 15 years ago, long before the area became a national marine sanctuary. Whalewatching can be a tricky undertaking -- now you see them, now you don't -- just as it is in any ecotourism enterprise. But the Stellwagen Bank area is considered one of the ten top whalewatching sites in the world, and on that day our boat captain and the whales did not disappoint.

What a show it was! One young humpback whale must have breached two dozen times or more in a row. Other whales were tail slapping or flipper slapping or busy gulping small fish or resting at the surface after their piscine feasts in a behavior known as logging.

Since that time I've been out when whales were scarce and when whales were plentiful. They seem to come and go, based on their own natural calendar and environmental factors that we do not completely understand. Nevertheless, a trip into the sanctuary is always an adventure.

Sometimes the trip to the Stellwagen Bank Sanctuary is flat calm -- the boat moving along at a steady speed as gulls hover above awaiting the opportunity to recover scraps of food. On other days, gusty winds will whip up the waves, creating a choppy, bumpy course. In the winter, the annual Christmas Bird Count sets out to count the avian species calling these waters home -- razorbills and kittiwakes and murres among them. On a summer's calm clear day you can see far off into the distance to witness a larcenous phalarope harassing a tern until it drops its catch, or a dive bombing gannet piercing the surface waters from a steep dive as it spots its targeted fish.

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On some trips into the sanctuary it would appear that you were all alone, surrounded on all sides by open water no different than waters anywhere else in the world (or at least the North Atlantic). The murky greenish water, so characteristic here, is not really dirty or polluted, but a rich soup of plant and animal life. Golden brown algae or diatoms fill the water thereby giving it is color (golden-brown plus blue makes murky green).

Feeding on this plankton buffet are small animals, including the ubiquitous copepods, the most common form of sea life, each smaller than a grain of rice. Take a gulp of sea water accidentally, and you've probably ingested quite a few of these little critters.

Vast expanses of water allow for remarkable horizon-wide sunsets.

The right whale's northern critical habitat (a feeding area) includes part of the sanctuary.

Northern Right whales, a species which was once heavily hunted, and of which only a few hundred still survive, love these small crustaceans. The whales come to the waters of Cape Cod Bay and Stellwagen Bank in the late winter and early spring to plow through thick patches. How they locate these concentrations of zooplankton is not understood. As they feed, sometimes at the surface, but more often submerged, the whales appear to be oblivious to vessels, making them susceptible to fatal ship strikes. Occasionally a V-shaped blow will appear at the surface, indicating the presence of one of these giant creatures.

What appears at first glance to be empty of life is, on closer inspection, occupied by a multitude of species. Other pelagic animals float or swim by -- the mesmerizing jellyfish, the quick flash of the bluefin tuna, the outlandish ocean sunfish, or massed groups of small sand lance, the preferred prey of many species of whale and fish. Wilson's storm petrels scoot along the surface of the sanctuary

searching for tiny animals that will build up their fat reserves and provide the fuel power to take them to their wintering grounds in the far reaches of the southern hemisphere. Suddenly, a vessel may be joined by a pod of playful white-sided dolphins, riding the bow wakes and jumping for what seems like the joy of it.

Several flashes of blue may mean that a school of Atlantic bluefin tuna are passing by.

The surface world of the Stellwagen Bank National Marine Sanctuary is just one small part of the bigger picture, a picture that most of the public does not get to experience either personally or vicariously. Due to the depth of the waters (65 feet at its shallowest part on the bank and ranging down to 600 feet in parts of Tillies Basin), scuba diving in the sanctuary is not a common occurrence. But years of bottom fishing have given us a good idea of the types of creatures that reside on the seafloor there, and scientists have been sending submersibles and remotely-operated vehicles down to begin to understand how the sanctuary's creatures are using their habitat and interacting with one another.

Unlike some of the other sanctuaries where much of the underwater terrain has not been explored, we are lucky to have been the focus of a major mapping project by the U.S. Geological Survey. Every part of the sanctuary has been covered by multi-beam side-scan sonar surveys, leading to the production of images that look just like aerial photographs. Gouges from retreating icebergs during the last Ice Age can be seen in the northeast corner of the sanctuary; glacial eskers are found between the bank and Cape Ann. Based on the return signal of the sonar, scientists now know which parts of the seafloor are mud, which are sand and which are gravel/cobble/boulder. This sediment characterization forms the basis for research projects looking at the types of animals that inhabit certain areas and how they use that habitat.

Sea stars are not sessile creatures, they do move about, and this horse star seems to be on the move.

The underwater landscapes in the Gerry E. Studds/Stellwagen Bank National Marine Sanctuary range from cerianthid forests in mud basins to deep boulder reefs that shelter numerous species of fish including the aptly named redfish. Pink shrimp hide under anemone crowns and wolffish find dens among rock accumulations. Goosefish partially bury themselves in the sand and lure prey right into their mouths with their own form of fishing pole. Lobsters seem to be satisfied with either rocky nooks or mud holes.

This year's Sustainable Seas Expedition allows us to get a close-up look at one of these specific underwater habitats -- boulder reefs. Deeper, darker, and colder than its tropical coral reef counterpart, the boulder reef is still a magnet for fish -- just more difficult for access by human researchers. With submersibles and remotely-operated vehicles and drop cameras we are getting a better understanding of what is happening under the waves as the whales and boats pass overhead. Other research in conjunction with SSE will give us further insights into the diversity of animals in the sanctuary and how they relate to their habitat. The mission to Stellwagen Bank has only just begun.

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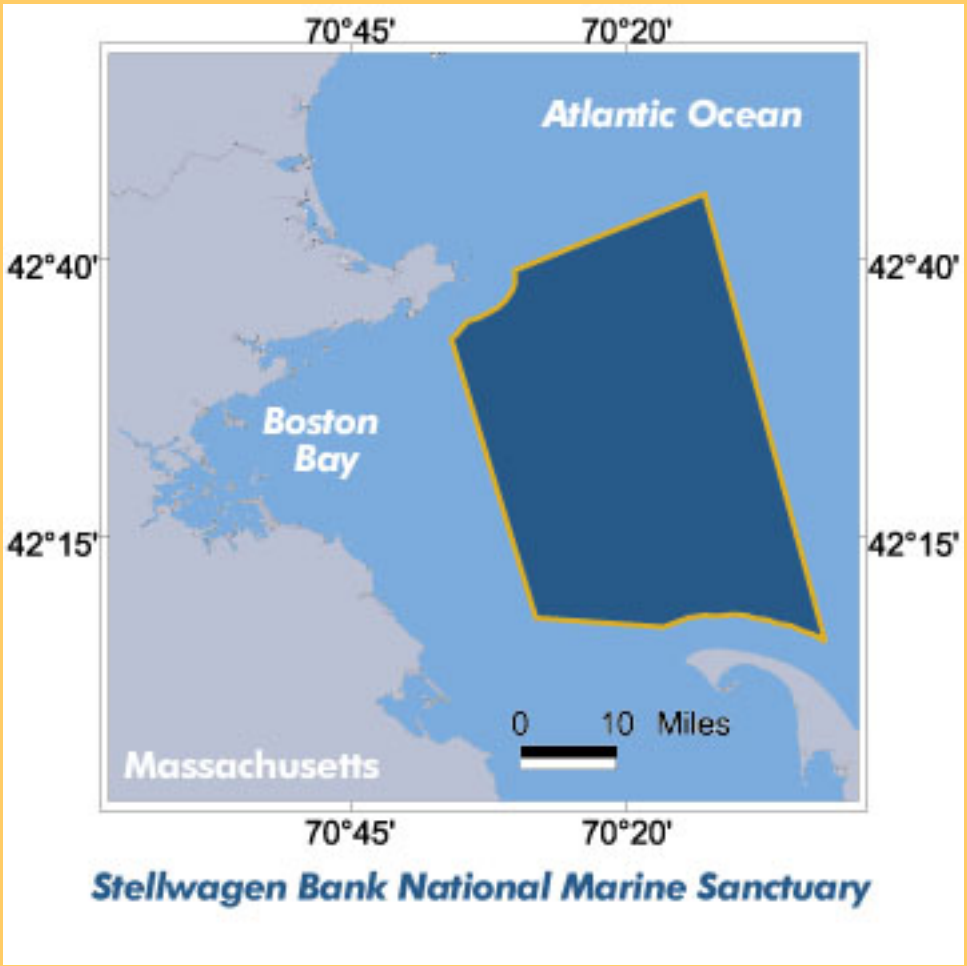
Maps

The Sanctuary



The slow retreat of massive Ice Age glaciers formed what is today Stellwagen Bank, a sand and gravel plateau at the mouth of Massachusetts Bay. There, ocean currents sweep water in and out of the bay, with the bank partially blocking the opening and funneling the flow into relatively narrow passageways. Nutrient-rich

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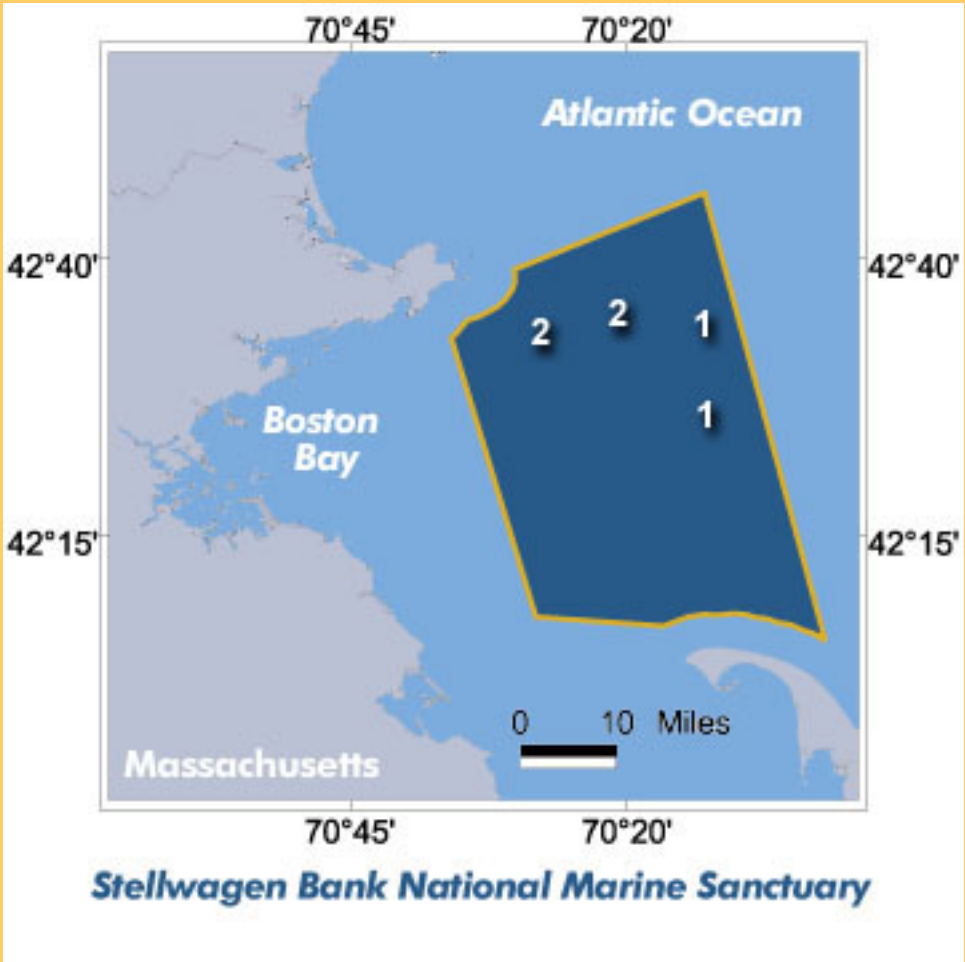
water in deeper Stellwagen Basin and the greater Gulf of Maine encounter the bank and rise up over this underwater obstruction, creating complicated upwelling currents that power the food web of the region. With the energy of sunlight, these nutrients, now pulled to the surface, nourish oceanic "plant" or phytoplankton growth, just as fertilizer does to a lawn. This rich New England vegetable soup feeds blooms of small animals -- the zooplankton -- which in turn support a vast multi-layered food web that culminates with the great whales.

(top)

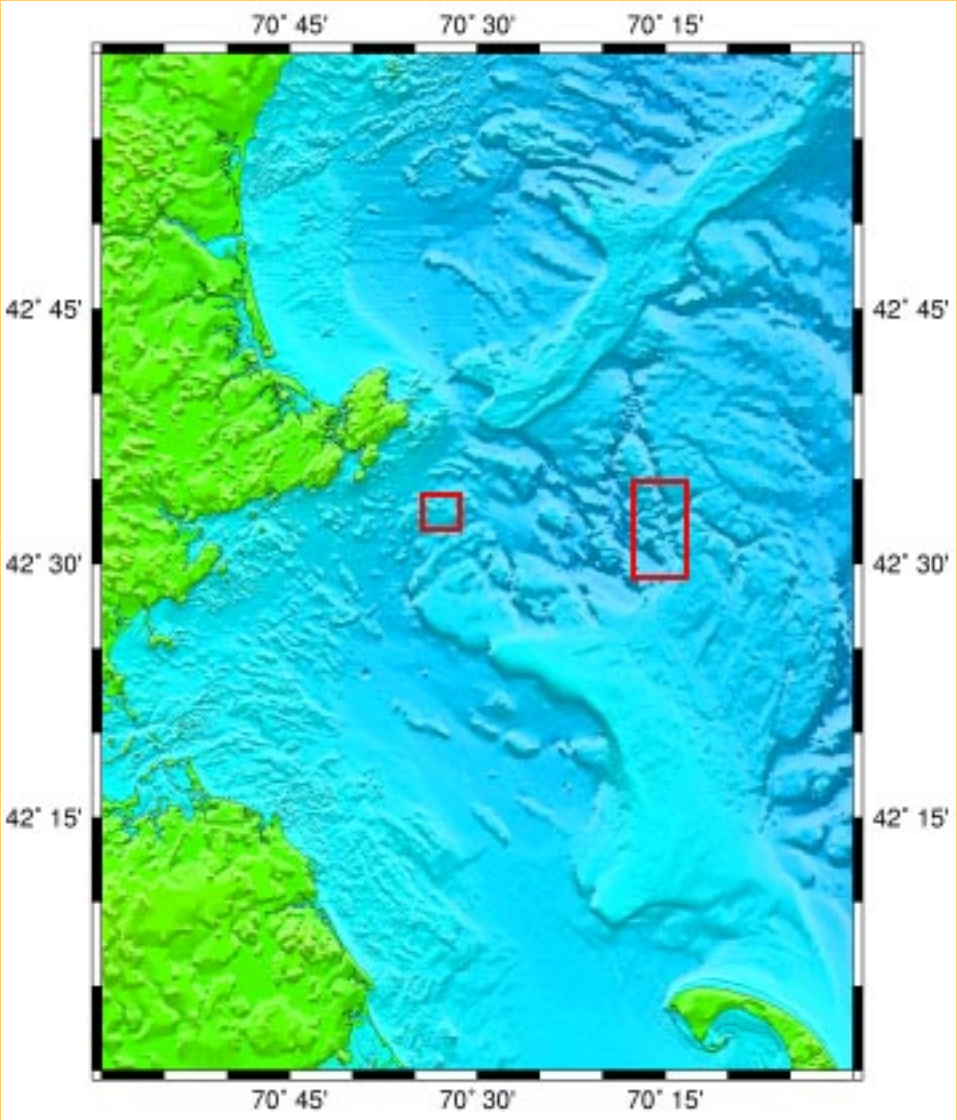
The Mission



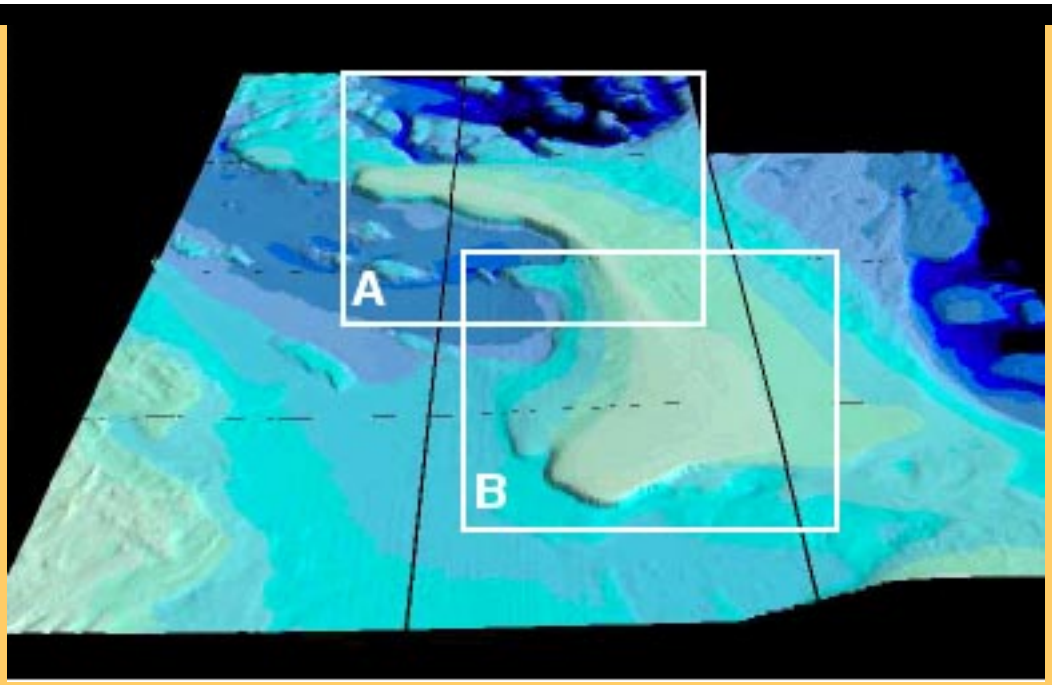
1.) The primary dive sites are deep boulder reefs within the Maine Cod Closure Area. 2.) Alternate dive sites provide a bit more shelter in case of rough seas and inclement weather. Here too, the study sites are boulder areas, in the Tillies Basin off Cape Ann.

(top)

The Sea Floor



This is a 2-D map of the sea floor of the Stellwagen Bank region and surrounding land areas. The tip of Cape Cod is visible in the lower right. The two rectangles show the approximate areas of the expedition dives. Boulder Reef, the area to the right, is the highest priority area. Science activities will include behavioral and biodiversity studies.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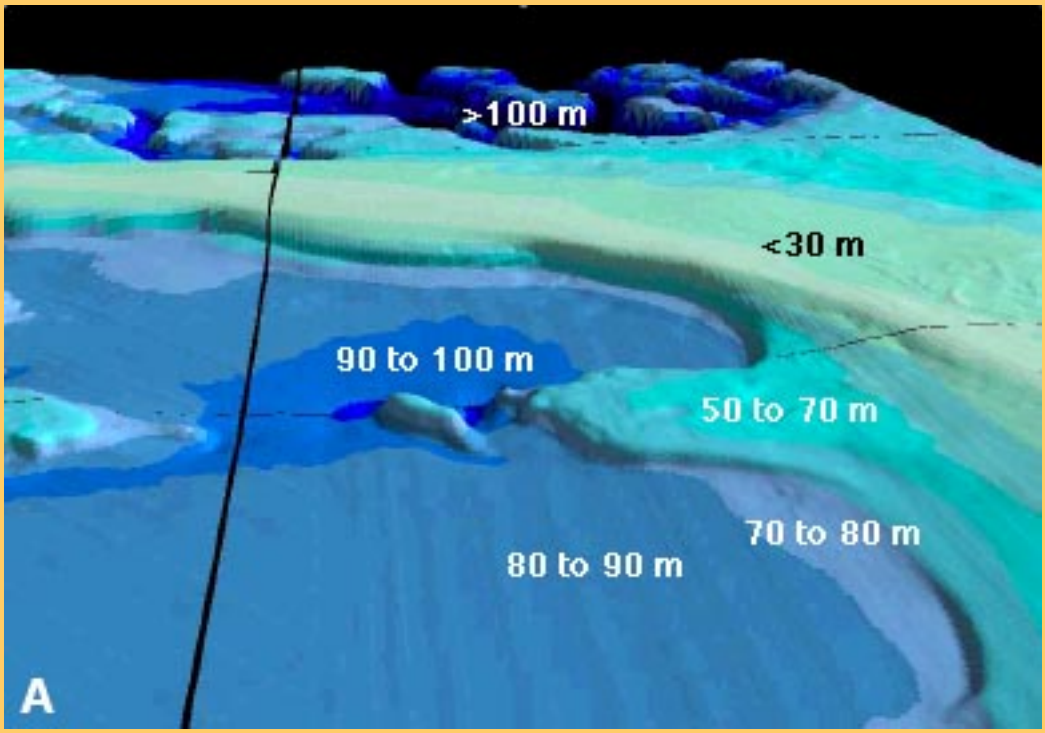
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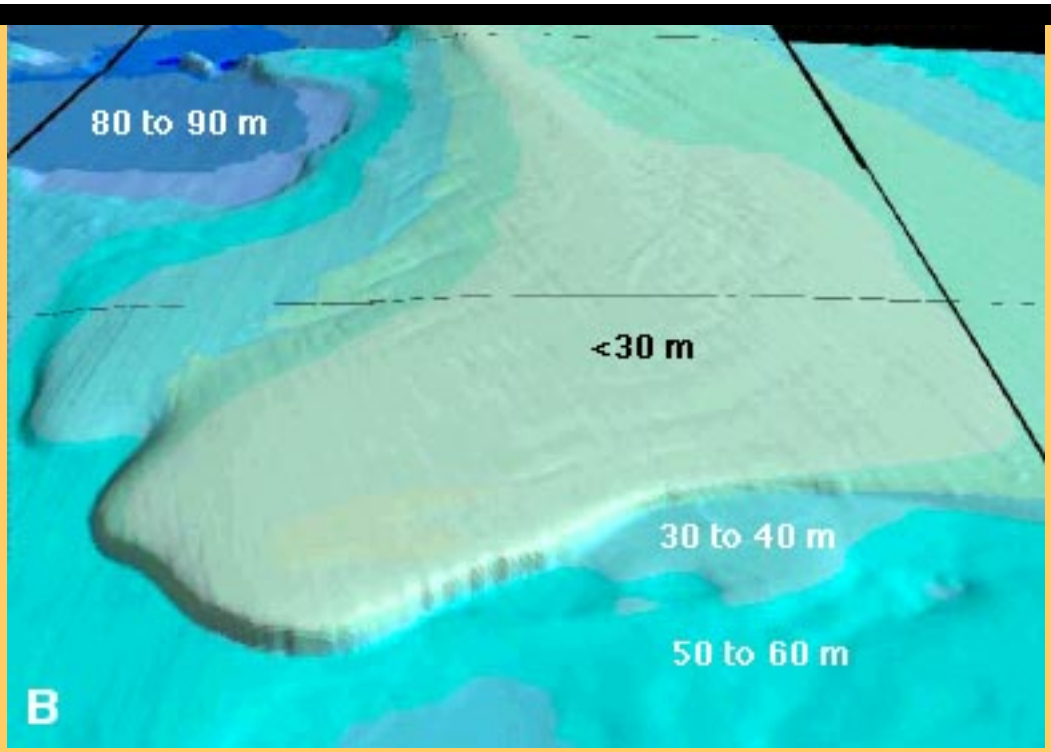
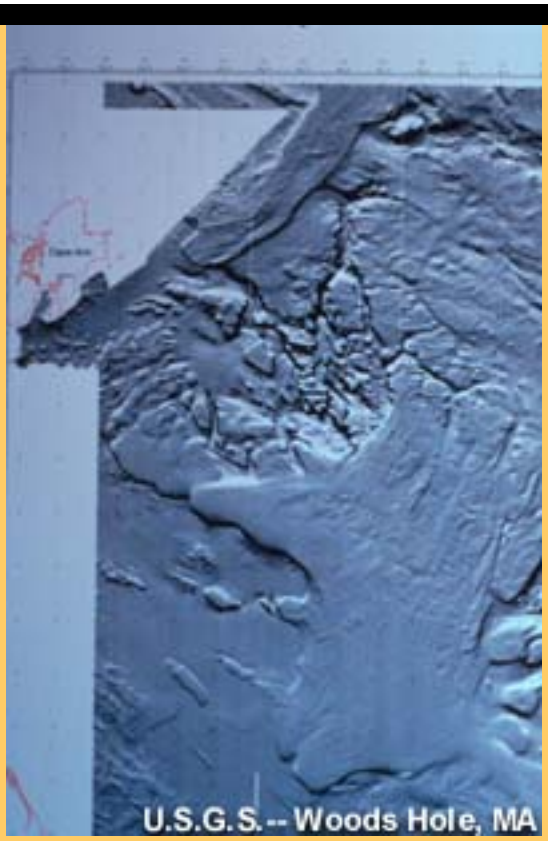


As these 3-D maps show, there is excellent data on sea floor depths for Stellwagen Bank. The topmost map shows the entire bank. Below it, maps A and B show the northern and southern portions, respectively. The black lines transversing the map are longitude and latitude lines.

The entire Stellwagen Bank region is relatively shallow water. The two dive areas (shown on previous map) are in deeper northern waters, but, even so, the waters are only 60 to 80 meters deep. (Source: based on USGS and NOAA's hydrographic survey data collections)



A multi-beam side scan sonar survey of the sanctuary by the U.S. Geological Survey has produced a remarkable image that looks like an aerial photograph of the seafloor topography.

(top) **RETURN**

Understanding the Lives of Fishes of the Deep

Peter Auster and James Lindholm
National Undersea Research Center (NURC)
University of Connecticut

Peter Auster

We study the ecology of fishes. Most people think that this involves going to tropical islands and working in warm, clear water with colorful and diverse fishes swimming over an otherworldly coral landscape. In fact, we understand a great deal about coral reef fishes, precisely because they occur in such pleasant conditions for study (who wouldn't want to go work in tropics?), and because they are accessible using simple technologies such as snorkel and scuba. Using the power of direct observation, we can study individual fishes interacting with their prey and predators, and how they utilize various habitats. It is through this ability to see individual animals in their environs that we have made so much progress understanding the lives of many species on coral reefs and in other shallow water habitats such as kelp forests, seagrass meadows, and mangrove swamps.

However, while many people can envision the world of a coral reef fish, these same individuals only associate species that occur in deep, cold, and turbid outer continental shelf habitats with their dinner plates. Yet these wild animals, fish such as cod, haddock, redfish, cunner, cusk, and a diversity of other species, lead lives just as interesting as their warm-water relatives, linked to the habitats in which they occur. It is simply a bit more challenging to view these fish in action.

When we venture beyond the depth range of snorkelers and scuba divers, our ability to study fishes is limited. Consequently, research

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James Lindholm

on fishes of the outer-continental shelf has been conducted traditionally by capturing them using trawls, dredges, traps and other kinds of nets. These types of studies tell us a lot about the populations of fishes, such as where they occur, their average size, age, sex ratios, and when and where they spawn. However, such studies tell us nothing about how individual animals live and interact with their environment. While we might learn that redfish occur near boulder reefs and anemone fields, research conducted using traditional gear will tell us little of the nature of the interaction between redfish and these habitats.

SeaBOSS, a benthic oceanographic sampling system, is lowered over the side to obtain still and video images of the seafloor.

It is here that the Sustainable Seas Expeditions provide us an excellent opportunity to study the ecology of fishes on deep boulder reefs. Only by going underwater, using various kinds of research submersibles (like the manned submersible DeepWorker 2000) and underwater robot systems called remotely operated vehicles (or ROVs) can we do the types of studies that our counterparts in the tropics have done so well. These technologies provide us the opportunity to explore greater depths, for much longer periods of time, than is permitted with scuba. And in the case of DeepWorker 2000, we are able transport ourselves to these depths, using our own eyes to observe ecological systems at work.

During the Stellwagen Bank mission, we will be focusing our attention on deep boulder reefs at several sites within the Stellwagen Bank National Marine Sanctuary. Like shallow coral reefs, these boulder reefs are complex habitats that provide fish shelter from predators and bottom currents, while also serving to concentrate prey for easier capture. Unlike corals that occur in well-lit shallow waters, these structures occur in the twilight region between depths of 50 and 90 m (150-300 feet).

Our studies will use the DeepWorker 2000 like a "blind" to study the

Frilled anemones cling to a boulder as do other encrusting organisms. The boulder reefs of the sanctuary support a diversity of life just as more tropical coral reefs do -- they're just deeper, and darker, and colder.

behavior of fishes, much like ornithologists use blinds to study birds. By positioning the sub next to a boulder reef and shutting down thrusters, we hope to view the behavior of fishes in their "natural" state. In particular, we will be looking at how behavior changes from day to night. On coral reefs, communities of fishes change from day to night, with some species emerging from crevices in the reef at night to feed, while others descend into the reef at night for a "quiescent" or rest period. Some species of shallow water fishes off New England behave the same way.

Using the DeepWorker 2000, we hope to answer the following questions: What happens to fishes in waters where even at high noon, light levels are similar to a cloudy day at dusk? Do fishes react to small changes in light? Do small fishes take shelter deep within the reef at night? When do larger fishes emerge from the reef to feed? Do predators spend more time around these reefs at night?

A sponge forest provides cover for a longhorn sculpin which lurks along the seafloor of the sanctuary.

Answers to these and other questions are critical to understanding how fishes use these poorly studied habitats, and how we as humans manage our activities to minimize our effects on the ocean. Using sophisticated underwater sensors and cameras attached to the DeepWorker 2000 and the power of our own human eyes, we will collect data with hopes of gaining an improved understanding of the lives of our local ocean wildlife.

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Two Overlapping Metaphors

Richard Wheeler
Educator, Naturalist, Time Magazine Hero-of-the-Planet

(Mr. Wheeler's sea kayak trip from Funk Island north of Newfoundland to Cape Cod became the subject of a NOVA video "The Haunted Cry of a Long Gone Bird." Over the past several years Mr. Wheeler and the sanctuary have been collaborating on the development of a soon-to-be-completed curriculum package which will include a video "Bounty of the Banks", a teacher guidebook and an audiotape by master storyteller Jay O'Callahan.)

"What made you decide to do it?....You spent four months paddling along the coasts of Newfoundland, Nova Scotia, and New England in that tiny boat of yours.....You say that you were following the ancestral route of a flightless bird that has been extinct for over 150 years.....What attracted you to that bird ?"

I've been asked that question many times, and I really can't blame people for asking it, even when they slip in a zinger question such as, "Are you nuts or something," because the notion of a sixty year old grandfather following the route of a flightless, extinct sea bird does tend to give new meaning to those jaded expressions, "over the top" and "off the wall."

My answer is the same each

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The Great Auk was hunted to extinction by 1844, ten years before the discovery of Stellwagen Bank. It probably wintered on the bank, just as its cousin the razorbill does today.

time, but I've never written my "answer," so I will seize this opportunity to do just that because there is a direct connection between "my" bird and "your" Stellwagen Bank. (My use of the "my" is of course facetious, but the use of "your" is deadly serious. I don't "own" the Great Auk, but you and every other American should begin to think of Stellwagen in possessive terms for reasons I will attempt to explain.)

For most of my life, I tell them, I have been a very serious amateur naturalist, and for the last 10 or so years my reading and my observations have led me to believe that our relationship with our planet is tragically flawed. I wanted to lend whatever support I could to those who had reached that unsettling realization before I had...environmental educators and awareness raisers...not prophets of doom.

Because I had seen that bumper sticker that tells us to "Think globally; act locally" so many times I automatically felt the need to focus on one part of the globe, and no one who knows me was surprised that I chose the Gulf of Maine, because that body of water has been my "front yard" all my life.

But how would I do it? The Gulf of Maine is small in relation to the whole planet, perhaps, but if I was going to come up with any meaningful education programs I was going to have to come up with a plan that would make the Gulf of Maine bite-sized. How would I do that?

Richard Wheeler's voyage took him from Newfoundland to Cape Cod. Important ocean features in the Northwest Atlantic Ocean not far from his route include the Grand Banks, Georges Bank, and Stellwagen Bank.

The Great Auk became the answer. The bird had become extinct so long ago that no one now alive would need to feel guilty or blameworthy, and yet in the telling of the story people would surely make the connection between the human flaws that led to the demise of the Great Auk and the human flaws that are, sadly, alive and prospering today and which, if left unchecked, could cause other Gulf of Maine

critters to go the way of that flightless bird.

Our great New England poet Robert Frost once described a metaphor as "saying one thing but meaning something else." The Great Auk is an apt illustration of that definition. On one level the story of the Great Auk is just that: the account of a creature that never "learned" to outsmart humans and which therefore perished. They provided the early explorers with food; later, their flesh, oil and feathers supported commercial ventures.

But there are messages for us in this story, in the logs of the ships of the early explorers: "There are so many of these birds," they wrote,, "that no matter how many we kill there will always be more." There is also the statement by 18th century naturalist Sir Richard Whitburne that illustrates a belief that is imbedded within our culture: "It was generous of our Lord to provide us with so innocente a creature for our sustenation." The Great Auks were put there for us, in other words..... just like the fish of Stellwagen Bank? More than anything else, those two observations... one remarking that no amount of human predation could possibly wipe out something that existed in such staggeringly large numbers, and the other a bland statement of the persistent assumption that everything in what we call "nature" was put there for us...are to me the ones that lift the story of the Great Auk and cause it to become the driving metaphor of a tragic epic poem about the human race.

Once cod were so plentiful, mariners reported scooping them up with a bucket. Now researchers are lucky to photograph one of these commercially-important fish.

So I did my paddle-trek as a result of my conviction that the spirit of the Great Auk has a message for all of us today, and I flung myself onto its old route in a sort of quest to soak up a feeling for the ways the Auk-as-metaphor could be used in education and awareness programs. As it turned out, the Newfoundland fisheries collapsed as I was making my way along that coast, and the surprising truth is that even though I had "bought into" the Great Auk metaphor hook, line and sinker, I had a hard time coming to the realization that human predation was the principle cause of the "disappearance." How could a fish that lays its eggs in the millions ever get wiped out? But that is what happened, and ten years later there is no reassuring sign of a recovery by this incredibly fecund fish in the place where there were once so many

that they provided food for the populations of two continents.

My association with The Stellwagen Bank National Marine Sanctuary is a natural one for a teacher who believes as much as I do in the enormous teaching power of appropriate metaphors. I spend my time exploiting the Great Auk metaphor, but what is Stellwagen Bank if not the most powerful metaphor for the ocean that we have? If the sanctuary continues its thrust of making us look at the ocean through the lens of Stellwagen-as-metaphor don't we have a chance to bring about a change in the way people relate to the ocean? And while we're thinking big, why not from that to the way we relate to the entire planet? Saving Stellwagen isn't what it's all about. Far more is at stake.

So far humans worldwide have behaved in ways that have led to the imperilment of most of those special areas of the ocean of which Stellwagen is just one.

(top) **RETURN**

Protecting Whales

Ms. Fran Howley's 5th grade class
Pemetic Elementary School
Southwest Harbor, Mount Desert Island, Maine

A right whale breaches off the Massachusetts coast. These whales are the most critically endangered of all the great whales.

We have been studying whales in class and we are concerned about their population. We received a report from Journey North [an internet-based science/math education program] about northern right whales that said one was found dead and floating in Cape Cod Bay. Scientists determined that it was probably hit by a ship. Another right whale that was seen tangled in line, but rescuers were unable to find the whale again so they could free it. This is sad because there are only 300 North Atlantic right whales left on earth! If we keep killing them they will soon be extinct!

We would like the government to make laws to help save the whales on the coast of the United States. Maybe we can make laws about how fast boats go and where fishing line can be put.

We would like boats and ships to take care when traveling through sanctuaries, migration routes and breeding grounds. We know that near Massachusetts, boats to and from Boston go right through the feeding grounds of several types of whales.

We also think boats should be limited to how many minutes they spend near whales because of their noise and how that may be

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Tuna boats and humpback whales share the same waters, since tunas and whales eat the same food -- sand lance.

hurting the animals' hearing. Mothers and babies might also get separated and not be able to find each other because of the engine noise. We think people should have a permit to whale watch and they should stay in certain areas.

In the past, humans had uses for many parts of the whale. Now we have man- made materials that substitute for whale products, so we don't need to hunt them. Pollution and global warming are problems too.

We need to take better care of the whales' habitat. If boats and people on shore pollute the ocean, the whales' food will start to die and then the whales will too. Like us, the whales need to eat!

We are writing to help people understand and protect the whales. They are beautiful creatures and we don't want to lose them. We would like to see more people help save the whales. They can write letters, call people, or join whale conservation groups.

Sand lance peak out of the sediment. Humpback whales have devised several methods to catch this fish -- their favorite food.

Can you imagine what it would be like if there weren't any whales? We can't! We would like our generation and other after us to see these magnificent animals.

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Sounds in the Sanctuary and Sea

Dr. Peter Scheifele
National Undersea Research Center (NURC)
University of Connecticut

Peter Scheifele

The ocean can be a terrifically noisy place. At its calmest, the sea hums along at a noise level on par with having a conversation with a close friend. In the midst of a storm, the ocean may sound more like an international airport runway; the noises of tall waves crashing against the surface and the roaring engines of cargo ships can create a thunderous cacophony. Then, there are those noises that even the most attentive listener will miss. I once followed what looked like a juvenile lobster across Stellwagen Bank's sandy floor with a microphone on a hunch that it was emitting some sort of sound beyond the range of human hearing. After slowing the recorded sound down considerably, I could hear it loud and clear. Turns out lobsters DO scream, just at far too high a pitch for any human to perceive.

Click here to listen to a recording of two humpback whales -- a mother and her calf.

Click here to listen to a recording of two humpback whales feeding in the Stellwagen Bank sanctuary.

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Click here to listen to a recording of a fishing vessel in the waters of Stellwagen Bank.

Click here to listen to a recording of a ferry boat crossing the St Lawrence River from Baie St. Catherine.

Science never paid too much attention to ocean sounds until about five years ago when Walter Munk at Scripps Institute of Oceanography proposed an experiment that unintentionally alerted the scientific community to the growing problem of noise pollution in the world's waters. The Acoustic Thermometry of Ocean Climate experiment, or ATOC, was masterfully designed to assess any increase in ocean temperatures. We know the speed of sound passing through the water depends on three things: temperature, salinity and pressure. The latter two being relatively constant, Munk believed that if he sent a series of giant low-frequency sound waves over long distances through the ocean, he might be able to detect an increase in ocean temperatures. The experiment promised to yield a more accurate understanding of ocean temperature change than a simple average of temperature readings from several acute points in the sea.

Humpback whales make a variety of calls in addition to their famous "songs" (most often heard in the breeding grounds but occassionally up north at Stellwagen Bank).

But back on land, a cry went out in the scientific community that the ATOC experiment may harm the marine life which depends on sound to communicate and survive. We know that the low-frequency bellows of communicating whales can span ocean basins. Would the ATOC experiment disrupt their all important calls? We also know that sea porpoises and dolphins bounce high-frequency sound waves off of underwater structures to navigate their way through the sea. Might a large blast of man-made sound compromise their way of life or, worse yet, render them deaf or hearing impaired?

These questions remain unanswered. By its nature, the ocean has a

highly complex acoustic architecture that is notoriously difficult to tease apart and study. In the veritable orchestra of ocean sounds, low frequency seismic movements of the earth provide a sort of bass-line that underlies all other noises. Meteorological factors such as the sounds of crashing waves or the reverberation of each falling raindrop fill out the treble clef. And marine life comes in with the melody; cod fish sing to one another at a frequency of about 50 hertz; dolphins and porpoises squeal; swim bladder fish huff and puff as they take in then release air. Just about every living thing contributes to the overall effect.

Man-made noises have made an increasing contribution to ocean sounds in recent years. The signature sounds of each passing ship are so unique that the military can use them to identify friend or foe. Low-flying planes coming in to land at coastal airports propagate strong waves of sound into the sea. The bottom-dragging nets of fish trawlers are so noisy that a net two miles away can sound through a hydrophone as if it's right next door.

Research at the National Undersea Research Center includes recording a variety of ocean noises, including different types of ships, such as this type of tanker.

Marine life has done its best to adapt to the recent intrusions of anthropogenic sound into its environment. Many animals have started making louder vocalizations in an attempt to overcome higher ambient volume, a phenomenon called the "Cocktail Party Effect." As of yet, nobody can predict what might happen if anthropogenic noises were to become so loud that animals couldn't compensate by raising their voices. A handful of scientists are investigating the impacts of noise on whale hearing, but as of yet, no conclusive statements can be made about it.

Dr. Darlene Ketton at the Woods Hole Oceanographic Institution examines tiny hairs that line the inner ear canals of deceased whales looking for signs of physical damage. Whale audiograms, similar to the hearing tests humans use, promise to give us an idea of just what some marine mammals hear. I, myself, have undertaken to elucidate the physics of sound in marine environments, and the audiology of whales. Other researchers study the behavioral reactions of whales to loud noises. But as with all scientific research, progress is slow and tedious.

For this reason, we must guard against becoming too impatient. In our day, the public and policy makers alike increasingly demand instant gratification; they expect answers overnight, and solutions that follow shortly. Unfortunately, this expectation directly undercuts the slow meticulous nature of good scientific research, the kind of research that will someday yield a better understanding of how marine life copes with unnatural sound.

Before that day comes, it makes sense for humans to exercise caution when they strike out into the world's waters. No single point source is to blame for the insidious problem of noise pollution. Everyone of us who uses the ocean for commerce, research, or even pleasure, is responsible. Only together can we keep the symphony of natural ocean sounds intact.

Click here to learn more about the NATIONAL UNDERSEA RESEARCH CENTER for the NORTH ATLANTIC & GREAT LAKES.

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Marine Protected Areas: When You're There, You Know

Brad Barr
Former Manager, Stellwagen Bank National Marine Sanctuary Senior Policy Analyst, National Marine Sanctuary Program

30 June, 1999

Brad Barr answers questions about protected areas from students on board a research ship in the sanctuary.

When I first visited Stellwagen Bank many years ago, I knew I was in a special place. You perceive this sense of specialness somewhat more subtly than you might on a visit to the Grand Canyon, Banff National Park in the Canadian Rockies, or the Cape Bretton highlands in Nova Scotia where you encounter one indescribable scenic vista after another, but you get the same impressions nonetheless. In fact, for many years, to introduce this point, I started my talks about Stellwagen with slides of the water's surface facing north, south, east, and west. Just the ocean's surface. It looks pretty much the same from above, whichever direction you look. But this area is so much more than just another patch of ocean.

It's sort of like when you are traveling through an unfamiliar town looking for someplace to eat. You may pass lots of different places, but the one you stop at is the one surrounded by the most cars, and when you go in and the waitress calls you "honey," you know

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you're in the right place. While the sanctuary doesn't usually have someone who will call you "honey" when you arrive, it is a place you just know is special. Nearly a million people visit the Stellwagen sanctuary each year and those people can't *all* be misguided. The many whales, bluefin tuna, and groundfish that come to Stellwagen Bank each year certainly would appreciate this analogy... The sanctuary is their crowded diner along the side of the road.

While there are more scientific definitions of "marine protected area," this perception of specialness is mine. I have had the opportunity to visit marine protected areas (or MPAs) in other parts of the world, as well as nearly all the sites that comprise the National Marine Sanctuary Program. I can honestly say that this perception of the special nature of MPAs is close to universal. During a trip last year to a meeting in Australia, I traveled north from Sydney to Queensland, and when we passed the southern boundary of the Great Barrier Reef Marine Park, you could just tell that the place was something special, something worth saving, something people valued. Go to Monterey, to the Olympic Coast, the Florida Keys, or the Hawaiian Islands Humpback Whale Sanctuary and you'll see what I mean.

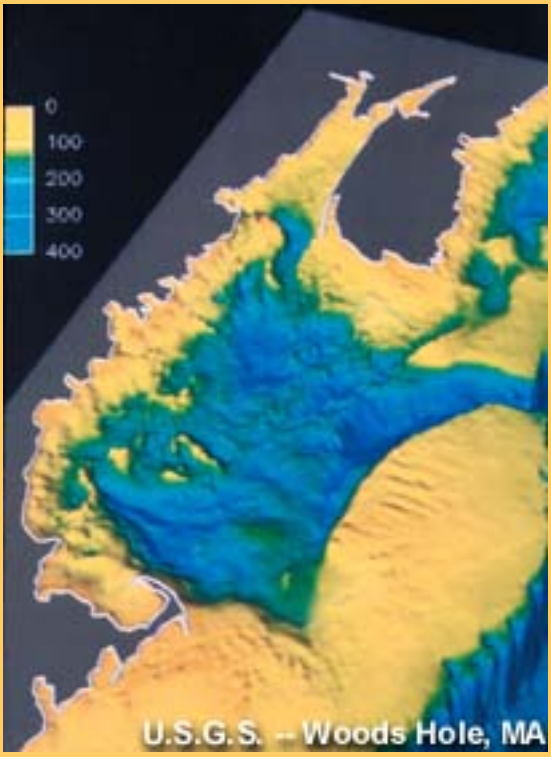
In an effort to protect humpback whales, NOAA and other organizations have been developing whalewatching guidelines and other education and conservation programs.

OK, maybe it's just me and the filters through which I view the world. But, for perspective, I would offer that during the Dedication Ceremony for the Stellwagen Bank Sanctuary in 1993, story after story was told from the dais by folks who felt the same sense of "specialness" during their visits to the Bank. If this perception is some figment, it is shared by a whole lot of people.

As a biologist, I am aware of what resources and attributes make a particular site worthy of protection. I can appreciate, for example, the awesome diversity of some deep sea bottom communities discovered off North Carolina a few years ago, and can see reasons why such areas should be preserved if threatened by the long reach of man's influence. However, the places that engender people's passions, their sense of wonder and awe, certainly something more than a passing academic interest, are the ones that become MPAs. It is the people that make the difference between some place with

special natural resources, and someplace special. A place special enough for us to agree to establish regulations restricting our own activities in that area. We are willing to do this, an arguably altruistic act, to ensure that our kids, and their kids, will be able to experience the same sensation of specialness.

Few of these areas we chose to protect are closed off from all activity. Unlike a terrestrial park that can be gated, the ocean is not a place where gates are very practical or appropriate. Many of the existing MPAs in the US and elsewhere allow quite a few activities to take place within their boundaries, based on the sometimes overly optimistic belief that those activities will not threaten the resources or qualities of that site. While the ocean can take some disturbance and bounce back, this robustness has its limits. As we increase our understanding about how marine ecosystems function, we are becoming more aware of how sensitive some of these areas are, and finding a greater need for protections we didn't think were necessary a few years ago. The costs of this higher level of protection may be significant in further restricting what we can and can't do in these areas, but they are costs we must bear if we are to have something of value to pass on to future generations.



With its mix of habitat types, the sanctuary serves as an ideal laboratory for the greater Gulf of Maine.

There is considerable activity in New England and Maritime Canada regarding the issue of MPAs, and the Stellwagen Bank National Marine Sanctuary has played a leadership role in regional MPA activities. Two years ago, the Sanctuary helped to fund the development of an inventory of marine protected areas in the Gulf of Maine. We are now using that information to help bring together Canadian and US Federal agencies involved in protecting marine areas to establish an integrated MPA network for the region. The inventory also helps us to identify where future MPAs might be desirable and appropriate. The goal of this integrated network is to identify opportunities for MPA managers to engage in projects of mutual interest and benefit, to share ideas and information about effective management of MPAs, and, ultimately, to try to make sure that we are doing

enough to protect the important resources of the Gulf of Maine ecosystem. While few agencies have the resources to do any of this on their own, collectively the goals may be achievable.

In addition to this work:

o The Council on Environmental Cooperation's Global Program of Action (a program established under North American Free Trade Agreement or NAFTA) for the Gulf of Maine Region is supporting activities of government agencies and non- governmental environmental groups related to the establishment and management of marine protected areas.

o A collection of environmental groups and federal and state agency representatives on the US side of the Gulf of Maine, led by the Conservation Law Foundation, has formed the Gulf of Maine MPA Collaborative (GOMMPAC) to provide leadership in setting a regional agenda for MPA designation and management.

o Marine Conservation Biology Institute recently convened a workshop at the New England Aquarium to identify areas of the Gulf of Maine that possess resources that could benefit from MPA designation. The report from that workshop, to be released in the Fall of 1999, will identify the areas recommended for protection by the scientists from the US and Canada that participated in the workshop, and discuss what resources or qualities make these areas worthy of protection.

o The Canadian Parliament, in 1996, passed the Oceans Act, which contained the directive for the Department of Fisheries and Oceans to become the lead Canadian agency for establishment and management of MPAs. This has generated not only considerable activity on the part of DFO, who are responsible for the development and implementation of an MPA program, but also within Parks Canada and the Canadian Wildlife Service, who also have MPA programs. DFO and the other relevant Canadian Federal agencies are closely coordinating their activities with the US National Marine Sanctuary Program, and participating in many of the regional MPA initiatives.

All of these initiatives are focused on finding these special places, places people are passionate about protecting, special places we would like to pass along to the next generation.

The growing interest in MPAs as a way to better manage these special areas is a terrific trend, and worthy of the enthusiastic participation it is experiencing here in the region. However, we need to remember that this tool won't fix everything that's broken.

Scientists are only beginning to understand some of the relationships between species in the sanctuary.

It is important that we look to and strongly support state coastal management programs to help address the difficult and complex issues in the coastal zone. We need to be sure that areas around MPAs are not abused, but used in a sustainable way. Simply because we have protected the most sensitive or important areas doesn't mean we have finished the job and can fold our tents and go home. There is a need to keep learning more about the ecosystems we are managing through research and environmental monitoring, to set goals for management performance and measure progress toward achieving those goals. We need to protect resources and qualities, but remember that people are central to the success of such protection programs.

While the Federal government serves as stewards of these ocean resources, these resources are owned, in common, by all the citizens of the US (and Canada). As owners, we need to take a personal interest in our property, to make sure the stewards are doing what we feel is appropriate and necessary. Our active participation is essential. We hold this property in trust for future generations. MPAs will help ensure that we have an ocean legacy.

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Fishing the Middle Bank

Frank Mirarchi, Fisherman
June 18, 1999

Visitors to the Stellwagen Bank National Marine Sanctuary often witness vignettes that make the kind of memories that last a lifetime. It might be the white flash of a gannet suddenly plummeting into the sea, or the majestic sight of a humpback whale breaching, barely visible in the fog-shrouded calm. The bank is a place where natural beauty is stark and prominent, unfettered by daily routines.

Fishermen empty their net on deck in preparation of sorting through the catch.

There is much more to this place than meets the eye, though. Before it ever became a National Marine Sanctuary, long before it became known as Stellwagen, it was named "Middle Bank" by fishermen. Middle Bank is one of a series of glacial ridges that serrate the floor of the Gulf of Maine. Fishermen came to know areas where the ocean floor was serrated because of the unusual productivity in the overlying waters. We know now that it is the upwelling of nutrient-rich currents which nurtures such bountiful sea life.

As is the proclivity of discoverers, fishermen named all of these places. When I began to fish in 1963, generations had preceded me. Old fishing areas, now within the sanctuary, were well-known; The Horseshoe was good for yellowtail flounder in October; in the Shoal Ground, yellowtail and cod proliferated in the spring; Northwest corner filled with cod in the autumn, then whiting until Christmas.

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Fishermen from Gloucester, Plymouth, Scituate and Provincetown would leave their ports to become one community at sea. News from home of family and friends was shared, as were the locations of dangerous wrecks and hangs. Information on catches was considered privileged, however, and was not shared. Interpreting the movement of boats became an art. Competition was keen, but never predatory.

Around 1970, the fishing culture, which had functioned inconspicuously for centuries, underwent an inexorable change. Factory trawlers from East Germany, Poland and the USSR began to exploit areas that heretofore had been the realm of community-based fisheries. Growing public concern engendered political action. In March, 1977 the US government declared jurisdiction over Living Marine Resources (LMRs) within 200 miles of American shores, the area defined by international law as a county's Exclusive Economic Zone (EEZ). However well-intentioned, the Magnuson Act as it was soon known, bore unforeseen consequences. The realization that a billion dollars worth of seafood

The wolffish, or ocean catfish, once ignored due to its unattractive appearance, is now considered to be an overexploited species in the Gulf of Maine.

was now the exclusive domain of American fishermen caused an unprecedented rush to build newer and larger boats. During the decade of the 1980's, the aggregate of tonnage of the New England fleet more than doubled. By 1990, catches had begun to falter. The available stocks of fish could no longer support such an overcapitalized fleet. There were simply not enough fish to go around.

The decade of the 1990's has found fishing embroiled in controversy, but new regulations have dramatically reduced the extent to which New England waters are fished. Licensing programs now govern access to most fisheries. A fisherman can't simply add a new fishing boat to his fleet. He must retire an older boat and then transfer all fishing permits to the newer one. Even then, the new boat must approximate the replaced vessel in size and in power. Programs that control the number of allowed fishing days have greatly limited fishing opportunities, and large areas are often closed to protect spawning and juvenile fish.

But, perhaps most significantly, a cultural awakening has begun. The fishing families of New England and elsewhere are recognizing how important their way of life is and are adapting to the challenge of maintaining it, often with great difficulty.

Fishermen understand that the old rules no longer apply. The sea has become the subject of intense debate over appropriate uses. Progressive-minded fishermen are entering the fray, using science to verify the argument that sustainable fishing is not an oxymoron.

Presently, collaborative projects between working fishing vessels and scientists in and around the Stellwagen Bank National Marine Sanctuary are attempting to mitigate the effects of human activity in the oceans. Through cooperation, fishermen and a variety of federal and non-governmental organizations -- such as Massachusetts Division of Marine Fisheries, National Marine Fisheries Service, US. Geological Survey, Center for Coastal Studies and Manomet Center for Environmental Science -- hope to find answers to some tough problems.

Fishermen enjoy the freedom of being out on the open sea, but have to contend with dangerous conditions.

With the advent of new technologies like "pingers" (noisy net attachments that deter approaching porpoises) or advanced fishing gear designed to minimize damage to the sea floor, we just might achieve our goals. Already we have seen increasing cod catches after years of depleted stocks. It is important, however, not to declare problems "solved" prematurely. If we rush to take too many fish just when a species is starting to recover, we risk sabotaging their recovery. If we've learned anything, it's that taking too much can be disastrous for both the fish, and the fishermen.

Much of the success of these initiatives stems from fishermen's willingness to share the skills and secrets acquired throughout a lifetime on the water. Their collaboration with scientists has done a lot to bridge a gulf of suspicion and misunderstanding between the two groups. After two decades of rough seas, we may be entering an era when sustainable fishing is possible.

(top) RETURN

Gerry E. Studdes

Text Forthcoming

(top) RETURN

SEA SOUNDS

WHALEWATCHING

GERRY E STUDDES

PROTECTED AREAS

SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

STELLWAGEN BANK

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July 9, 1999
Sustainable Seas Expedition 1999 Underway at Stellwagen Bank National Marine Sanctuary

James Lindholm, National Undersea Research Center (NURC)
University of Connecticut

James Lindholm

The Sustainable Seas Expedition (SSE) began the East Coast portion of the 1999 field season at Stellwagen Bank National Marine Sanctuary (SBNMS) on the Fourth of July. Operating from the 4th to July 16th, the Expedition will employ the Deepworker submersible, an acoustic hydrophone, a bottom grab, and an array of vessels to study the diversity of wildlife within the sanctuary from microbial organisms on the seafloor, to fishes on boulder reefs, and on to whales throughout the water column.

Under sunny skies and unseasonably warm temperatures, the NOAA Ship Ferrel moored alongside the Coast Guard Pier in Boston for the on-loading of equipment and personnel. Resplendent in full dress, the Ferrel and her crew, along with scientists from the National Undersea Research Center at the University of Connecticut, and personnel from SBNMS, SSE and Nuytco, participated in a two day open house for hundreds of the visiting public. Only a couple blocks away at the New England Aquarium, SSE and SBNMS personnel staffed a booth describing the Expedition and its plans for the sanctuary, and gave the public a chance to get up close to an amazingly authentic model of Deepworker 2000.

Adding to the excitement, the Ferrel's position at the Coast Guard dock afforded all on board an excellent view of the night's fireworks, as well as a 19 gun salute from the USS Constitution (the nation's oldest commissioned warship). While the temperature continued to hover near 100 degrees, all aboard the Ferrel spent the 5th and 6th preparing the ship for launch and recovery of Deepworker. The Ferrel is the first ship on the East Coast to get the subs, and following the mission here at SBNMS, the ship will head south to Gray's Reef National Marine Sanctuary. Meanwhile, submersible pilots Peter Auster and James Lindholm (both from the NURC) got their first look at

the new 2000 footers, and quickly jumped inside to survey all the new additions to the sub since the training back in March in Seattle. Both pilots agreed that the additional 6 inches of space in Deepworker made for a much easier time maneuvering about the sub. Both pilots are very eager to get in the water. At 10:00 a.m. on the 7th, the Ferrel departed from Boston for the waters off Cape Ann, Massachusetts to test the sub and the launch and recovery protocols. We will report more soon as the Expedition continues.

(top) **RETURN**

July 10, 1999
The Expedition Continues...

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

James Lindholm, National Undersea Research Center (NURC)
University of Connecticut

The second half of SSE's first week at Stellwagen Bank National Marine Sanctuary saw a coordinated effort by the crew of the Ferrel, the crew from Nuytco, and the SSE staff and scientists to develop launch and recovery protocols for Deepworker when using the Ferrel as

Dive supervisor, Larry Shumaker.

the platform, as well as deal with various technical issues with the subs. Multiple launches were conducted throughout the 7th to the 9th while procedures were identified and skills were honed. All involved made a substantial effort to get the project up and running. Sub pilots Peter Auster and James Lindholm (both from the National Undersea Research Center at the University of Connecticut) each went over the side a couple times to pilot the sub while launch and recovery operations were underway. On Friday, dive supervisor Larry Shumaker dove Deepworker to the bottom at a coastal site off Nahant in Massachussets. Next Peter made a dive to 50 feet off of Gloucester, which was ultimately aborted due to problems with through-water communications (a phenomenon with which past sites are intimately aware).

Sylvia Earle arrived in the area late the night of the 8th, and spent the morning of the 9th aboard the sailing vessel MIMI. The MIMI, a 72 foot wooden sailing ship, is being used as the platform for an innovative program which involves deaf high school students in bioacoustic research. They will be with us throughout the Stellwagen Bank

mission, and we'll write more about their activities, and provide log entries from the student participants, as the week progresses.

The afternoon of the 9th, Faith Ortins hosted Sylvia and others aboard the dive charter Extremis (a 36-foot converted lobster boat) for a scuba dive in sanctuary waters. We dove to 92 feet in chilly 38-degree water over sandy bottom, where sand lances, sand dollars, and small jellies were in abundance. After our dive, Faith shared with us what is reputedly the main attraction to diving off the Extremis: Faith's home-baked "decompression brownies." Two words: chocolate heaven.

Sylvia Earle preparing to dive on the Extremis.

The morning of the 10th, the Ferrel pulled into port in Gloucester, Massachusetts, and Sylvia, Gale, sanctuary manager Anne Smrcina, and several others got on board. In an effort to resolve ongoing problems with through-water communications, Richard Nordstrom of Cis-Lunar Development Laboratories took a look at the systems we were using and recommended some changes we could implement now, as well as some others which could further improve the comms between the ship and the sub.

Chief steward of the FERREL, Romualdo Tolento.

Unfortunately, the weather today is limiting our options for diving the sub. We finally identified a location, Sandy Bay, where we would be sheltered from the 20 knot winds and 8-11 foot swell. James Lindholm was able to complete his checkout dive, and noted improvement in the through-water communications, except for a profoundly annoying and incessant squealing noise coming through his headset. After James' dive, we planned to dive Peter again, but winds even in this sheltered cove kicked up to 30 knots, and we had to call it a day.

The chief steward on the Ferrel, Romualdo Tolento, and his new cook Lonny Foss, seem to be making every effort to outdo the fabulous cooking we all raved about on the McArthur. Just as the Mac is known as the best-fed ship in NOAA's west coast fleet, the Ferrel's reputation for great meals is long-standing. And tonight, they pulled out all the stops, with cloth tablecloths, stemware (sparking cider, no champagne), prime rib, and a most remarkable raspberry-and-cream dessert.

Tomorrow (July 11), weather permitting, Sylvia will dive in the Sanctuary to survey the rich biodiversity found within its borders. On Monday, the Expedition will continue as Peter and James begin their study of fish behavior on deep boulder reefs. Stay tuned.

(top) **RETURN**

Sylvia Earle and Anne Smrcina enjoy a candlelit dinner courtesy of the FERREL's crack team of stewards.

July 11, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

They predicted that today would be the best weather day of the year, and for once, we weren't disappointed. It was gorgeous. Beautiful sunshine, gentle breezes, and glassy calm seas. The FERREL steamed out of Gloucester to our chosen dive site, about 20 miles east of Sandy Bay. A sailboat race, with 250 colorful boats heading for Halifax, was close enough to add color to the horizon, but not close enough to interfere with dive operations.

Sylvia receives her final checkout from Nuytco technician with Peter Auster looking on.

The plan was to dive the sub with Sylvia piloting in the afternoon, followed by another dive in the evening with Peter Auster at the helm. Sylvia was soon in the water, to 252 feet, with good visibility. The only real frustration for her was the through-water comms unit, which was again causing no end of grief. Between the shrieking feedback sounds she had to suffer with throughout her dive, and the periods of lost comms, it became clear that we have a lot of work to do to make it right.

The problem with through-water comms is not limited to this sub, or this project. It's not easy to make communications work through water, and any background noise, from boat engines or submersibles' thrusters, can cause major interference. Also, because we're dealing with such small submersibles, we have space and weight limitations. We can't put a really large unit on the sub, and the smaller ones are not as powerful. The Nuytco staff are working diligently to find solutions to the problems we're encountering.

Sylvia's dive was on rocky bottom, exactly the sort of habitat that typically supports a fabulous profusion and diversity of life. It was thus remarkable, and a bit surprising, that the area Sylvia surveyed was very nearly barren. She reported seeing only two codfish, a few brittle stars, and an assortment of jellies. She stated that she would have expected much more life in the area she surveyed. Its absence raises the pressing question: Why?

After Sylvia's dive was completed, she and I, along with several others, got aboard the dive boat Extremis for transport back to shore for the evening. The FERREL had planned to stay out and complete the first night dive of the mission, but because of the comms problems, they ultimately decided to scrub the dive and pull into Gloucester for the night. Tomorrow, Richard Nordstrom of Cis-Lunar Development Laboratories will rig the sub with new communications gear, and we'll try again to work out the problems with through-water comms.

Sylvia's launch.

(top) **RETURN**

July 12, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Peter Auster and James Lindholm
National Undersea Research Center (NURC)
University of Connecticut

I thought yesterday was perfect. Today was even better. Perfect clear blue sky, warm sunshine, and water as calm and still and clear as we've ever had since the expedition started. We got on station at Peter's chosen dive site, and launched the sub without incident.

The FERREL on incredibly flat seas.

We've been using a second through-water comms unit on the chase boat, as we did in the Channel Islands. Often the noise from the engines and the distance from the sub make comms from the ship unreadable, while the chase boat can position itself directly above the sub for a better signal.

Peter's dive went well, with lots more fish in evidence than Sylvia observed on her dive (near the same location). **Here's Peter's dive report:**

"After confirmation of surface and underwater communications was completed, I descended to the seafloor 255 feet into the cold and turbid northwest Atlantic. The bottom, a layer of boulders like a low relief coral reef, suddenly appeared out of a haze of marine snow.

"Small groups of juvenile redfish and cunner occurred along the track of the sub. Many fishes maintained position over the tops of small boulders and darted for cover in time to avoid a collision with the sub.

"I came upon a juvenile haddock sitting firmly on the bottom, surrounded by boulders. I parked DeepWorker and watched and photographed how it used its fins to

hold position on the bottom with a minimum of energy.

"Cod and longhorn sculpin were also observed during the dive. As the boulders and associated crevices got larger, the size range of fish which utilized these areas also got larger. I took video and still photographs along the trackline to document the habitat complexity of this particular site. It was a successful, but all too short, excursion."

While Peter was diving the sub, I have to confess that dive operations weren't all that was on our minds. Sometime the previous day, someone had anonymously slipped squirt guns

Richard Nordstrom of Cis-Lunar Research.

to a handful of the ship's crew and science party. For a brief while, the chasing, attacking, sniper fire, and ambushes added some welcome levity to the day (although I was disappointed that I was not among those issued a weapon).

After Peter got back on deck, Richard Nordstrom helped install a new comms unit on the sub. Unlike the one we were using before, this one is pressure-rated to 2000 feet, and mounts on the outside of the sub, where interference from the sub's electronics is greatly reduced. The extra wiring delayed Peter's launch a bit, but we completed the pre-dive efficiently, and I joined the cox'n and the swimmer on the chase boat to run through-water comms.

With the new comms unit, talking to the sub was now like carrying on a conversation in a large, empty auditorium with great acoustics. A bit of an echo, but otherwise crisp and clear, with very little background noise. They were still unable to maintain comms from the ship, but the method of using the chase boat to run comms seems to be working well.

Here's what James has to say about his dive:

"Excellent dives in the eastern sanctuary today, as both Peter and I dove DeepWorker to a deep boulder reef. Due to problems with tracking the sub underwater, we have had to rule out night dives for the rest of the cruise. To account for the absence of night dives, which were originally integral to our research plan, we are now going to assess the change in reef fish assemblages over the reef along two different axes: 1) along the reef from the up-current end to the down-current end, and 2) over piled boulders vs. single layers of boulders.

"During today's dive to 241 feet, I made observations of the fishes' number, position,

behavior and association with the reef at eight sites along a section of single-layered boulders. The diversity of fish and invertebrates was incredible to observe first hand. Over a period of two hours I recorded video and still photos of a number of species (e.g. cusk, monkfish, haddock, cod and redfish) while noting all data on our trusty data sheets. Even at the bottom of the ocean, literally wrapped in new technology, we are still relying on good old pen and paper to record our observations."

After James was back on deck, we steamed back towards Gloucester to anchor near shore for the night. Tomorrow, we hope to complete more science dives at another of Peter's dive sites.

(top) **RETURN**

July 13, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

James Lindholm
National Undersea Research Center (NURC)
University of Connecticut

As pleasant as yesterday's weather was, I guess we're paying for it today, because conditions are gray, drizzly, and generally unpleasant to work in for those of us on deck and especially on the chase boat. Winds and seas were still calm enough so that launching the sub this morning was no problem, but conditions went from bad to worse this afternoon, with 25 knot winds, and rough seas.

James Lindholm gets final instruction from a Nuytco technician.

James Lindholm returned from his morning dive with the following report:

"Yet another excellent dive today in what is shaping up to be a pretty successful research cruise. Today I dove DeepWorker for the third time in the sanctuary, this time to over 300 feet for a little more than 3 hours. While yesterday I observed fish behavior over a single layer of boulders, today I visited a piled boulder reef at a site several kilometers to the west.

"It is axiomatic of the natural world that if you provide structure, organisms will come. This generally holds true for aquatic and terrestrial systems. The interesting questions arise when you begin to investigate which organisms come to the structure, and how those organisms make use of the structure.

"I touched down this morning in a field of iophon sponges and cerianthid anemones. Amid this emergent structure was a diverse array of fish from a range of size classes?recently settled juveniles to adults. As I moved on to the piled boulders, the

number of fish increased tremendously.

"I sampled 20 sites along a reef that extends northwest/southeast. Particular stand-outs were redfish, ocean pout, and cod. I observed animals feeding up in the water column above the reef, holding station just below the reef's horizon, and occupying crevices down between the piled boulders. Also interesting was the diverse array of sponges and other emergent sessile organisms attached to the boulders, which provides additional cover for the various fish that occur there.

"Unfortunately, we experienced our first bit of rough weather this cruise, and Peter was not able to make a dive. But weather permitting, we will be back out tomorrow once again to continue our study."

Once we'd finally determined that the weather was not going to permit us to dive the sub, the decision was made to tie up at the Coast Guard station in Gloucester for the night. The sub crew will be working late, getting some bugs worked out on the rescue sub, and the battery charger. And all of us will get a chance to pop into town for any supplies we need (I, for example, plan to pick up a few more squirt guns so I'll be ready for the next battle when it happens!).

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STELLWAGEN BANK

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July 14, 1999

Peter Auster, Scientist
National Undersea Research Center (NURC)
University of Connecticut

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

We overnighted in port in Gloucester, departing at a bleary-eyed 6:30 a.m. A return to sunny skies today, but enough of a swell to make the ride out to our first dive site a little bumpy. The Nuytco team worked late last night trying to repair the sub's battery charger, but finally determined that without replacement components, there's no way to make it work. Without fully charged batteries, the sub can't dive -- a frustrating state of affairs for both the scientists and the sub technicians.

Fortunately, we had the Phantom ROV to give us a virtual view of the seafloor. We conducted four very successful ROV dives to groundtruth features of the seafloor, which had

been identified previously using multibeam sonar (from the U.S. Geological Survey). ROV video confirmed that the steep tops of a series of ridges near our dive station are composed of scattered and piled boulders, which serve as habitat for a range of fishes and attached invertebrates.

The most gorgeous sunset we've seen yet.

After we'd completed ROV ops, we steamed back to Gloucester, where we will again spend the night in port. We're expecting the replacement part for the sub's battery charger to arrive in the morning via Federal Express, and as soon as it comes, we'll head out to our first dive site. All in all, it was a successful day, and the information we gathered using the ROV will be useful in supplementing the science we're conducting with DeepWorker.

(top) RETURN

July 15, 1999

Gale Mead, Expedition Log Editor
Sustainable Seas Expeditions

Peter Auster, Scientist
National Undersea Research Center (NURC)
University of Connecticut

Gale begins:

Today was the perfect day. We were able to get two long and flawless dives in at our deep reef station. Peter Auster piloted both dives to approximately 250 feet.

The FERREL left Gloucester late morning, and headed out to the first dive site. Both of Peter's dives went beautifully. Weather was perfect, visibility was good, the sub performed well, communications worked great, and he was able to get some good footage of the habitat and wildlife.

Lauching the sub from the FERREL.

He writes:

"Habitats seen included cerianthid forests, scattered boulder, and piled boulder (reef) habitats. This site had a very high diversity of fishes. Cod, haddock, silver hake, yellowtail flounder, little skate, wolffish, cusk, redfish, and cunner were all packed into a relatively small area. I saw more cod and haddock on these dives than I have in many other dives using other subs and ROVs. Ascending into the setting sun, ending the last dive of the cruise, I have already started planning another cruise with DeepWorker sometime in the future."

Gale continues:

The perfect ending to a very successful mission. Now, the FERREL will steam down to Savannah, Georgia, and start preparations for the Grays Reef National Marine

Sanctuary mission, which officially begins on July 26.

(top) RETURN

Summary of Investigations

Ecology of Fishes on Deep Boulder Reefs

Scott Gardner, from Nuytco, prepares Peter Auster for a dive in the DeepWorker.

Peter Auster and James Lindholm, both from the National Undersea Research Center at the University of Connecticut, conducted a study of the habitat use of fishes on deep boulder reefs using the DeepWorker submersibles. Five daytime dives were completed to assess species composition on different parts of reefs, which were categorized by habitat complexity. Preliminary analysis of data from the submersibles, combined with previous remotely operated vehicle (ROV) studies, indicates that community composition was correlated with habitat complexity across boulder reef structures. Future studies are planned to determine how light effects the distribution and behavior of fishes. Light levels vary seasonally, by depth, and by photoperiod. Dives both day and night will allow a first order assessment of how reef structures are used for shelter as well as foraging areas.

Bioacoustic Research

During the Sustainable Seas Expedition in the Stellwagen Bank National Marine Sanctuary, a contingent of students and teachers

from the American School for the Deaf in West Hartford, Connecticut assisted principal investigator Peter M. Scheifele of the National Undersea Research Center at the University of Connecticut in conducting bioacoustic studies of humpback whales. The goals of the research were to: continue monitoring ambient noise levels in the whale habitat areas; evaluate the contribution of anthropogenic noise to the ambient noise; and analyze a humpback whale phonation that is believed to be associated with a potential new feeding behavior. The research was carried out aboard the S/V *Mimi*.

Ambient Noise Assessment. Noise measurements were taken during the period July 9 through July 15, 1999. Although the analysis of this year's noise levels is still in progress, the noise levels for 1999 are thus far consistent with those taken in 1997

A remotely operated vehicle used in habitat surveys is launched.

and 1998. Some 230 discrete noise samples were taken on this mission, each sample being two minutes in length.

Contribution of Anthropogenic Noise. Of the total samples taken over half included the contribution of nearby vessels and whales. Individual analysis of vessels (most of which were whale watching vessels) has not been completed. Of significance this year are recordings of the New England Aquarium twin-hulled, high speed catamaran. This vessel uses a pump-jet system for propulsion, and sound signatures of this type of vessel have not been developed.

Aggregations of feeding whales were located from a blimp.

Potential Humpback Whale Feeding Phonation. Over the last two years, recordings have been made of a phonation that appears to be made during feeding times for whales in the sanctuary. Given the scarcity of pelagic prey species in the water column it is thought that the whales are now bottom-feeding on the American sand lance (*Ammodytes americanus*).

Peter Auster is being launched for a dive in the DeepWorker.

A study by Ivar G. Babb and Peter M. Scheifele is currently underway to determine if there is correlation between the population of sand lance and the humpback whale. If this is the case, we are speculating that the whales may be learning to use sound (in the form of this particular phonation) to move the sand lance into the water column for feeding. This would represent a significant modification to the humpback feeding process. During this mission, the research crew recorded the phonation of interest repeatedly, again during feeding. They have begun an acoustical analysis of the phonation and have developed a "humpback whale phonation evaluation and archive" system. This system will allow phonations to be catalogued according to their frequency, content, contour, duration, and inter-phonation repetition rate. It also allows phonations (such as the one in question) to be analyzed for repeatability. This program development is in progress.

(top) RETURN

Whalewatching

Text Forthcoming

(top) RETURN

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WHALEWATCHING

GERRY E STUDDES

PROTECTED AREAS


Dann Blackwood, USGS


Anne Smrcina


USGS
Dann Blackwood, USGS

SUSTAINABLE SEAS EXPEDITIONS

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FLOWER GARDEN BANKS

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EXPEDITION UPDATE

September 1 - September 13, 1999

The Flower Garden Banks mission got off to an unusual start. This was the first time that it was necessary for the scientific party to transit on board the FERREL from the previous sanctuary in order to be on the spot when the ship arrived at the Flower Gardens. Scientists rode the ship from Key West, Florida so the ship would not have to go into port in Texas, and could therefore start the mission sooner.

The first day of the mission, Wednesday, September 1, was set aside for checkout dives for the local DeepWorker pilots.

On day two, September 2, we've struggled with increased wind and swell that have kept the subs out of the water. Weather or no weather, though, we intend to be in the water tonight for scuba operations. In addition to the FERREL, we have a private dive charter boat called the MV SPREE which the sanctuary has hired to support research on the annual coral spawning event. In a display of unparalleled wonder, the corals release their gametes into the water approximately one week after the August full moon; we expect to see the spawning happen either tonight or tomorrow night.

On September 3 - 4, weather conditions continued to be too rough to permit launching of the DeepWorker. Instead, we've made good use of the ROV, and the large number of qualified scuba divers on board the MV SPREE, to study the West Bank reefs and observe the coral spawning. Love is in the air, so to speak, or more accurately in the water, as the coral spawning

LOG

September 2, 1999

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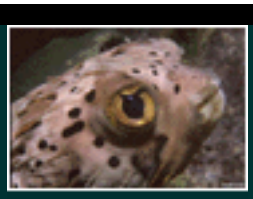
Summary of



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FISH CLEANING

NUTRIENT STRESS

A DIVER'S VIEW

also marks mating season for a wide variety of other reef critters.

Sunday, September 5, we moved operations to the East Bank, where we are using the ROV to study brine seeps. Scuba operations are also continuing on board the SPREE.

September 6, the FERREL and the SPREE both headed back to shore. On the way back, the SPREE was able to stop at Stetson Bank for an early morning scuba dive. For many divers who visit the sanctuary regularly, Stetson is their favorite. Although there are fewer corals, the fish, sharks, and other critters make this site a special treat to dive, and the geological structure of the area, with its pinnacles and steep wall, make the place unique.

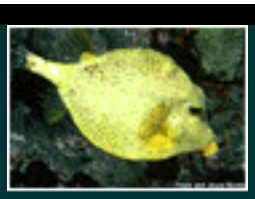
On the 7th, a very successful student summit was held, with over 130 student participants from area schools. An open house aboard the FERREL was well attended, in spite of its midweek timing.

The 8th was a day to gear up and get ready for the next leg of the mission. The FERREL departed Galveston at 6:00 PM for an all-night steam out to the East Bank. Meanwhile, the MV FLING, sister ship to the SPREE, prepared to join the FERREL for the first two days of this leg, with a special group of conservation-minded oil industry representatives, as well as additional members of the project team.

The morning of the 9th, divers on the FLING wasted no time jumping in as soon as they were given permission to do so, at 7:30 AM. Meanwhile, on the FERREL, we'd had plans to practice some changes to sub launch and recovery procedures, but while the seas were flat enough to permit diving the sub, other weather hazards have sprung up: we were surrounded by water spouts! Between these diminutive twisters, high winds, and heavy rain squalls, we were stuck waiting for conditions to improve before we can proceed with sub operations. Finally, things came together, and Steve Gittings and Sylvia Earle had a very productive two-sub dive.

September 10 saw a return of the high seas that

Investigations



have plagued this mission from the beginning. Although we were unable to launch the subs, we made good use of our time by completing a number of scuba dives on the East Bank, and conducting ROV operations on the brine seeps.

September 11, we were gladdened to find flat, calm seas awaiting us first thing in the morning. Laddie Akins and Emma Hickerson completed a long two-sub dive in the morning to conduct fish abundance surveys. In the afternoon, Sylvia Earle completed a long and productive dive to 315 feet. Weather permitting, we have more sub dives planned for the rest of the week. We will, however, be keeping a close eye on the progress of hurricane Floyd.

The morning of the 12th got off to a great start with a two-sub dive manned by National Geographic photographer Kip Evans, and scientist Steve Ross. The highlight of their dive, and continuing the generally voyeuristic nature of this mission, was the chance to observe two manta rays spawning, right in front of the sub! In the afternoon, we had another productive two-sub dive, as Quenton Dokken and GP Schmahl dove to 185 feet.

The morning of September 13, the last day of the 1999 Sustainable Seas Expeditions field season, we were able to complete a solid two-sub dive with Laddie Akins and Emma Hickerson at the helm. By the time they came back on deck, though, winds and seas were again getting rough, and we were forced to cancel the afternoon's planned dives. Please check back soon, as the remaining log entries from our pilots will be arriving.

Between now and the next mission, we will continue to update the log and other areas of the Web site with more information about the work we've been doing during this field season, and the ongoing activities associated with the expeditions, so stay with us!

- Gale Mead, Expedition Log Editor

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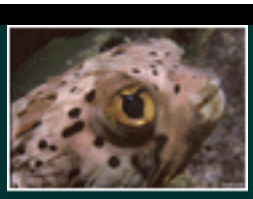
Interview with George P. Schmahl, Manager
Flower Garden Banks National Marine Sanctuary
August 1999

What are your objectives for the Sustainable Seas Expedition in the first year?

Click here for audio response. (RealAudio), for help see **About this Site**

George P. Schmahl

There are two primary objectives for the Sustainable Seas Expedition this year. First, this mission is scheduled to correspond with the predicted annual mass coral spawning event, which occurs 8 to10 days after the full moon in August. We will use the Sustainable Seas Expedition to add to our knowledge of this spectacular natural phenomenon. Although we know quite a bit about mass spawning of corals at the Flower Garden Banks, most of our observations are based on a series of short-duration SCUBA dives. Since even the shallowest portions of the coral reef in the Sanctuary are 60 feet deep, a typical dive is limited to an hour or less. The DeepWorker submersible will allow scientists to spend four hours or more at a time to make longer-term observations of coral spawning behavior, and to carry out careful experiments on the effects of environmental factors on spawning success.



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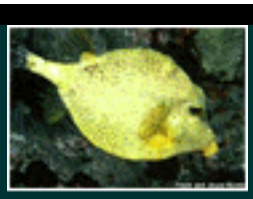
The other primary objective is to explore the deeper areas of the sanctuary. The most prominent feature of the Flower Garden Banks is its remarkable coral reef. The reef, however, comprises only a little more than 1% of the extensive marine habitats within the sanctuary. The Banks rise from a surrounding depth of around 400 feet on top of an ancient salt deposit that has pushed its way through layers of rocks and sediments. Only the very shallowest portions of the banks support coral growth. Most of the area in the sanctuary lies below that depth, and is generally too deep to explore effectively using SCUBA gear. These deeper-water communities are fascinating in their own right. Below the active living coral reef are ancient "drowned" reefs, natural gas seeps, a "super-salty" brine lake, expansive terraces dominated by algae and sponges, and deep, highly turbid water zones, known as "nepheloid" layers. All of these habitats are only known through infrequent glimpses from tethered cameras or the occasional submersible. We hope to add to our knowledge of these deep zones and begin a detailed characterization of the plants and animals that call these depths home. We may even observe something that no one has ever seen before!

Is there really a thriving coral reef in the northern Gulf of Mexico?

Click here for audio response.

The Flower Garden Banks are one of the best-kept secrets in America's oceans. A popular misconception is that the Florida Keys is the only place in the United States where coral reefs exist. The Flower Garden Banks--the northernmost coral reefs on the continental shelf of North America--are located 100 miles off the coast of Louisiana and Texas. The occurrence of coral reefs in this unlikely location is the result of a unique combination of environmental factors. First, the two peaks that form the East and West Flower Garden Banks come within 60 feet of the surface. Since coral reefs require a large amount of light to thrive, the places in which they survive must be shallow enough to allow sufficient light penetration. While the nearshore waters of Texas and Louisiana are typically muddy from the influence of



An example of the reefscape at the Flower Garden Banks: Brain coral (*Diploria strigosa)*,exposed reef rock, branching tube sponge (*Pseudoceratina crassa)*,algae, parrotfish, bluehead wrasse juveniles, and brown chromis.

the Mississippi River and coastal runoff, the offshore areas (more than about 50 miles out) are bathed by the warm, clear water that flows up from the Caribbean. This water mass makes a circuit around the Gulf of Mexico before joining up again with the Gulf Stream along the southwest coast of Florida. This tropical water also brings with it the larvae of many of the same plants and animals that form coral reefs throughout the Caribbean. These organisms found a perfect place to call home on the underwater peaks of the East and West Flower Garden Banks.

The combination of warm, clear water and shallow, hard substrate have resulted in the formation of a coral reef much farther north than would typically be expected. These reefs are over 600 miles from the reefs of the Florida Keys and over 400 miles from the nearest reefs of Mexico. Together, the East and West Flower Garden Banks contain about 350 acres of tropical coral reef with more than 20 species of coral. The reef harbors more than 250 species of coral-reef invertebrates, such as mollusks, brittle stars, sea urchins, and lobsters. More than 220 species of resident tropical and migratory fish species, including manta rays, whale sharks and schooling hammerhead sharks, are also found here.

How healthy is the coral reef of the Flower Garden Banks?

Click here for audio response.

(top)

The Flower Garden Banks contain some of the healthiest coral reefs in the Gulf and Caribbean regions. We know this because these reefs have been the focus of one of the longest-term monitoring programs anywhere in the world. It began in the early 1970s and continues to this day. It began in the early 1970s due to concerns about oil drilling in the vicinity of the East Bank, and continues to this day. The monitoring is now jointly funded through a partnership between NOAA and the Minerals Management Service of the U.S. Department of the Interior. The results of the monitoring program and the associated research demonstrate that the coral reefs of the Flower Garden Banks are in remarkably good shape. For example, the average coral cover on the East and West

Flower Garden Banks is nearly 50%, and this percentage has not changed significantly in over 25 years. In addition,

This landscape depicts the high coral coverage (around 50%) of the West and East Flower Garden Banks.

the monitoring data indicate that overall coral growth is positive in comparison to the negative growth rates recorded for many other areas of the Caribbean. Coral diseases are rare at the Flower Garden Banks, and the impacts of coral bleaching have been relatively slight. The extent of the annual mass coral spawning event attests to the reefs' reproductive health. In summary, the reefs of the Flower Garden Banks are extremely healthy and have appeared to be extremely stable during the period of investigation.

In an era that has seen unprecedented declines in the health and vitality of coral reefs worldwide, the reefs of the Flower Garden Banks are not only holding their own; all indications are that they are thriving and growing. Why are these reefs doing well while others are suffering? It is a challenge that scientists have the opportunity to address through careful observation and directed research. The reefs of the Flower Garden Banks may prove to be a perfect laboratory to study this most important question.

What is the most important part of your job as Sanctuary Manager?

Click here for audio response.

The most important part of my job as Sanctuary Manager is to ensure that the health of the marine resources of the Flower Gardens and Stetson Banks will be maintained for future generations. At the same time, it is also important to allow recreational and even commercial uses when such use is compatible with the primary objective of resource protection. The hardest part of any resource manager's job is to know where that balance lies-&endash; how can we protect this unique environment and still

allow reasonable use of its resources?

Through the National Marine Sanctuary Program, we strive to accomplish this through a program of research, education and outreach, and resource protection strategies. This is much easier said than done. At the Flower Garden Banks National Marine Sanctuary, we have a total staff of three people, and a relatively modest budget. How can we possibly carry out a program to protect a highly vulnerable marine community over 100 miles offshore? For this sanctuary, the answer has been that we do it through a network of partnerships with a variety of groups that care very much about this special place. Even before the Flower Garden Banks was designated as a sanctuary, individuals and groups were committed to providing protection through the installation of mooring buoys, raising public awareness, and working with the oil and gas industry to ensure that the area would not be harmed from offshore development. Without the efforts of a large number of dedicated people, we simply could not have achieved what we have.This interest has occurred in all areas of sanctuary management, including education, research and resource protection. So I view the most important aspect of my job as continuing to cultivate the many successful partnerships and cooperative programs that have been the hallmark of this site.

Describe some of these partnerships that you have mentioned.

Click here for audio response.

(top)

One of the first partnerships we developed was with the recreational dive community. In fact, it was the interest of the dive community that first led to the nomination and eventually the designation of the Flower Garden Banks as a National Marine Sanctuary. Today, a variety of dive shops, operators and clubs assist the sanctuary. They provide volunteer divers, offer logistical support, and carry the environmental message to their members and customers. It was a group of divers and marine scientists who formed the nonprofit organization known as the Gulf Reef Environmental Action Team (GREAT). This group installed the first mooring buoys at the Flower Gardens and organized a monitoring program at Stetson Bank before it became part of the sanctuary. Dive-industry shows, such as the annual Seaspace exhibition sponsored by the Houston Underwater Club, have championed the cause of protecting the marine environment.

Other state and federal agencies have been active partners with us, most notably the Minerals Management Service, which, early on, identified the Flower Garden Banks as a sensitive area and modified the regulations on oil and gas development to specifically protect the reefs. Other agencies that have assisted greatly are the U.S. Coast Guard, which provides enforcement and surveillance of the sanctuary, and the U.S. Geological Survey, which provided state-of-the-art seafloor mapping of the Flower Gardens and Stetson Bank.

We also work closely with a variety of educational entities, most notably the Texas State Aquarium, the Houston Museum of Natural Science, and the Aquarium of the Americas in New Orleans. They have provided facilities for educational and outreach programs, and volunteer support for several projects. One of the most interesting partnerships we have is with the oil and gas industry. This industry has demonstrated its commitment to sound stewardship of the marine environment, and has provided support for a number of research and education projects at the Flower Gardens. Our longstanding association with Texas A&M University must also be acknowledged, for it was through the interest of its scientists and faculty that the original research programs were initiated.

Perhaps the most important partnership for the sanctuary over the years has been with the Gulf of Mexico Foundation, which created within itself the Flower Gardens Fund. This fund has been utilized to solicit and accept donations from nongovernmental sources; the resulting funds assist in all sorts of projects, from research and education to resource protection.

What do you personally hope to get out of the Sustainable Seas Expeditions?

Click here for audio response.

I am a biologist by training, and I am excited about the opportunity to utilize the DeepWorker's cutting-edge technology to explore the ocean depths. I hope to make some dives in the DeepWorker and observe marine communities in areas deeper than I have ever been before. Most biologists I know sometimes think they were born too late. Although we live and work in an era in which technological breakthroughs are leading to incredible advances in all areas of science, many of my colleagues, myself included, secretly yearn for the "glory days" of biology in the 18th and 19th centuries. This, of course, was the era of the great naturalists, who wandered the earth exploring, discovering and describing new places, animals and

plants. The greatest of these were also talented artists, writers and poets in addition to being skilled scientists and observers. Very few biologists can get away with doing that kind of work anymore, it seems. Now, the frontiers of science are faced in a lab coat rather than snake-proof boots. Yet the Sustainable Seas Expeditions offer some of us the chance to become a real explorer--a naturalist in the traditional sense, even if only for a day or two. To go to new places, to see new things, to capture them on film at least, and to describe them in a way that will spark the imagination and interest of many people--that is what I personally hope will be the legacy of the Sustainable Seas Expeditions.

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Shelley Du Puy, Education Coordinator
Flower Garden Banks National Marine Sanctuary

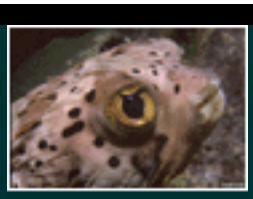
Sanctuary staffer, answering the phone...

"Good morning, Flower Garden Banks National Marine Sanctuary, may I help you?

Caller: "Yes, I'd like to send a dozen roses to my daughter. She's graduating from Texas A&M this weekend."

Mention the Flower Gardens to most people and their first thoughts are of hot houses and neatly trimmed marigold beds. This is not surprising when you consider where these entrancing coral reefs got their name. Turn of the century snapper fishermen could actually see the "gardens" of corals and sponges 50 to 100 feet below the surface. They occasionally snagged brightly colored bits of these animals on their lines as they fished. They likened them to the more familiar common flowers, hence the name, Flower Gardens!

The Flower Gardens are actually the northernmost coral reefs in the United States. Located about 115 miles directly south of the Texas/Louisiana border, the East and West Flower Garden Banks are perched atop two salt domes rising above the sea floor. Salt formation began 160 to 170 million years ago when salt layers were deposited in what was then a shallow sea, subject to evaporation. Sediments were



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continually deposited over the salt layers.

To enjoy a panoramic view of Flower Garden Banks click on the image above. (Requires Quicktime. Click here for more info and software dowload.) Special thanks to the Environmental Institute of Houston at the University of Houston, Clear Lake, for the video.

Eventually, internal pressures became great enough to push isolated pockets of the salt layers up through the sediments, forcing the seafloor to bulge upward in distinct domes. The Flower Gardens coral reef community probably began developing on top of the domes 10,000 to 15,000 years ago. The community has thrived sufficiently to obscure all trace of the deformed bedrock on which it developed, forming dense coral reefs.

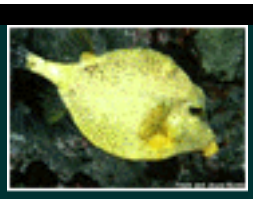
The nearest tropical reefs to the Flower Gardens are 400 miles away off the coast of Tampico, Mexico. Scientists believe that corals at the Flower Gardens probably originated from Mexican reefs when currents in the western Gulf of Mexico carried the young corals (*planulae*), other animal larvae, and plant spores northward. A few of these planulae were lucky enough to settle on the hard substrate of the Flower Gardens.

Amazingly, this location in the northwestern Gulf provided all the comforts of home for hard corals: a hard surface for attachment, clear sunlit water, warm water temperatures (between 68 and 85 degrees Fahrenheit), and a steady food supply. The corals now form the basis for a complex, yet balanced ecosystem, providing a regional oasis for shallow-water Caribbean reef species.

It was this wonderful biological diversity and breathtaking beauty that prompted researchers and recreational divers to seek protection for the Flower Gardens. They launched what would become a 20 year effort, culminating in 1992, to designate the Flower Garden Banks National Marine Sanctuary.

In 1996, a third bank was added to the Sanctuary. Stetson Bank is located about 30 miles northwest of the West Flower Garden Bank. That small difference in location produces an amazing difference in the habitat. Because of their more northerly position, the winter water temperatures are four degrees cooler, on average, than the Flower Gardens. That small temperature difference is enough to prevent corals from growing fast enough to pile up into a coral reef, as they

have at the Flower Gardens. Instead, you find individual coral colonies interspersed with a much denser population of sponges. You can even see the siltstone bedrock showing through in many



Photo

places. While the predominant coral species at the Flower Gardens are large boulder shaped corals such as brain coral and mountainous star coral, the prevalent species at Stetson are smaller encrusting corals, such as fire coral and green cactus coral. Divers describe the effect as an underwater moonscape.

Two different species of brain coral found at Flower Garden Banks include boulder brain coral (*Colpophyllia natans*) in the foreground and symmetrical brain coral (*Diploria strigosa*) in the background.

As you begin your descent through the water column into this unspoiled wilderness, you are passing through the pelagic zone. Here, you find those species that survive by cruising from place to place in search of a meal or a mate. You may encounter such charismatic characters as manta and spotted eagle rays, hammerhead and silky sharks, the ubiquitous chub, loggerhead sea turtles, jack crevalle, amberjack, and if you are really lucky, a whale shark.

Just below 50 feet on the Flower Garden Banks, you encounter the shallowest portions of the high diversity reef habitat, which continues to depths around 100-120 feet. As you explore over 300 acres of marvelous high relief reefs, you discover that they include the majority of the species found at the Flower Gardens: 21 corals, over 250 reef invertebrates, 175+ fish, and 80 marine algae. For reasons still unknown, there are no elkhorn or staghorn corals, and no shallow water sea fans or sea whips, all of which occur on other Caribbean and Gulf of Mexico reefs.

The most obvious organisms in the high diversity reef habitat are the massive boulder-shaped coral colonies. Many have been sculpted into mushroom shapes by a process called bioerosion, in which other organisms gradually wear away the colony around its base. Available space created by bioerosion and breakage is quickly colonized by algae, sponges, and other attaching organisms. The dominant coral species are the mountainous star coral (*Montastraea sp*) and the brain coral (*Diploria strigosa*).

Below 90 feet on the high diversity reef, you will also see, nestled among the larger corals, ridges or knolls with high concentrations of the small branching finger coral Madracis mirabilis. These unusual thickets also feature finger sponges, encrusting sponges and algae.

The Madracis ridges are also found scattered around the low diversity reef habitat.

To examine the low diversity reef habitat, you must venture below 120 feet into water as deep as 170 feet, not advisable for the average recreational diver. At these depths, corals grow in a flattened manner to maximize their exposure to light, a critical element of life to the symbiotic algae living in the corals' tissues. Habitat relief is much lower than on the shallow reefs. Fewer corals live in this zone, primarily because most species need more light. The dominant species are a star coral (*Stephanocoenia michilini*) and fire coral (*Millepora alcicornis*).

Photo

Mushroom-shaped boulder coral sculpted by bioerosion are quickly colonized by a diversity of organisms.

At about 150 feet, you will begin seeing the algal-sponge habitat, which extends to around 270 to 290 feet deep. Dominated by coralline algae, this habitat covers several square miles, a much larger area than is inhabited by corals. Algal nodules, up to fist size, cover 50 to 80 percent of the bottom in places. Because of the area covered and the amount of carbonate deposits produced, the algae may be more important to reef formation, overall, than corals are on the banks. Although less is known of the biota in this habitat, some believe that the species diversity may be comparable to that on the coral reefs.

If you were exploring the southeast flank of the East Bank, at about 220 feet deep you would discover an unusual underwater salt lake almost 200 feet wide and only ten inches deep. Fed by a brine seep from the underlying salt dome, the lake is highly saline, has high levels of hydrogen sulfide and dissolved hydrocarbon gases, and no oxygen &emdash; not exactly what we think of as ideal living conditions for most organisms! The lake flows into a canyon that allows mixing to occur. This dilutes the brine, adds oxygen and reduces the toxic hydrogen sulfide. So much salt has dissolved from beneath the bank that a large depression, known as a graben, has

Photo

Mustard yellow fire coral, a dominant species at Stetson Bank has stinging cells which cause short-term intense burning and pain. This coral is also found at both Flower Garden Banks but is not dominant there.

formed. The graben is more than a mile across and 15 feet deep.

A unique assemblage of biota has developed in and around the lake and in the canyon. Dominant organisms are sulfide-oxidizing bacteria, living at the very thin interface between the dense brine lake and the normal sea water above. A white mat of bacteria and algae covers the floor of the canyon. A specialized community of organisms, called thiobios, inhabit the sulfide-rich canyon stream and feed directly on the plants and bacteria growing there. Most fish cannot tolerate the sulfide of the canyon brine stream, but some are able to take advantage of the food source there by diving into it for quick meals.

The lower two-thirds of the algal-sponge habitat begin a transition zone between organisms that exhibit distinct shallow-water traits and those adapted to deep water. A distinctive transition species is the white, bedspring-shaped, antipatharian sea whip.

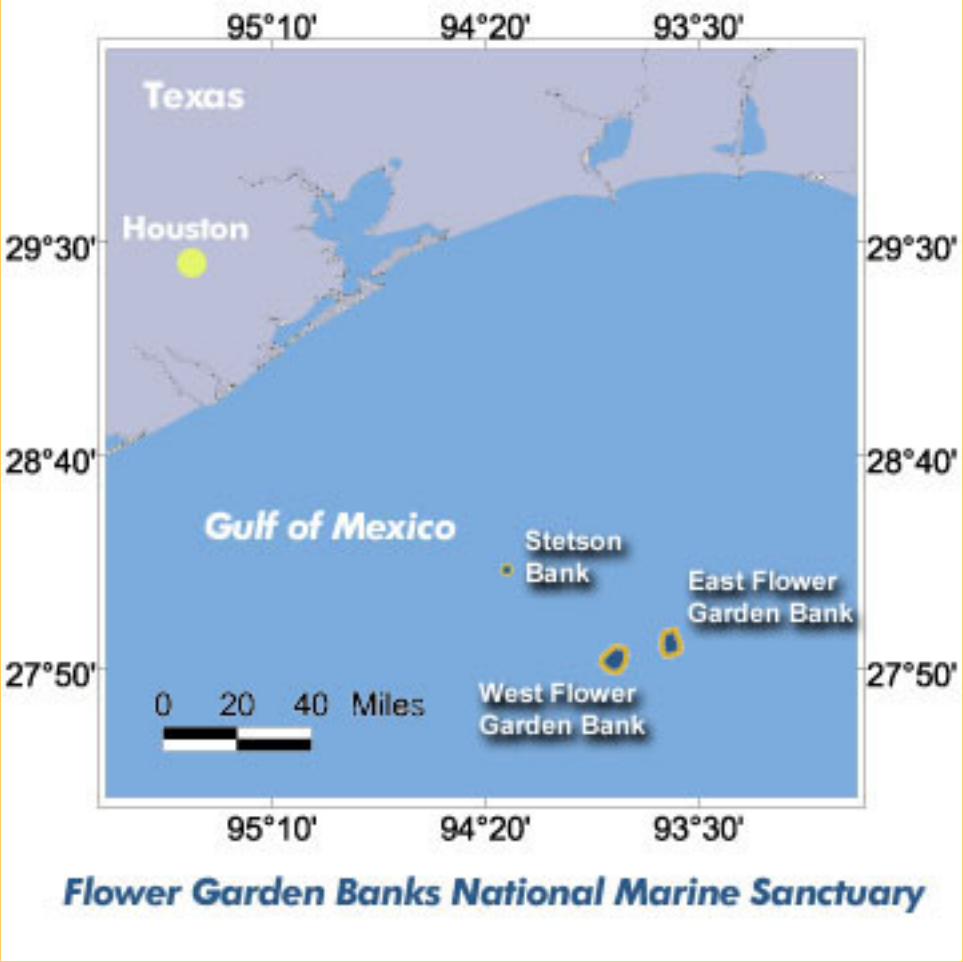
Scattered throughout the deeper portions of the Banks, where coralline algae do not thrive and reef-building corals are totally absent, are remnants of ancient reefs. These drowned reefs are the remains of reefs that probably thrived during periods of lower sea levels when they were closer to the surface. Now, the depths and comparatively turbid conditions limit the species diversity.

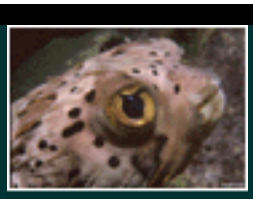
At their bases, the banks are surrounded by mostly unvegetated sand or mud bottom. While many believe these areas to be barren, closer examination reveals a healthy community of organisms living on and within the sediments. Micro algae, a variety of worm species, crabs and sea stars are examples of the organisms inhabiting these areas.

(top) **RETURN**

Maps

The Sanctuary





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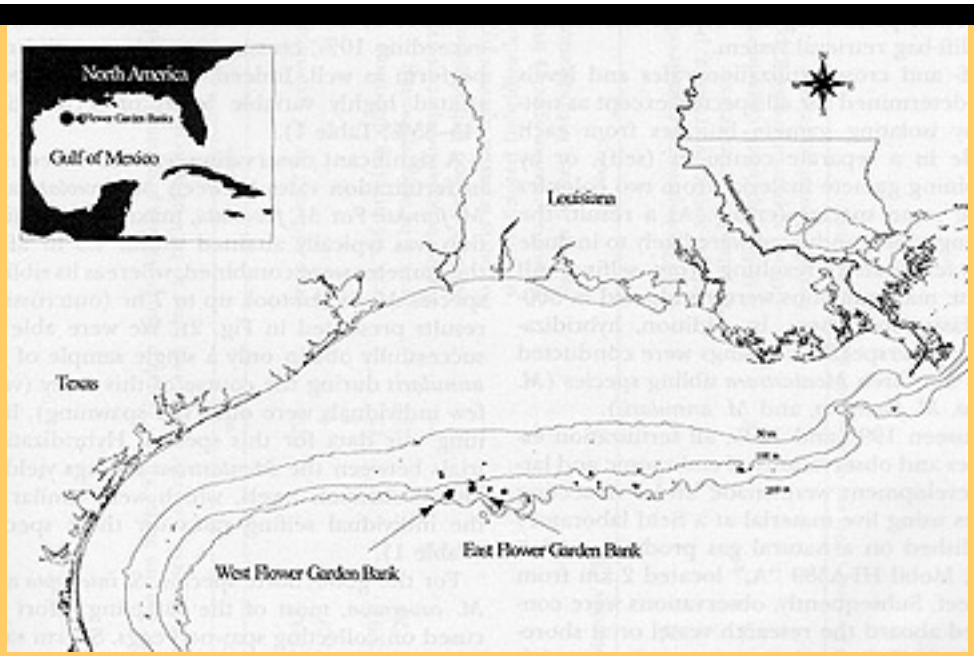
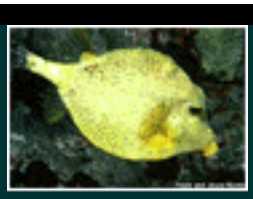
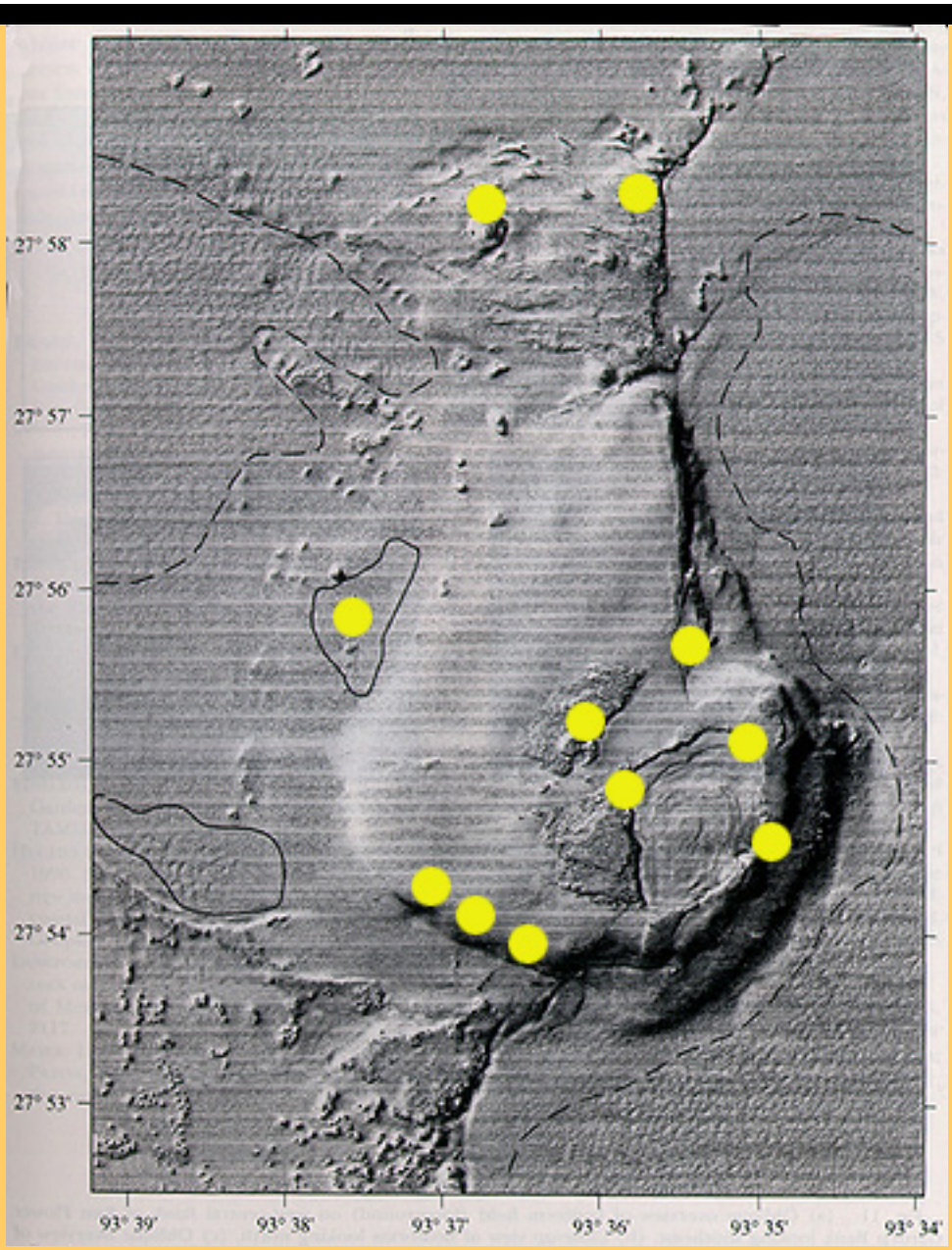


The Flower Gardens are the northernmost coral reefs in the United States. Located about 115 miles directly south of the Texas/Louisiana border, the East and West Flower Garden Banks are perched atop two salt domes rising above the sea floor. Salt formation began 160 to 170 million years ago when salt layers were deposited in what was then a shallow sea, subject to evaporation. Sediments were continually deposited over the salt layers. Eventually, internal pressures became great enough to push isolated pockets of the salt layers up through the sediments, forcing the seafloor to bulge upward in distinct domes. The Flower Gardens coral reef community probably began developing on top of the domes 10,000 to 15,000 years ago. The community has thrived sufficiently to obscure all trace of the deformed bedrock on which it developed, forming dense coral reefs.

(top)

The Mission

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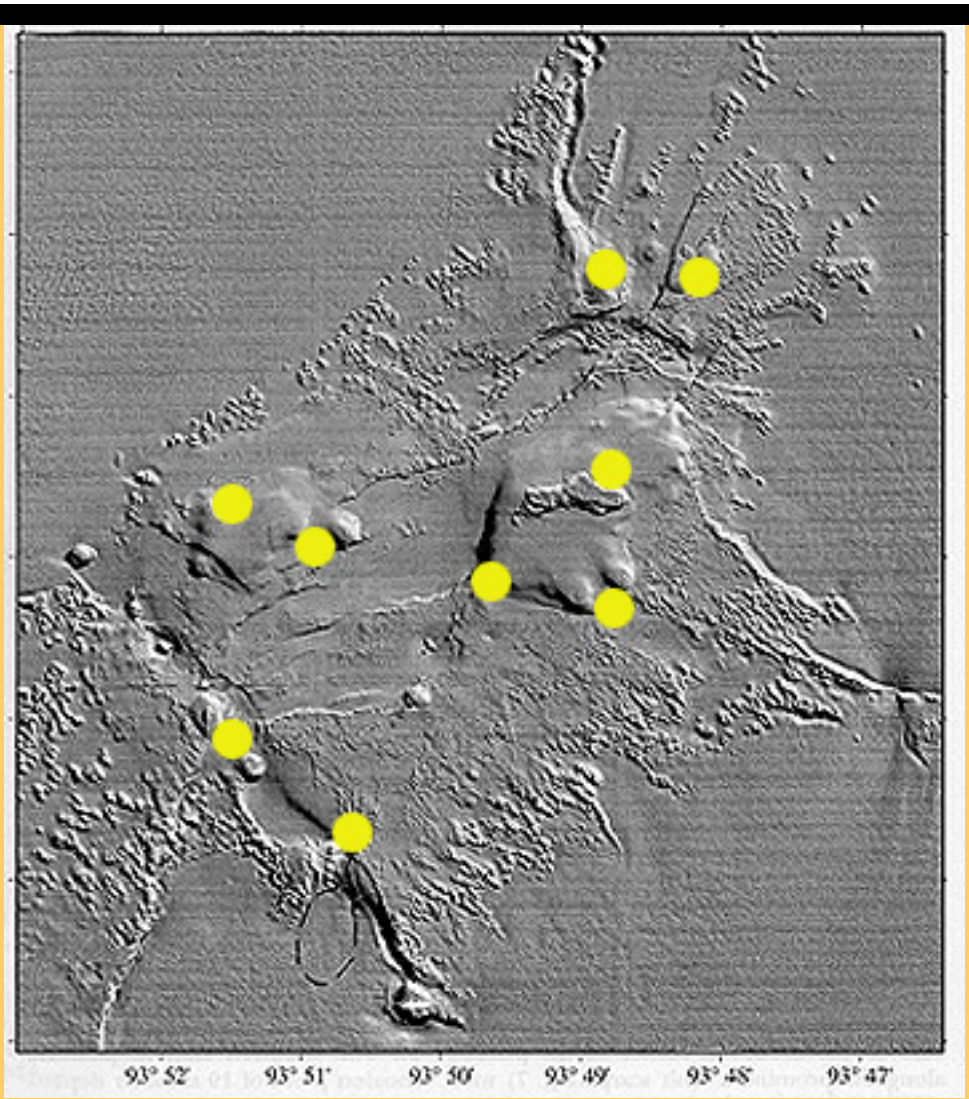
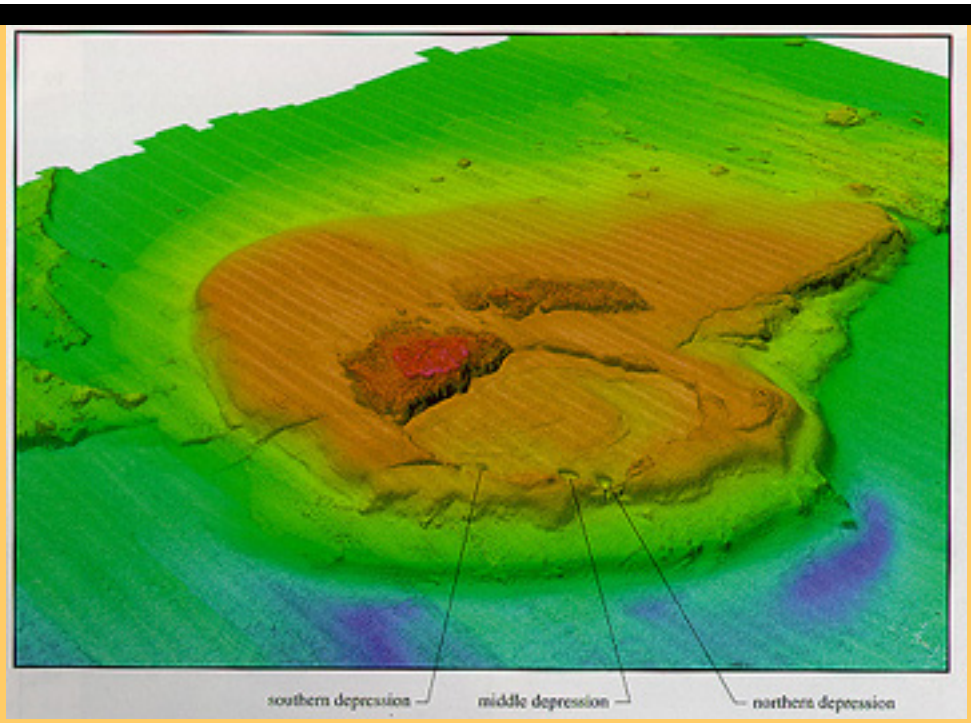


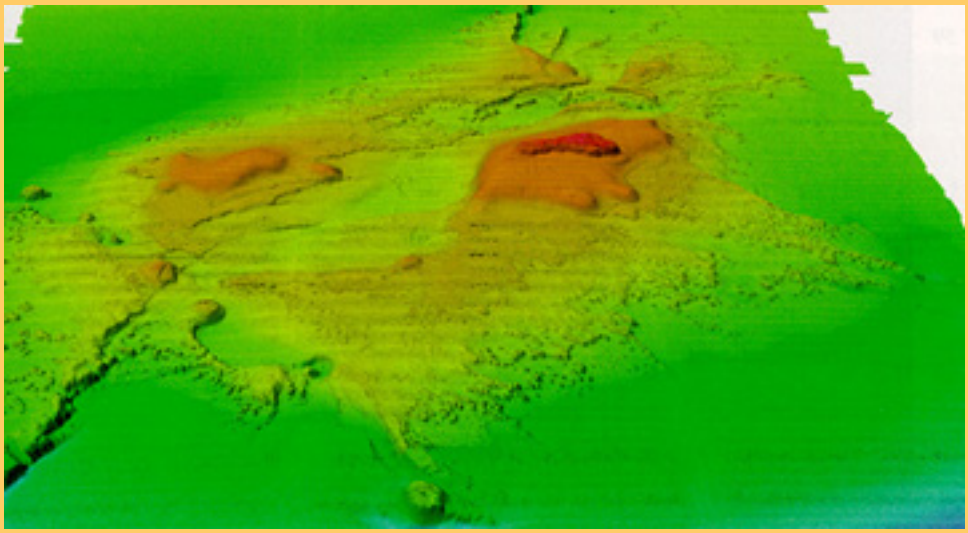
North-looking plan view of grayscale shaded-relief bathymetry of East (top) and West Flower Garden Banks. Yellow dots show approximate dive locations. The expedition team will be conducting reef and fish surveys, observing the coral spawning in deep water, investigating existing and possible brine seeps, exploring underwater cliffs, and conducting research transects. Weather and logistics will determine when these activities take place, as well as their actual locations.

The Sea Floor

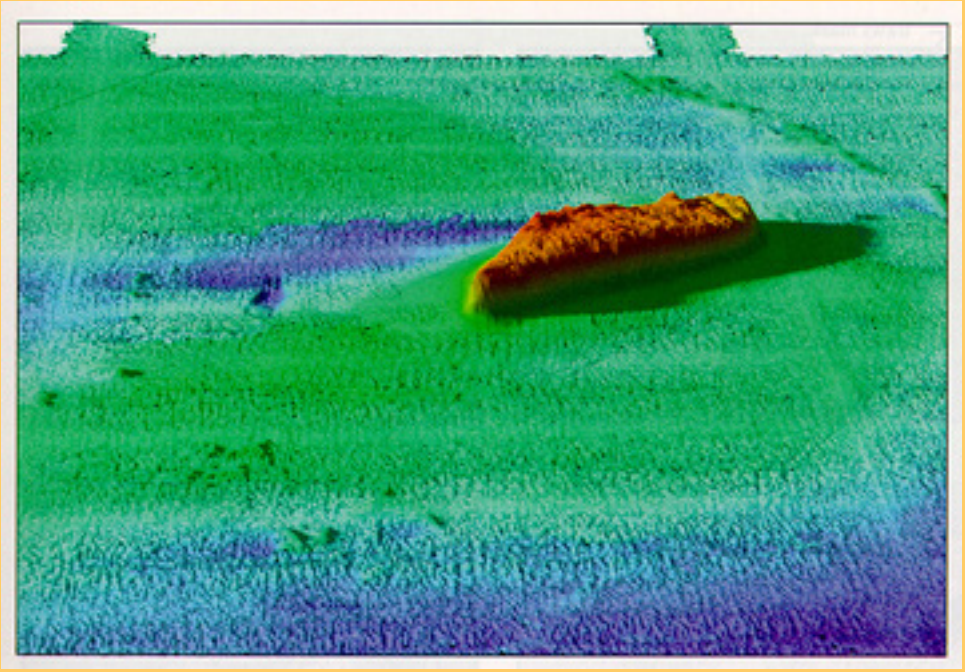
(Bathymetric imagery reprinted courtesy of Gulf of Mexico Science Journal, Volume 16, Number 2, December 1998)



North-looking oblique view of color-coded shaded-relief bathymetry of East Flower Garden Bank. Three small depressions are indicated, the northern depression has a known brine pool. Vertical exaggeration 5X. Top of Bank approximately 20 meters deep. Bottom of Bank approximately 120 meters deep.



North-looking oblique view of color-coded shaded-relief bathymetry of West Flower Garden Bank. Vertical exaggeration 5X; illumination azimuth 045 degrees. Top of Bank approximately 20 meters deep. Bottom of Bank approximately 120 meters deep.



North-looking oblique view of color-coded shaded-relief bathymetry of Stetson Bank. Vertical exaggeration 5X. Top of Bank approximately 30 meters deep. Bottom of Bank approximately 55 meters deep.

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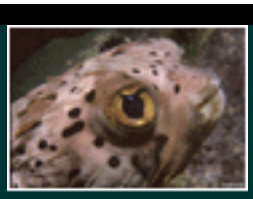
Research in the Flower Garden Banks

Emma Hickerson, Research Coordinator
Flower Garden Banks National Marine Sanctuary

In order to conduct scientific studies 110 miles offshore, one must have a sense of adventure, unlimited patience, tenacity, and a certain amount of stubbornness in your nature. Many obstacles bar our way to investigating the many questions waiting to be answered at the Flower Garden Banks National Marine Sanctuary: weather, sea conditions, ship schedules, distance, the animal or organisms we are studying, and sometimes reliable help.

Much of the research at the Sanctuary is done on little funding and a lot of cooperation. Researchers help one another on various projects, which benefits all, as they learn much more than they bargained for. The sanctuary resources do not (yet) allow for direct funding for projects, but we attempt to provide resources with ship time each year to conduct their necessary data collection. The Flower Garden Banks National Marine Sanctuary charters recreational dive operators to provide the research vessel and crew to conduct activities, and on some occasions, has been able to utilize NOAA ship time.



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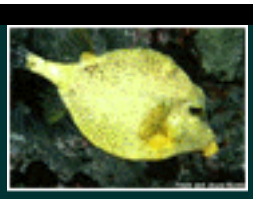
Coral reef researchers secure a rack of tiles to the exposed reef rock to collect coral gametes during the mass spawning event, allow them to be fertilized, and place them back on the reef in the hopes that the planula larvae will settle out onto the artificial substrate. This technique, if successful, could help in repopulation of damaged reef systems.

In spite of all of this, an enormous amount of solid science is conducted at this Sanctuary on a regular basis. The annual research cruise schedule begins in winter when we brave the adverse weather conditions often encountered during this season, to document the shark and ray *(elasmobranch)* populations utilizing these rich topographic highs. From around December through April, schools of scalloped hammerhead sharks (*Sphyrna lewini*) and spotted eagle rays (*Aetobatis narinari*) occur swimming around and over the Flower Garden and Stetson Banks. Sandbar (*Carcharhinis plumbeus*) and tiger sharks (*Galeocerdo cuvieri*) are also encountered during this season. Large schools of silky sharks (*C. falciformis*) are present around the oil platform located within the sanctuary's boundaries, approximately one mile from the East Bank of the Flower Gardens. Throughout the year, manta rays (*Manta birostris*) are seen sweeping over the banks, or feeding at the edges, and southern stingrays are observed lying in one of the many sand flats. Another type of ray, the devil ray, (of which there are two species) are rarely seen but do occur during the summer months. As summer reaches a peak, and moves towards autumn, divers are thrilled by encounters with the largest of all fishes, the whale shark (Rhincodon typus). Many of the encounters with sharks and rays went undocumented until 1994, when Jeff Childs, a Marine Ecologist from Texas A&M University, started his graduate studies.

Spring can be a questionable time to get to the Flower Gardens, but we try to get to Stetson Bank to conduct the annual monitoring. From year to year, identical photographs are taken at repetitive photostations. These images are digitized and compared year to year, to document the health of the reef system. Random quadrats are photographed and analyzed to assess the coverage and diversity of the bank. To date, the monitoring at Stetson Bank has not been officially contracted. Eight years of data has been obtained by a pool of dedicated volunteers. The data is now being analyzed by Texas A&M University graduate student, Sarah Bernhardt. It is important to continue these annual monitoring efforts, and to incorporate updated techniques and analyses.

Summer brings calmer weather, and usually one or two multi-discipline research cruises are scheduled. Recent cruises have yielded a diverse group of scientists from Texas and Louisiana:



University of Texas graduate student Jay Reichman has been analyzing the genetic makeup of the endosymbiotic algae living within the tissue of the star and brain corals of the Flower Gardens.

Also from the University of Texas, Derek Hagman, along with Dr. Peter Vize have been studying the genetics of several fish species to understand their relationship with the fish found in other areas of Caribbean. Along these same lines, they are comparing the coral species between different locations.

Drs. Suzanne Fredericq and Naomi Phillips, with the help of their graduate students, Brigette Gavio and Fred Gurgel, of the University of Southwestern Louisiana have recently joined are research cruises in an effort to characterize genetically and taxonomically, the composition of the algae at the sites. They have already found unusual assemblages to add to the database at the Flower Gardens.

Chris Caldow, from the University of Houston, along with his professor, Dr. Jerry Wellington, have been successful in collecting three-spot and bicolor damselfish to study and compare the population age structure between the banks, and at other areas of the Caribbean. Chris looks at a cross-section of the otiliths (ear bones) of the fish, which reveal the age of the fish. Similar to trees and corals, growth layers are visible from year to year. Very interesting data has come from his comparisons.

Dr. Ken Dunton and his graduate student, Lanny Miller, from the University of Texas, Marine Science Institute in Port Aransas, have been investigating the nitrogen levels (N15) in organisms and comparing them with levels found in other systems. These levels may be useful in assessing the amount of harmful products that may be indirectly affecting the coral reef system.

Dr. Christy Pattengill, along with the Reef Environmental Education System (R.E.E.F.) have been conducting fish surveys at the Flower Gardens for the past 5 years. The large amount of data collected is providing the Sanctuary with baseline data that can be compared with future data collection efforts. More information may be obtained from the **REEF Web site**.

Texas A&M University professor of invertebrate zoology, Dr. Mary Wicksten, has been working with us at the Flower Gardens, and documenting the crustaceans at the Flower Gardens, in particular, Stetson Bank. In addition to this valuable work, Dr. Wicksten has been investigating the fish cleaning behavior at the banks. This fascinating behavior occurs on a regular basis on the reef &endash; small wrasses, gobies, or juvenile hogfish set up a "station" on a

Research Coordinator, Emma Hickerson, takes blood from the dorsal sinus - after running lab tests, we are able to determine the sex of the juvenile animal. This animal (Chocolate) turned out to be female. Lower testosterone levels indicate a female.

prominent coral head sponge, or coral banded shrimp wave their tentacles advertising that they are open for business. A client fish (many times large grouper, parrotfish, or creole fish) will "park", spread their fins, gills, and open their mouth wide while the cleaner species picks off dead and loose tissue, scales, and parasites.

The United States Geological Survey (USGS) conducted a survey of all three of the banks in the winter of 1997. This data is providing us with high resolution bathymetry, which has been instrumental in the planning and implementation of various research projects.

In the late summer, 8 and 10 days after the full moon of August, the reef explodes in a display rivaling any fireworks show I've ever witnessed. The star and brain corals synchronously release their gametes into the water, along with other species of marine invertebrates including brittle stars and christmas tree worms. Dr. Peter Vize and Derek Hagman from the University of Texas have been studying this phenomenon since the discovery of the occurrence (the first in the Atlantic) at the Flower Gardens as recently as 1991. The Flower Gardens provides an excellent site for studying this natural event because of the low diversity (around 25 species) and high coverage (approx. 50%).

The sea turtles of the Flower Gardens were virtually unstudied until I (Emma Hickerson, Texas A&M University) undertook the project. Since 1994, I have been collecting sighting data from researchers and recreational divers to get an idea of the occurrence of these endangered and threatened animals. In 1995 we initiated a satellite

and radio tracking program. To date we have successfully captured and tracked 5 large juvenile (120-300lb) loggerhead turtles. The majority of sea turtle research is conducted on and around nesting beaches. Because we are working in deep water habitat for sea turtles, we have been able to uncover several unique aspects of loggerhead behavior. One very interesting animal is Triton, a male loggerhead, who has been going through puberty over the period we have studied him. He was first captured in June of 1995, and has been captured on two other occasions. He is a resident of the West Bank of the Flower Gardens. We have been able to document his progression through puberty, as well as know his whereabouts for more than four years. We hope to learn more about this amazing animal while he continues to inhabit the Flower Gardens, and moves on for reproduction, and (if he does) to adult feeding grounds. The four other loggerheads tracked to date have all been large juvenile females. More information regarding the tracking of these animals can be found at: **http://www.cccturtle.org/** . Click on the satellite tracking program, then the Flower Gardens project.

This is but a small collection and brief description of the investigations that have been and are currently being conducted at the Flower Gardens. Sanctuary researchers recently brought together manuscripts covering several different disciplines, to produce a dedicated issue of the journal, Gulf of Mexico Science (Volume XVI, No. 2). Copies may be obtained by emailing a request to Emma Hickerson. We hope to continue this effort every 4 or 5 years.

There are many exciting plans for the science program at the Flower Gardens, including the integration of GIS into all possible aspects of the program. SSE has provided us with an opportunity to investigate the deeper parts of the reef system--some of it has been seen during earlier expeditions, but we will surely be the first to lay human eyes on some of the features and creatures of the Flower Gardens from inside the DeepWorker.

(top) **RETURN**

HIGHLIGHTS
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NATURAL SETTING

MAPS


RESEARCH

EDUCATION

HISTORY

Education

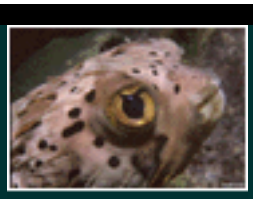
Shelley Du Puy, Education Coordinator
Flower Garden Banks National Marine Sanctuary

"So, what is a coral reef anyway?"
--overheard in Ms. Johnson's 2nd grade class in St. Louis, Missouri

Loaded in that innocent question are all of the challenges inherent in the Flower Garden Banks National Marine Sanctuary's education mission.

An artificial coral reef is used at events such as SeaSpace (Houston) to educate children about marine life and the marine environment of the Flower Gardens.

Storm water runoff and other waters from roughly 2/3 of the continental United States drains into the Gulf of Mexico, not to mention the hydrological contributions of Mexico. That's a LOT of people! Every single one of them affects the water and habitat quality in the Gulf of Mexico, just by going about their daily life routines. The lifeblood of the Gulf is the water that feeds it. And, that lifeblood is affected every time someone in the watershed brushes their teeth, flushes the toilet, takes a shower, waters or fertilizes the lawn, takes a drink from the municipal water supply (often created by damming a river to make a reservoir), uses those same reservoirs for swimming/fishing/boating, cools their home, or drives an automobile. Add to that mix the potential impacts of ocean industries, such as shipping and petroleum production, then further complicate matters by throwing in an increasing diving population and some types of fishing.



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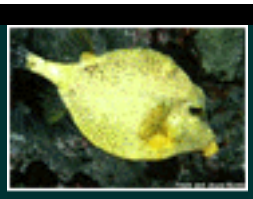
A DIVER'S VIEW

How do you educate an audience that large, that diverse, and that geographically widespread when you are trying to protect a fragile coral reef smack dab in the middle of the northern Gulf of Mexico? It's difficult enough to reach the people who use the resources directly and live close to the coast. How do you convince someone living in Iowa, or Missouri, that he has a reason to care about a place hundreds of miles away from home? How do you explain to someone who probably has never seen the Gulf coast, that the thousands of individual daily lifestyle choices she makes can have an impact on those reefs, way out there in the Gulf of Mexico?

If I had to summarize our approach to that exciting challenge in one word, I would say "partnerships." When you are trying to reach such a widespread audience, partnerships are crucial to accomplishing any education or outreach goal. All of us working together are greater than the sum of our individual efforts. We partner with dive clubs and associations to reach individual divers and their families through club presentations, trade shows, and environmental awareness events. We partner with other Federal agencies and individual industry representatives to reach the oil and gas industry. We partner with individual divers, non-profit organizations, oil and gas industry representatives, state and local government agencies, researchers and academia to reach teachers and students. We work with all of these to reach John and Jane Q. Public. Not a single Flower Garden Banks sanctuary program is accomplished without a partner! Most of them have multiple partners.

Artist Joel Hickerson teaches children from 3 to 83 how to draw in his art class at the annual SeaSpace convention in Houston. This session is called "Grouper got big ol' lips!"

There is a parable, popular among environmental educators, about a young boy who was observed on a beach full of stranded sea stars. He was gently tossing the sea stars back into the bay, one at a time. When a passerby pointed out the enormity of the situation and told him he couldn't possibly make a difference in the long run, the boy picked up another sea star, tossed it into the bay and replied "I made a difference to that one." Taking the parable one step further, if each of us toss a few sea stars back into the bay, we CAN make a collective difference in the long run.



How do we reach two-thirds of the continental United States, plus Mexico? We link with as many partners as possible and start with the 'sea stars' nearest us. We reach out to the divers, the oil and gas industry, the charter boat operators, the fishers, and the teachers. We recruit those same 'sea stars' as partners and begin working our way inland, then into Mexico and, eventually, the rest of the world. The ultimate goal? Help people make the links between their daily lives and the oceans, regardless of where those lives are lived. Show them how they can join the partnership and make a difference to our oceans.

Education Partnerships Involving the Flower Garden Banks sanctuary

The Sustainable Seas Expeditions (SSE) are a superb example of the partnership philosophy that prevails at the Flower Garden Banks National Marine Sanctuary and throughout the National Marine Sanctuary Program. In addition to the national level partners, local partners at each sanctuary have been integral to the success of these expeditions. For the expedition at the Flower Garden Banks, the Texas State Aquarium is hosting a Sanctuaries and Coastal Ocean Resources Day, featuring the DeepWorker model, SSE pilots, sanctuary staff and representatives from a variety of state, federal and private organizations involved in ocean conservation.

The U.S. Army Corps of Engineers in Galveston is making their facility available for the Open House. Teachers and principals at several schools are preparing their students to actively participate in the live internet broadcast, Web chats and student summits. Researchers are taking the time to chat with students, teachers and the public to convey what they have discovered and their excitement in these discoveries. Without the support of these partners, the research and exploration accomplished during the expedition would likely never be related to most of the public. Many of the local partners involved in SSE are long time friends and partners of the sanctuary. For those who are first time partners with us, we hope it is the first of many fruitful partnerships.

Teachers and students are targeted through several different avenues. This is the audience where we have made the most progress in reaching those landlocked areas that drain into the Gulf of Mexico. By "piggy backing" our specific information onto existing workshops and programs that discuss the watershed, we are able to focus our own efforts on the coral reefs and coral/sponge habitats.

One such program, "Cyberways and Waterways," is an exciting new partnership for us. It is a project that brings us closer to our goal of moving inland with the ocean message. Partners in this project

come from all levels of government, non-profit organizations, individuals, businesses, teachers and schools. The goal is to use technology to teach students about their local rivers and tributaries and how they link to ecosystems upstream, downstream and out in the Gulf of Mexico. Teachers and students will be trained to collect water quality and biodiversity information at their chosen sites. They will examine uses and abuses of our water sources. Students will then share their information through a central Web site and develop projects related to specific aspects of the watershed. Periodic live broadcasts and Web chats will provide students an opportunity to see other project sites and interact with experts in various fields such as waste water treatment and coral reef ecology.

The annual education workshop is sponsored by the Gulf of Mexico Foundation and includes 18 educators.

One of the most enduring partnerships we have is with the recreational dive community. Recreational divers were key players in the effort to have the Flower Garden Banks sanctuary designated. The dive community has continued to be active in sanctuary programs. Each year, divers volunteer to attend a training session and then give presentations to between 1,500 and 1,800 seventh graders during the month of February, through another partner, the Houston Museum of Natural Science. This effectively reaches two target audiences with one partnership: the divers who learn about the sanctuary and the students who receive the benefit of the divers' presentations. Many of these divers also extend their speaking services to schools and other youth organizations throughout the year.

The dive community also includes the sanctuary in local, regional and national dive events, such as Seaspace, offering free booth space and assistance in staffing exhibits. Through these functions, we are able to reach a large number of divers with the sanctuary message of protecting the resources while allowing compatible uses. Researchers, who frequently use the recreational charter vessels to access their study stations in the sanctuary, serve as conduits of information about the sanctuary to the vessel crew and any recreational dive passengers.

Our most intense, in-depth educator program to date is a partnership with the Gulf of Mexico Foundation. Each year, the Foundation sponsors a 4-1/2 day workshop for 18 formal (i.e. classroom) and informal (e.g. aquarium education staff) educators. Applicants compete to participate by summarizing how they would apply the experience to existing curricula and programs. Successful candidates receive a full day of classroom lectures on coral biology, reef fish identification, human and natural impacts to the coral reefs (with a focus on the Flower Garden Banks), the National Marine Sanctuary Program in general, and the Flower Garden Banks specifically. This is followed by 2-1/2 days of SCUBA diving in the sanctuary, interspersed with informal question and answer sessions with researchers and sanctuary personnel, who participate in the trip.

Educators apply their newly acquired fish identification skills by collecting relative abundance data as part of the Great American Fish Count. In 1999, an advanced workshop was held to allow previous participants an opportunity to expand on their knowledge base. Participants assisted researchers in collecting data for on-going projects at the Flower Garden and Stetson Banks.

A soon to be completed project, called "Treasures of the Gulf" will provide an interactive computer based format for learning about state and federal protected areas in coastal and offshore Texas, including the Flower Garden Banks sanctuary, and the water links between them. It will be available in three different platforms: a traveling kiosk, CD-ROM, and World Wide Web. The traveling kiosk is intended to reach members of the public who we don't ordinarily target. It will be featured in public areas such as shopping malls and tourist visitor centers. The same interactive program will available to teachers on CD-ROM, for classroom use. The more structured environment of a classroom will promote more in-depth study of the information in the program. Finally, the World Wide Web will make the information available to a wider geographic area. Our partners in the project were the Environmental Institute of Houston (University of Houston, Clear Lake), the Texas Parks and Wildlife Department, the U.S. Fish and Wildlife Department, the Environmental Protection Agency, and Compaq Computers.

The Minerals Management Service (MMS), and the oil and gas industry they regulate, have also been valuable partners since the sanctuary's inception. Sanctuary staff participate in MMS sponsored Information Transfer Meetings where we keep MMS and industry representatives up to date on sanctuary regulations and policies. The sanctuary is also frequently included as a guest presenter in industry training seminars. This offers us an opportunity to interact directly with industry personnel responsible for ensuring their company is operating in an environmentally safe manner.

Researchers, who conduct studies on both the production platforms and in the sanctuary, again act as conduits of information between the sanctuary and personnel manning the platforms.

Although the extent of commercial fishing that occurs in the sanctuary is not well known at present, we have targeted this user group through our sister agency, the National Marine Fisheries Service. Notices describing the fishing regulations within the sanctuary were distributed to port agents, who interact with the commercial fishing community on a regular basis. We hope to expand on these efforts in the future.

(top) **RETURN**

The History and Future of the Flower Gardens

Stephen R. Gittings, Science Coordinator
Marine Sanctuaries Division, National Ocean Service, NOAA

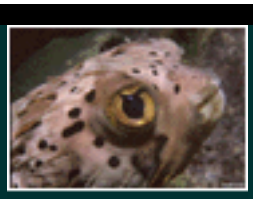
Emma L. Hickerson, Research Coordinator
Flower Garden Banks National Marine Sanctuary

The history of exploration, research, and environmental protection at the Flower Gardens is a model of accomplishment through partnerships - a demonstration of how a spirit of mutual support leads to the achievement of shared goals.

Steve Gittings (Sanctuaries Science Coordinator) and Emma Hickerson (FGBNMS research coordinator) wait for epoxy to dry on a satellite transmitter before they release the loggerhead sea turtle.

Over 100 years ago, Gulf of Mexico fishermen working far from shore discovered a number of shoals with tremendous fish populations. They began to routinely harvest the bounties of these productive ecosystems. Understandably, word of their existence or their location didn't filter far from their own wheelhouses for quite some time.

It wasn't until the 1930s that many of these two dozen or so features were located and mapped by chart makers. Geologists studied two of the shallowest features, called the Flower Garden Banks because of the brightly colored "rocks" that sometimes snagged on anchors and fishing hooks, in the 1950s and began to suspect they might harbor tropical corals and associated



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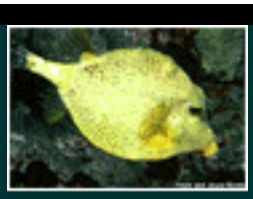
A DIVER'S VIEW

organisms. The first scuba divers at the Flower Gardens in the early 1960s (scientists and volunteers working with the Houston Museum of Natural Science) were greeted by massive, continuous coral reefs larger than most golf courses, dense schools of tropical fish, manta rays, turtles, and sharks in the warm clear waters over the banks. Over the next 35 years or so, first-time visitors to the Flower Gardens have consistently reacted with the same awe as those first adventurers - Tom Pulley, Charlie Doh, Dick Thomey, and others - some of whom can still be coaxed to tell their sea stories.

Thus began about two decades of exploration at the Flower Gardens. Between 1960 and 1980, expeditions to the banks by divers and submersibles, mutually funded by the Museum, the Flower Gardens Ocean Research Center, and later by the Bureau of Land Management, gradually elucidated the tropical assemblages not only on the tops of the banks, but throughout their depths down to over 100 m deep. Scientists also found some unique features, including ancient drowned reefs, natural gas seeps, and a brine lake and overflow canyon on the East Bank inhabited by chemosynthetic bacteria. Studies on the brine seep suggested that large volumes of salt must be in the process of dissolving from beneath the bank. High resolution images of the banks, made possible by technological advances in the 1980s and 1990s, and produced first by the Navy and then at even higher resolution by the U.S. Geological Survey, clearly revealed a depression over a mile across, up to 15 m deep, and surrounded by faults, that strongly supports this theory.

The goldentail moray (Gymnothorax miliaris) are one of only a few species of eel found at the Flower Gardens and Stetson Bank.

The last twenty years has seen a scientific evolution at the Flower Gardens from exploration to monitoring and research on the shallow coral reef zones. The descriptive and taxonomic surveys of the banks through the 1970s gave way in the 1980s to studies on coral growth rates, recruitment, coral recovery rates following mechanical damage, and the effects of a region-wide die-off of sea urchins. In the 1990s, scientists investigated coral bleaching, mass spawning, embryology, genetics, uptake of trace metals by corals, coral-algae symbiosis, fish assemblages and trophic structure, sea turtle habitat use, manta and shark behavior, and even the occurrence of birds in the sanctuary.



A TEACHER'S VIEW

TEMPLATE

The 1990s also was a period of significant growth for tourism at the Flower Gardens, with three thousand or so recreational divers arriving each year aboard large dive charters. But this decade also benefited from a genuine commitment by this group to protection of the Flower Gardens from real-life threats to their continued health. To reduce the effects of anchoring, a group of divers installed mooring buoys on the banks in 1990, then later donated them to the marine sanctuary, which was designated in 1992. Some of the same people served on the advisory committee for the sanctuary and participated on the many monitoring and research projects conducted during this period. During one phase of monitoring between 1989 and 1992, 64 different divers participated on the project. Over 50 were unpaid volunteers.

Another group to pitch in during the 1990s was the oil and gas industry. From annual donations to the Flower Gardens Fund, an arm of the Gulf of Mexico Foundation established to support the sanctuary, to allowing scientists to live and work on their platforms for weeks at a time, companies working around the Flower Gardens actively supported conservation and scientific research.

The first decade of the new millennium brings new challenges to the Flower Gardens. Predicting how use and the threats posed by changing patterns of multiple use may be the most important. For example, how the recreational diving industry will change in the next decade is unclear. On one hand, people are coming from farther and farther to visit this unique location. Dive groups from many U.S. states frequently book trips aboard the two largest live-aboards that operate at the Flower Gardens. On the other hand, repeat visits by divers from the Gulf Coast may be on the decline, as most of the active divers in the region have been there numerous times. Thus, depending on what balance results, one possibility is that more or

Monitoring has shown that the reefs at the Flower Gardens are very healthy, with over 50% coral coverage in the study sites. In this picture, a diver is photographing one of the stations during the annual monitoring at Stetson Bank.

larger live-aboard charter boats will begin to operate at the Flower Gardens. In preparation for this eventuality, it would be prudent for managers and researchers to begin to address the question of carrying capacity of the reefs. Research and monitoring topics of specific interest might be determining current use levels, predicting future use, seeking evidence of impacts at current use levels, modeling future impacts, and conducting table-top risk assessments, such as reasoning potential impacts and identifying ways to monitor them.

Also among the challenges for continued preservation of the Flower Gardens is the need to remain vigilant in the face of a changing offshore oil industry. As oil prices drop, or as deepwater production increases, large companies tend to sell off marginal assets. This has begun to happen near the Flower Gardens, particularly among the older platforms and fields. Smaller companies purchasing such platforms may or may not be as environmentally sensitive as their larger associates, potentially increasing the risk of spills or other operational accidents. In any case, a substantial effort needs to focus on educating the new companies about the value of the neighboring resources, and the regulations, policies, and operating procedures of the sanctuary. The objectives should be to understand each party's needs, to develop collective respect, and to form a mutually productive partnership by pursuing shared goals.

An area of negligible research attention over the years has been tracking the effects of commercial fishing on the Flower Gardens. Though gear restrictions exist in the sanctuary, mainly to reduce the threat of mechanical damage by destructive bottom fishing methods, fishing effort is not controlled. Most fishing takes place in the extensive area of rugged topography in the deeper portions of the banks beyond scuba diving depths, but little is known regarding how much fishing occurs, when it occurs, or what proportion of the commercial stock is removed annually. One way to address the question of impact would be to establish deep water monitoring stations in areas known to be fished regularly. Data collection could involve traditional sampling or repetitive visual censuses using submersibles or remotely-operated underwater vehicles. Shipboard or aerial surveys, and observations from nearby platforms could help to discern temporal and spatial patterns of fishing and other activities.

Another challenge in the next decade will be to monitor the effects

of regional and global changes in climate patterns. There is much debate over the evidence purported to indicate the effects of climate change at many reefs throughout the world - coral bleaching and mass mortalities, for example. In many cases, this is because it is difficult to separate the impacts of the apparent regional changes in climate from all the other stressors affecting coral reefs on a local scale, such as overfishing or water quality changes. The Flower Garden Banks would be ideal locations to conduct such studies. The ecosystems are fairly simple compared to other reefs. The banks are far from shore, have very predictable annual temperature cycles, have relatively low diversity, and the shallowest reefs are comparatively deep, around 20m, reducing the confusion caused by the short-term variability typical of shallow water reefs. For these reasons, annual and longer term events would probably be easier to identify and evaluate. Recent studies on coral skeletons suggest that regional climate change over the last 100 years or so is clearly recorded by the annual bands of corals on the banks. Strong and distinct yearly fluorescent banding records in corals suggests the even annual changes may be more clearly identifiable at the Flower Gardens than most other reefs.

The balloonfish (*Diodon holocanthus*) is usually a shy little fellow, who retreats to a safe hole in the reef to peak out warily. If they are startled, they inflate with water to make themselves look a lot bigger and more threatening.

Perhaps the most exciting future potential resides in the most significant challenge - to build increasingly productive partnerships with the public and with conservation-minded support organizations. From research to public education, active participation by members of the public is the only way for a small sanctuary to have a large impact. The sanctuary staff will have to stimulate students, teachers, divers, dive clubs, environmental action groups, offshore industry, and researchers to continue to help meet the resource protection needs for this remote area. In so doing, the site will develop a broader constituency for itself and for the national system of marine sanctuaries. They will have to facilitate projects by graduate students in any number of fields, including science, technology, socio-economics, or public policy. Staff will also have to convince funding agencies in the government and non-profit arenas to sponsor research, education, and conservation programs at substantially higher levels than have been realized to date. This

should include efforts to raise the level of recognition of the Flower Gardens among major scientific funding agencies, perhaps even pursuing special area designations that encourage directed research. This may not be as large a challenge as one might expect. The Flower Gardens clearly harbor two of the healthiest coral reefs in the Western Atlantic, and may be among the few reefs anywhere that can still be considered to be in nearly pristine condition. They are, quite simply, ideal locations for fundamental coral reef research.

So it is to all those who helped make the Flower Garden Banks what it is - protected, healthy, respected, yet still something of a mystery to the "outside world" - who helped the graduate students and professional scientists do research and monitoring, and who volunteered their time to bear witness to children, teachers, and friends about the allure of the place, that this essay is dedicated. Abiding thanks to all of you.

(Originally printed in the *Gulf of Mexico Science Journal*, Volume XVI, No 2., December 1998. Permission to reprint for the purposes of this Web site granted by the Marine Environmental Sciences Consortium of Alabama.)

(top) **RETURN**

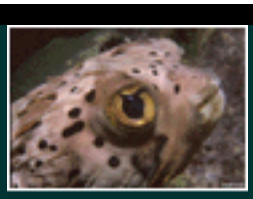
Geology of the Stetson Bank

Richard Zingula, PhD.
Retired Geologist, Volunteer, Recreational Diver

Stetson Bank, named for oceanographer Henry Stetson, is a salt dome. So what caused a "salt dome"? Let's start nearly 200 million years ago in the Triassic age, when the supercontinent of Pangea started to break up into Europe, Africa, and North and South America. In early Jurassis time, about 190 million years ago, the newly separated continents had drifted apart enough to form the ancestral Gulf of Mexico. The Gulf was shallow at that time. The source of marine water was somewhat restricted with only narrow openings to the main oceans. And, the climate was hot and dry. Because of those conditions, the Gulf at that time was the site of intense evaporation of the incoming sea water, and a thick layer of salt, the Louann formation, was deposited.

As the continents spread further apart and the Gulf deepened, the waters there became normal salinity, and rivers started to bring in mud, sand, and silt that covered the salt. Through time there was continued deposition of those clastic sediments which are denser than the salt. Because of the overlying load, in many locations the

underlying salt began to flow to areas where there was either a structural uplift, or where the overlying rocks were weaker than at other sites. In any case, the salt started to slowly push its way up through the overlying beds, bowing them up, and in many cases, piercing through them. However, in the case of Stetson, and some other domes, large blocks of rock were carried upward on top of the salt, pushing older



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At the East Flower Garden Bank, fissures in the sediment have allowed the trapped salt within the salt dome to escape. The escaping salt is called a brine seep, and has formed a super salty (hypersaline) lake, seen here, at about 240 feet deep. (Requires Shockwave Plug-in. Click here for more information.

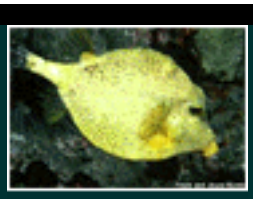
Special thanks to the Environmental Institute of Houston, University of Houston, Clear Lake, for use of the animated illustration. Graphics by Joel Hickerson. Animation by Chad Joyner.)

beds up into younger ones.

At Stetson Bank, rocks of latest Oligocene or earliest Miocene age, about 24 million years old, have been brought up above the surrounding sea bottom, and that is what we see while diving there. The thin, hard beds at Stetson are of fine sandstone to siltstone, and the thicker and softer beds are claystone or mudstone. Those same age beds that we see standing on end at Stetson are nearly horizontal and 10,000 feet below sea level a few miles away where they have not been affected by salt movement. I have taken several samples of mudstone and have had them dated by microfossils such as coccoliths and foraminifers. The foraminifers are also useful in determining what the water depth was at that time at that spot. There is some minor difference in age from one sample to another (probably because they came from different fault blocks), and some difference in paleo water depth. However, all samples that contain good foram assemblages show that water depth there at time of deposition of the mudstone was greater than 3,000 feet!

Geologic structures called salt domes are isolated pockets of salt layers pushed up through the sediments by internal pressures.

Salt domes vary in how close to the present earth's surface, or to sea bottom, the salt comes. In a number of salt domes (such as at Avery Island, Louisiana, home of McIlhenny's Tabasco Sauce), the salt is close enough to the surface to be mined. There are even a few in the Gulf today where there is salt at the sea bottom, with only a foot or two of Recent mud over the salt. In other domes, referred to as "deep-seated", the top of the salt may be as much as 10,000+ feet deep. Although most salt domes have the salt in a roughly circular "plug" or "stock" that may be anywhere from 1/2 to 2 miles in diameter, some are not circular. Some have horizontal projections, called "overhangs," at the top. And some may be topped by "caprock" which may be



either limestone or anhydrite, or both, due to solution of the salt. All have "faults" or fractures of the overlying and immediately surrounding rock due to movements of those beds.

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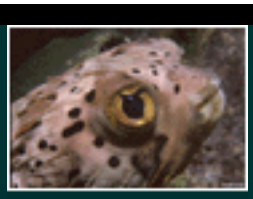
Some Poetry

Written by:
Emma Hickerson, Research Coordinator
Flower Garden Bank National Marine Sanctuary

Illustrated by:
Joel Hickerson



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Night Dive

peace

80 feet under the surface of the Gulf of Mexico

heavenly bodies light our way across the sandflat

hermit crabs explode in a display of bioluminescent splendor as they scurry away

brittle stars ease themselves over the corals, reaching out tentatively with their creeping arms

coral polyps wave their dainty tentacles hungrily

parrotfish stare blankly through shrinkwrap cocoons, waiting for morning

a nurse shark glides past, her body shimmering, leaving in her wake, a tiny fireworks show

we kick slowly back to the boat in a trance-like state

and communicate in silence the awe of Mother Nature

by Emma Hickerson

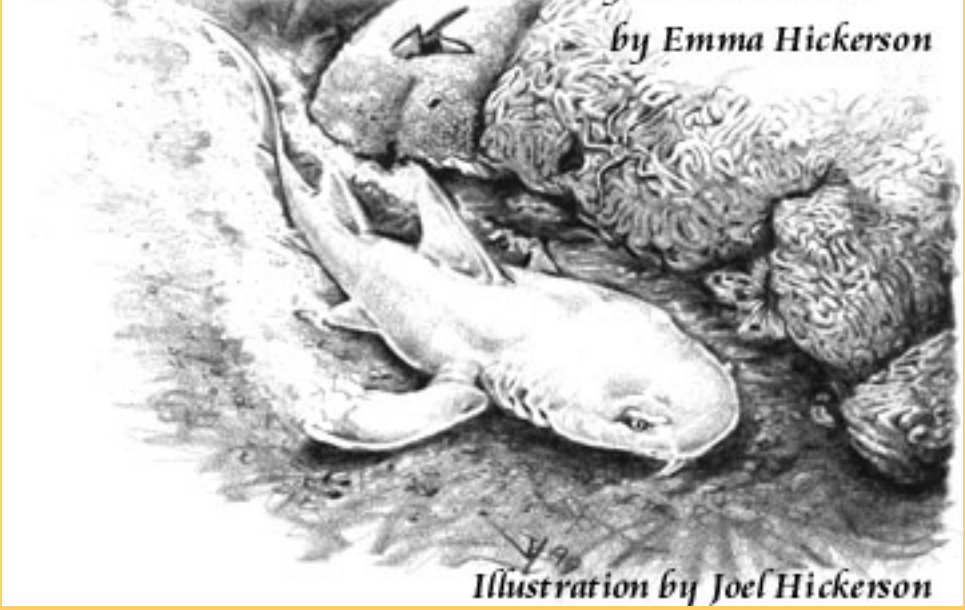

Illustration by Joel Hickerson

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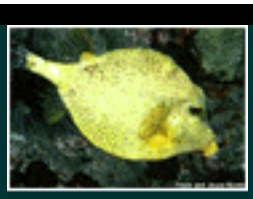

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Rejuvenating the Spirit: My Reflections on the Flower Garden Banks

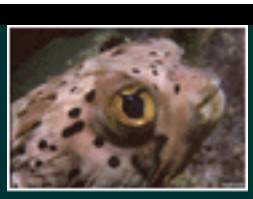
Jeff Childs, Marine Vertebrate Ecologist
Department of Wildlife & Fisheries Sciences,
Texas A&M University

I suppose the Flower Garden Banks National Marine Sanctuary means a number of things to each of the scientists working there. And I guess we each have our favorite stories to tell about the organisms we study or the people we have come to dive with there. So it seems natural to me to relate something about the sharks and rays which I've been studying there, as these animals have played a large part of my professional focus for the last eight years.

My favorite time of year to dive the Flower Garden Banks is in the winter. While the seas may be rough, there are days when all is calm, except for where the many fins of scalloped hammerhead sharks break the surface of the sea. It is not unusual to get up in the morning on the boat to find manta rays or carcharhinid sharks leaping from the water, sometimes performing what are eloquent acrobatics, and other times slumping into an undignified bellyflop. After gearing up and upon entering the water, I descend to the reef 60-80 feet below the

boat, where it is not unusual to pass through a school of scalloped hammerheads. On the reef, it is natural to gaze around in a 360 degree sweep, observing within 70 feet of me a manta ray, a multi-species school of scalloped hammerhead sharks and spotted eagle rays swimming together, and a couple of tiger sharks, when visibility is good.

Other sharks and rays I often encounter during the winter include nurse sharks, Caribbean reef sharks, dusky sharks, sandbar sharks, and spinner or blacktip sharks, and southern stingrays. Such dives



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are not only highly productive to me as a scientist, but also as a person, for such encounters often recharge my spirit and commitment to being a better steward of our oceans.

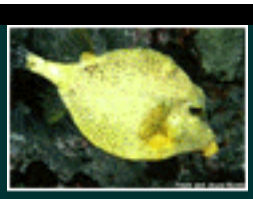
Manta rays, *(Manta birostris)*, may be encountered at the Flower Garden Banks throughout the year.

It is difficult to identify which of my many encounters are my favorites. All are unique and special. However, two stand out that may be of interest. One is of an encounter with a whale shark, the other with a manta ray. Both species frequent the Flower Garden Banks during the summer and autumn months, more so for manta rays than the whale sharks. As part of my studies identifying manta rays and studying their behavior and ecology, I periodically find myself roving over large areas of the banks on an underwater scooter. It was such a dive on summer afternoon, when I stopped the scooter, and completed a 360 degree visual sweep looking for elasmobranchs.

Behind me, perhaps 60 feet, a young manta (estimated at 6 feet disc width) was approaching me. Such behavior is not unusual for these rays, nor for some sharks I've encountered as well. I clipped the scooter to my BC, and waited as the manta ray slowly approached me, circling me, ventral (belly) side to me. The animal circled me at a distance of 7-8 feet, and it was clear the animal was visually focused on me. After completing several of these circles, it moved up close to me, first touching my legs with its caropteres (fins protruding forward

from the head), and then passing on up my body and shoulders. The animal posed no threat to me; manta rays are spine-free, and are basically harmless to divers. The animal passed overhead, performing a backward roll in front and above of me, before returning to me again.

It slowly glided by me, and I swam with it for several minutes before breaking contact with the animal to return to the boat. I would like to think it was a positive encounter for each of us; it certainly was exhilarating for me.



Jeff Childs has documented over 35 individual manta rays by using distinguishing markings on the underside of the animals.

As for the whale shark, encountering one of these behemoths is always a unique and vitalizing experience. These giants, like manta rays, are truly gentle sea creatures, and pose virtually no danger to divers. Though I've seen a number of whale sharks in and around the sanctuary, one encounter is especially worthy of relating. We were at the West Flower Garden Bank in October for the annual monitoring cruise. During the morning several divers reported a whale shark passing through the area, often swimming with divers for several minutes before moving on. The animal evidently remained in the area, for there were multiple sightings throughout the day.

Late in the afternoon, the whale shark, an 18-20 foot individual came to the stern of the boat where it remained for several minutes. Joel Hickerson, a good friend of mine, and I donned our snorkeling gear and quietly entered the water beside the shark. It remained beside us, passively swimming back and forth around us. There was a slight surface current, no more than half a knot, that carried us ever so slowly astern of the boat. I reached out, and gently caressed the shark, first along the dorsal fin, then casually passing my hand down toward its belly. Underneath the shark, a plethora of sharksuckers swam, some attached to the shark, some not.

The shark slowly passed over me, allowing me to determine its sex. Two small claspers extended from the pelvic fins, though not far, indicating the animal was a sub-adult male. I returned to the sea surface for a breath of air, and the shark circled, coming back to Joel and me. I reached out again and gently scratched the animal's chin. The whale shark stopped moving, whereupon

his caudal (tail) fin slowly sank, leaving the animal "standing" head up in the water column. He remained there as I gently scratched his chin. In performing this act, the animal's three foot wide mouth was no less than two feet from my chest. Whenever I removed my hand, the shark gently moved up and bumped me in the chest, sometimes several times, until I resumed my role as masseur.

Whalesharks are often gregarious, and allow interaction with ecstatic snorkelers and divers. They are plantivorous elasmobranchs (related to sharks and rays), and range from around 15 ft as juveniles to 40 or 50 ft as adults.

Joel and I traded positions, whereupon Joel also received the rostral nuzzling by the shark if scratching ceased. We each took turns with the shark, until we had drifted several hundred feet from the boat, at which point we broke away from our interaction with the shark and swam to the stern of the boat. The animal quickly resumed its natural horizontal position in the water, circled and followed us back to the boat, where Joel and I turned our colleagues on to the experience.

Such encounters are mesmeric and invigorating to the body, mind and soul. Without protection and care, such places as the Flower Garden Banks might eventually succumb to the trend that many habitats, both terrestrial and aquatic, have in the past century. No less is true for creatures such as manta rays and whale sharks that reside or visit these places, without whom this ocean planet in which we all live, would be tragically impoverished.

(top) **RETURN**

Coral Spawning

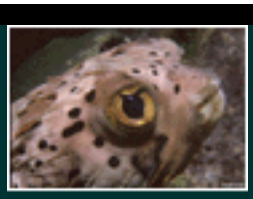
Derek K. Hagman, Marine Biologist
University of Texas

Each summer, following maximum seawater temperatures, the reef explodes in an orgy of reproduction. At least 10 species of invertebrates, including corals, worms, sea stars and sponges, and many fish species, participate in this reproductive period that culminates in the week following full moon.

Coral spawning is a spectacular event that occurs 8-10 nights after the full moon in August.

Most of the invertebrate species spawn together on a single night in what are known as multi-specific or mass spawning events, while fish spawning is more spread out and occurs before dusk. We have monitored this annual event since 1991 (first observations in 1990), characterizing the species involved, and their individual timing and behavior. We have also experimented with fertilization, hybridization and development with several coral species. In addition, we have had limited success in recruiting and growing out brain corals from larvae generated during our fertilization trials. These corals continue to thrive on both the East and West Banks.

More recent emphasis has shifted to determining the ultimate sources of larval input for the Flower Gardens. Since nearly all reef organisms have some form of larval planktonic stage, they have the potential for dispersal over vast distances (thousands of



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kilometers). More importantly, the Flower Gardens are isolated from other similar reef 4 4

systems by more than 600 km of open water, with their nearest neighbors located north of Veracruz, Mexico to the southwest and the Yucatan peninsula to the southeast.

We know that the Flower Gardens are reproductively active. However, we do not know if this annual reproductive effort helps maintain the existing populations at the Flower Gardens, or if they rely on input from other more distant reefs. We have been investigating this dilemma by examining mitochondrial genes in the fish and coral populations at the Flower Gardens, and other potential source points in Mexico.

A star coral (*Montastraea franksi)* releases egg and sperm bundles while a hungry ruby red brittle star (*Ophioderma rubicundum)*gathers up the gametes with its arms and creeps back under the coral ledge to consume them in private.

Our hope during the SSE mission to the Flower Gardens is that we will be able to observe the coral spawning as it occurs, and to gather more data to supplement what we already know about the event.

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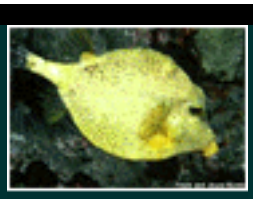


Fish Cleaning

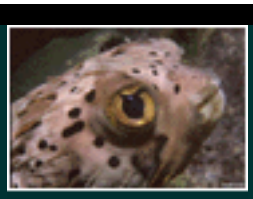
Mary K. Wicksten, PhD
Texas A&M University

Cleaning is a pattern of behavior in which a small fish or shrimp (the cleaner) removes debris, mucus, parasites, infected tissue or other material from a larger fish (the client), and does so unharmed. The relationship appears to be mutually beneficial: the cleaner gets a meal and the client is rid of an irritant. Cleaners range from opportunistic scavengers to specialists with characteristic color patterns and attractive behaviors. Cleaning is a common phenomenon of tropical and subtropical reef ecosystems.

This creole-fish (*Paranthias furcifer*) stops and spreads its fins out, and sometimes opens its mouth and puffs out its gills to allow cleaner fishes such as this juvenile spanish hogfish (*Bodianus rufus*) to get at all the dead tissue and perhaps parasites. Cleaning stations are usually set up at prominent points in the landscape, such as this blackball sponge (*Ircinia strobilina*). Animals documented as receiving cleanings at the Flower Gardens include many fish species, eels, and sea turtles.

Although the Flower Gardens and Stetson Banks are remote from other reefs and small in area, cleaning occurs there regularly. My study aims to compare behavioral patterns and species involved in cleaning at the Banks with cleaning behavior observed in the Caribbean, Florida, Hawaii and the western Pacific. Of particular interest is whether or not pelagic fishes, such as sharks and mantas, visit the Banks and are cleaned, as has been observed on isolated banks in the eastern Pacific.

So far, two species of cleaners have been observed at the Banks:



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juvenile Spanish hogfish (*Bodianus rufus*) and neon gobies (*Gobiosoma oceanops*). The hogfish stay at "stations", usually areas around high coral mounds, where they live for months or more. The gobies usually reside on or near the bottom, especially near sponges.

This queen parrotfish (*Scarus vetula*) is taking a bite out of some coral, while a couple of juvenile bluehead wrasse (*Thalassoma bifasciatum*) take the opportunity to undertake some cleaning work while the parrotfish is somewhat still.

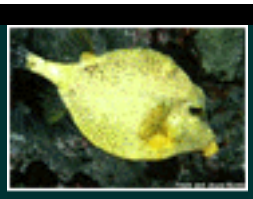
Common clients of both are creole fish (*Paranthias furcifer*). The gobies often clean spotted morays (*Gymnothorax moringa*). Parrotfishes and groupers also are cleaned. No pelagic fishes have been observed being cleaned, but observations so far have been confined to summer, when pelagic fishes are uncommon at the Banks.

Shrimp have not been seen to clean at the Banks. Caribbean cleaner shrimp species often associate with large sea anemones, which are absent at the Banks. However, other shrimp species clean at night. No night observations have been made yet.

Cleaning at the Banks is most similar to that in the Caribbean. The species of goby cleaner is different from that in the southern Caribbean. No cleaning by juvenile bluehead wrasse (*Thalossoma bifasciatum*) has been observed at the Banks. Cleaning activity is very different from that in the western Pacific and Hawaii, where species of the wrasse Labroides perform nearly 100% of the cleaning.

Gale Mead, SSE Mission Log Editor, adds:

This fascinating behavior requires patient and unobtrusive observation of cleaners and their clients. Use of the DeepWorker submersibles will enable us to make observations of longer duration than is possible with scuba, and without the potential disruption caused by divers' bubbles. We are looking forward with enthusiasm for the opportunity to expand our research through this approach.



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Nutrient Stress: Macroalgal Primary Production and Food Web Structure

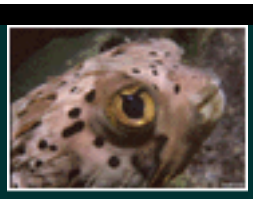
Harlan (Lanny) Miller and Ken Dunton, PhD.
Marine Science Institute, University of Texas

Over the last few decades algal proliferation as a result of coastal nutrient-loading has affected coral reefs worldwide. At nearly 200 km off the Texas coast, the Flower Garden Banks National Marine Sanctuary is a unique coral community seemingly removed from the nutrient enrichment typical of coastal environments.

However, the oceanic reef subsists down-plume of the Mississippi River, which discharges large amounts of fertilizer and human wastewater into the Gulf of Mexico. Coral reef communities are especially susceptible to nutrient excess since these organisms are highly adapted to nutrient-deficient, oligotrophic conditions.

Flower Garden Banks sanctuary is far enough offshore that it is as close to a pristine coral reef system as we could hope for in the United States.

Understanding community response to increased nitrogen inputs at the Flower Gardens is a priority since (1) baseline data is needed to understand possible nutrient stresses in the future, and (2) a reef removed from coastal influences is useful for comparisons with other Caribbean reefs systems.



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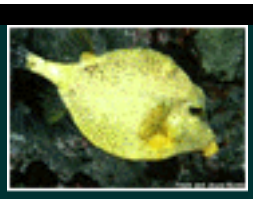
To determine whether the Flower Gardens is susceptible to nutrient stress we have begun investigations into the role of light and nutrients in carbon production by photosynthetic organisms. We have also collected preliminary data describing the basic food web structure of the coral reef community. Our objectives include identifying dominant and potentially nuisance macroalgal species, comparing photosynthetic production of several dominant algae, and determining general trophic structure (who eats who?) of the reef community.

The dominant benthic producers in the community are symbiotic corals, macroalgae, and benthic cyanobacteria. Benthic cyanobacteria form a purplish-red mat, are slippery to the touch, and sporadically attach to coral polyps. From several field experiments, we have learned that macroalgal carbon production exceeds that of cyanobacteria and that herbivores do not appear to directly consume cyanobacteria.

Nevertheless, cyanobacterial mats play a crucial role in the nutrient dynamics of the system. Nitrogen isotopic analysis suggests that benthic cyanobacteria likely fix nitrogen (process of converting atmospheric nitrogen into ammonium, a plant fertilizer), which ultimately leaches into the water column and is assimilated by eukaryotic macroalgae. As there is evidently ample light for photosynthesis, even at 20 m depth, macroalgal photosynthesis is therefore controlled by nutrient availability. Further, there are indications that nitrogen limits the system to a greater degree than phosphorus.

As the Flower Gardens community seems to be nutrient limited, the stability of the ecosystem could be linked to nutrient inputs from the Mississippi River. However, both low ambient nutrient concentrations and nitrogen isotopic composition of primary producers at the Flower Gardens suggest new nutrients are produced by benthic cyanobacterial mats rather than transported onto the reef by advection from coastal zones.

In the summer of 1999 we hope to continue research into the extent of Mississippi River nutrient enrichment into Gulf of Mexico ecosystems by sampling algae at open ocean banks throughout the river plume area. At the Flower Garden Banks, we look forward to our continued collaboration with Dr. Quenton Dokken (Texas A&M University - Corpus Christi) and to investigating photosynthesis and production of deep-water algae using the submersible DeepWorker 2000.



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A Diver's View

Lydia Locke, Loan Officer, Recreational Diver, Volunteer

Editor's note: Ms. Locke participated in "Down Under, Out Yonder," a 5-day workshop for formal and informal educators, that includes a 3-day dive trip to the Flower Garden Banks National Marine Sanctuary. This is a description of her experience.

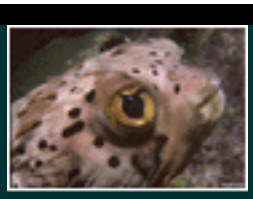
The Flower Garden Banks National Marine Sanctuary boasts up to 175 species of fish, 200 marine invertebrates and 21 different types of coral. Having an opportunity to see 50 or more of them during the "Down Under, Out Yonder " dive was absolutely wonderful and extremely gratifying. If you have a genuine interest in any organism that lives in the ocean, or our Gulf of Mexico, you could absolutely appreciate this trip.

The daytime seminars planted seeds to help us be more conscious of what we would be looking at, and how much of it there is to see in a limited amount of space.

There were examples of the differences in appearance between juvenile and mature species, and examples of common fish found amongst all three banks. We were taught how beneficial artificial reef systems are to man and sea creatures, and how important continued research of these habitats and ecosystems really is.

The tour began with some incredible diving sites, quickly moving up the satisfaction meter to an absolute 90/95 degrees. These dive sites were abundant with fish, invertebrates, common or otherwise, and seemingly endless visibility! The water surface ultimately reduced

Photo



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itself to a table-smooth sea of glass. The water temperature was in compliance with the rest of the trip and toed the line at temperatures of 80-84 degrees every day.

The smooth trunk fish (*Lactophrys triqueter*) is usually black and white in color, but at the Flower Gardens an unusual color morph of the fish has been documented and it is now called the golden-phase smooth trunk fish.

The variety of fish and their sizes was amazing! The trunk fish, scrawled file fish, porcupine fish, trigger, whitespotted file fish, honeycomb and scrawled cow fish were twice as large as expected. All but one looked extremely healthy. On the West Bank, I came across a medium sized hog fish with an ashen film on his side. The ashen growth was a thick layer ranging in color from ashen white to black spot. Half of the scar looked as though it was peeling and detaching itself from the primary surface of the hog fish's side.

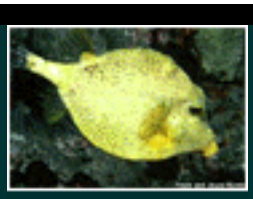
My first impression of Stetson Bank was that the site looked like a petrified forest. But with a closer glance you could clearly distinguish the layers of soil solidification. Here, I saw my first golden trunk fish [*ed. note: golden morph of the smooth trunk fish, documented only at the Flower Gardens and Stetson Banks*], and pencil urchin.

Photo

Saw an enormous French angel fish, but one experience launched this dive above and beyond all other dives prior to this, including the richness of Rig 389: I saw my first spotted eagle ray! There were two of these beauties gracefully passing through Stetson Bank just beyond the wall! These grayish blue partners appeared to have a wingspan of not less than 10 feet each. Their velvet jackets were comprised of distinguishably different markings. One was spotted all over (medium size polka dots), while the other wore a combination of spots and double vertical lines (like a ladder without steps).

Stetson Bank is lined on one side by a row of high relief pinnacles - a couple of which are covered with ten-ray star coral (Madracis decactis). The largest of the pinnacles is known as Sierra Madracis to regular visitors to the dive site.

After ensuring my three dive buddies saw God's grace, I was



compelled to get a better look, yet never losing site of my sport diver limit of 130 feet. (I did, however, exceed the boat limit of 100 feet and forfeited the following dive). As I came closer, they inched their way further from the wall. At this point, I bid my new found acquaintances farewell and gradually ascended totally mind blown!

Rig 389 was the other highlight. I have never seen such a luxuriously healthy rig! This natural thriving habitat was abundant with every type of fish imaginable and in every stage of development: infant, juvenile and mature. Simply magnificent!

The current lease holder of gas production platform HI-A389 has a working agreement with Texas A&M University's Center for Coastal Studies, allowing access to the platform for research purposes. When, however, the platform ceases to produce, federal regulations require that it be removed within one year for safety and navigation reasons. Unless some entity steps forward to assume responsibility for maintaining the platform as a research station at that time, it will no longer be available for research or recreational diving.

This five-day workshop was by far the most enriching experience I've had this summer. (Superseded only by 12 days of barefoot sailing the Caribbean during Oct.,1998) Not only did I learn during the seminars, but was stimulated enough to ask questions on the spot, no matter how trivial (as I believe I knew the least of the group). The handouts were great too! I can share this information with the science and diving students I work with. I also intend to fashion games and Q&A activities for the adults in my dive club. I'm confident this wealth of information and hands-on experience will contribute to my success as a volunteer at Moody Gardens as well.

I can see how exposure to programs of this nature offers incalculable benefits. Benefits for teens undecided about career goals, the importance of conservation (paper, plastic, bottles, metal, etc.), college students and educators, and divers. Recreation and sport divers with proven skills, a respectable level of ambition, and genuine curiosity of what goes on "Down Under".

I gained a lot from attending this trip, but then I wanted a lot. My only disappointment was that we didn't have time to do more. More hands-on activities such as helping Dr. Dokken replace the light measuring monitors or assisting Emma capture Triton, the tagged turtle, to replace the battery in his monitor. As you can probably tell by now, my heart is in the sea.

(top) **RETURN**

September 2, 1999

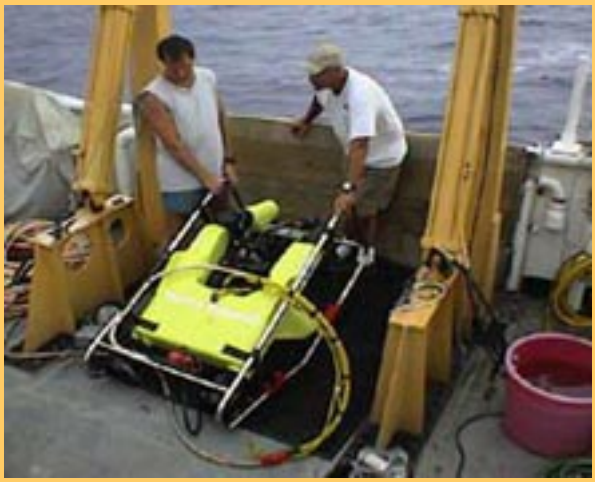
Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Peter Vize, Scientist,
University of Texas

What happened to our glassy calm seas?! We've got swells and chop and slop the likes of which we haven't seen since some of our work off the California coast last spring. Sub ops are out of the question, and while some folks are scuba diving off the MV SPREE, even that may not be possible later tonight.

The FERREL was joined on station at the Flower Garden Banks late this morning by the MV SPREE, a recreational live-aboard dive boat which the sanctuary charters for scientific scuba expeditions to study the reefs. The SPREE is a 100 foot converted crew boat formerly used to support offshore oil operations. It sleeps 34 passengers and six crew, although quarters are a bit on the cozy side.

Aboard the SPREE are a number of researchers, and several videographers from the National Geographic Society, who are covering this mission for their *Sea Stories* television series. I am also taking this opportunity to join the mission aboard the SPREE. Sylvia Earle caught a ride to the Banks on the SPREE, but will be living aboard the FERREL for the rest of the week.



While divers aboard the SPREE wasted no time jumping into the water as soon as we were on station, those of us spending the day on the FERREL waited and watched the weather to see whether we'd be able to dive the subs at all. Ultimately, we determined that it was too rough for sub ops, but we did get the ROV into the water. Tonight was expected to be the first night of coral spawning, and we wanted to make sure we didn't miss it.

When unfavorable sea conditions prevented the launch of the DeepWorker subs, researchers aboard the FERREL deployed an ROV to monitor the coral spawning.

The Flower Garden Banks are known as the place "Where the unpredictable is commonplace, and the predictable truly awesome." What's predictable here is the annual coral spawning, and it truly is an awesome event to observe. Somehow, eight nights after the full moon at the end of August, the coral here simultaneously get the signal that it's time to let fly with their sperm and eggs, doing what corals do to make new corals. Several hours a night for the next three nights, the reef will take on the appearance of an upside down snowstorm, as countless trillions of gametes are released into the water. Earlier in the day, divers observed the coral polyps swollen with sperm and eggs, ready to be released. It's almost time! Surface conditions deteriorated further, to the point that even scuba divers were kept out of the water. However, we made good use of the ROV to fulfill our voyeuristic intentions.

Peter Vize provided the following report on our observations of the spawning:

The ROV descended towards the reef top around 8:25 PM (CST). Within minutes of reaching the coral we saw the first colony releasing gametes -- a male *Montastraea cavernosa* surrounded by a cloud of opaque sperm (8:30). After documenting this event the ROV swung around and instantly spotted a second *cavernosa* male releasing sperm (8:33). Within the next two minutes we saw two more males release. At 8:35 we saw the first *caverosa* female releasing egg packets. This looks very different to the male spawning, as the eggs are released in large soft packets containing hundreds of gametes. Over the next ten minutes we saw five more females and one more male spawn, all within a very small area.

Divers observe as female corals release their eggs. Sanctuary researchers think this process may be triggered by the male's release of sperm.

A few years back when researchers were performing cross fertilization experiments at the Flower Garden Banks sanctuary they noticed that when *M.cavernosa* eggs collected in plastic bags immediately after release were cultured on deck for 24 hours they were all fertilized -- adding sperm was not necessary. The small amount of sea water collected along with the eggs probably contained enough sperm to fertilize all of eggs. It is possible that *cavernosa* females either sense the sperm release, or some compound released along with the sperm, and respond by extruding their own bundles of gametes. These bundles are very soft and break apart during or shortly after release. The tight coordination of spawning described above supports this hypothesis. The coordinated sperm release by multiple adjacent males may mean that males can read the same spawning ques, and once they know their

colleagues are spawning, release.

Although we were getting excellent data from the ROV the images were of fairly low resolution, and to get better documentation the unit was brought back to the ship and a higher quality video camera installed. Once the new camera was operational the ROV was relaunched and powered down, this time to the very bottom of the reef at 42 meters. No previous documentation of spawning at the Flower Garden Banks has been performed at this depth. Once again within minutes of reaching the bottom we observed spawning, another male *M.cavernosa* (9:15). Two minutes later we saw our first example of spawning by another species, with time *M.franski*, a hermaphrodite that releases bundles containing both eggs and sperm. This was recorded at a depth of 39 meters. Another male *cavernosa* male was recorded spawning deep (9:20, 37m) and shortly afterwards (9:25, 35m) a nearby female colony released its eggs.

We began to slowly work back up the wall, and at 33 meters saw our first brain coral (*Diploria strigosa*) spawning of the year (9:53, 33m). This is another hermaphrodite that released packets containing both eggs and sperm that break open once they float to the surface. Within a little over a half hour we had documented both sexes of cavernosa and two addition species spawning below the 100' mark.

A male coral begins to spawn, releasing its sperm into the warm sea waters.

Spawning activity decreased from about 10:00 PM onwards, but the final colony that we filmed was quite spectacular (9:56). This was a fairly large *M.franksi* colony that was arranged in a series of plates about five feet across. As Phil held the ROV steady we watched a wave of packet release descending down the colony, with the gamete bundles drifting slowly upwards on their way to generate a spawn slick. Nothing new was observed over the next 45 minutes, so the ROV was brought back on board.

Despite the more limited field of view from the ROV's video camera than would have been afforded from the DeepWorker, we managed to bring in an excellent dataset, record the coordinated spawning of both sexes of *M. cavernosa*, and for the first time record Flower Garden Banks spawning behavior at 137 feet of depth.

(top) **RETURN**

September 3, 1999

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Another day of sub-stellar sea state conditions, and while we're all anxious to get the DeepWorkers back in the water, it's impossible to do so safely until the sea lays down some. However, it's a fine day to scuba dive, as long as you can keep your balance walking across the deck of a boat doing 30 degree snap rolls with a tank on your back. In spite of such challenges, lots of good diving was had, all day long.

Sylvia Earle and Emma Hickerson completed a dive with the National Geographic Sea Stories film crew, using DiveComm through-water communications provided by Richard Nordstrom of CisLunar. Their dive was a big success, and we eagerly looked forward to nightfall, and our chance to get in the water to see the coral spawning with our own eyes, not just through the eyes of the ROV.

A Sea Stories team member briefs Sylvia Earle (right) and Emma Hickerson prior to their mission.

As the last of twilight faded from the sky, I was like an impatient little kid, anxious for the RHIB to take me back to the SPREE, as that's where my dive gear, and buddies were. Personnel transfers between the FERREL and the SPREE have been very difficult and hazardous because of the sea state. We've had people come close to being injured, and at one point one of the ladders at the stern of the SPREE was damaged beyond usability. As a result, the new procedure is to SWIM from the RHIB to the SPREE and then climb aboard. I'm glad we've got warm water!

My dive partners for tonight's dive are National Geographic photographer and veteran diver Kip Evans, and USA Today reporter and DeepWorker pilot Tim Friend. Earlier, Tim confessed to me that his scuba diving experience was somewhat limited, and this would be only his fourth open ocean dive, and his first night dive. The three of us descended into the inky blackness, the area around us brilliantly lit by the high-intensity lights of Kip's video camera.

USA Today reporter Tim Friend accompanies an underwater dive team to observe the coral spawning.

Diving with an underwater photographer presents some unusual challenges. First, if you have any intention at all of staying together, you can count on going where the photographer wants to go, not the other way around. Second, don't be surprised if a camera comes flying in your direction as the photographer switches cameras and relies on you to hold the one he's not using. Finally, if you're ready to surface and he's not, just wave goodbye as you ascend, because he's not going up until he has no choice. To be fair, Kip carried his own cameras on this dive, and conscientiously kept track of how everyone was doing on air consumption.

We cruised around the reef near the boat, looking for some spawning action. At first, we didn't see much, and I thought, "What do I have to do, put on my Marvin Gaye albums?" Then we came upon a pair of researchers eagerly collecting samples of eggs as they were being released from a coral head at about 70 feet. It was... magical. Tiny pink champagne bubbles, thousands of them, lifting off from the surface of the coral and into the water column.

Nearby, a dense cloud of sperm floated upwards from a small coral head. We moved along the reef, seeing here a male and there a female releasing their precious little bundles of new life. For some reason, I had Tom Jones' songs running through my head. And I'm feeling a little remorseful for intruding with bright lights upon this invertebrate orgy, which nature intended to occur in the dark.

Far too soon, both Tim and I are running low on air, and Kip sends us packing back to the surface, while he hangs out for a few extra minutes of filming. Back on board, I have to suppress my urge to grab a fresh tank and leap straight back into the water. There will be more spawning tomorrow night, when the giant brain coral is expected to go off. I can hardly wait!

(top) **RETURN**

September 4, 1999

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

This morning, I decided to stay on the SPREE for a scuba dive before transferring to the FERREL. I again partnered with USA Today reporter Tim Friend, and we cruised around the reef together, and checked out the scientific sampling equipment used to monitor salinity, currents, and water temperature in conjunction with the coral spawning event.

During last night's dive, Chris, a member of the National Geographic video crew, accidentally had an uncontrolled ascent from 75 feet. He seemed fine at the time, and decided to dive again this morning. When he returned from this morning's dive, though, he had a rash on his abdomen which was identified as skin bends, a very mild form of the potentially deadly decompression sickness that can strike scuba divers if they ascend too quickly. Much consternation ensued as they administered first aid and tried to determine how to evacuate him. Even though his condition was very mild, it was important to get him to a medical facility for evaluation and treatment. Arrangements were made for the SPREE to rendezvous with a Coast Guard helicopter, identical to the one we flew on in Florida, to airlift Chris to shore.

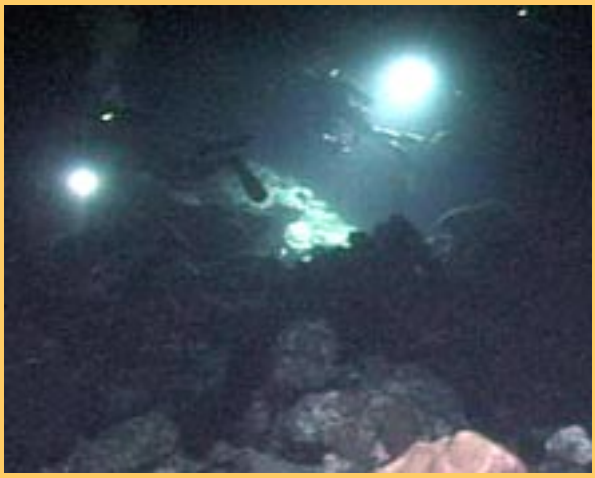
The SPREE motored out to an unmanned Oryx Industries oil platform, and the helicopter landed on the platform's helo pad. We transferred Chris over using the SPREE's zodiac, and Chris made the long climb up the stairs to the roof of the platform without any trouble. We caught up with Chris a couple days later, when the SPREE returned to Freeport, and he was in fine health after spending six hours in a decompression chamber.

Around 6:00 PM I dove with the two divemasters from the SPREE. It was a very cool dive, just cruising slowly along the reef checking out the critters. Among other things, we saw two golden coneys, a large number of creole wrasse engaged in mating rituals, and an amazingly beautiful juvenile yellowtail damselfish -- deep purply blue with vividly glowing neon blue spots.

Meanwhile, on the FERREL, the day had been spent watching the sea state and hoping for a chance to dive the sub. Eventually, an attempt was made to put the sub into the water, but it had to be brought back on deck before Peter Vize got a chance to dive, because there was some concern that the sub may have been damaged

during the launch. Subsequent sea state conditions prevented another attempt.

Back on the SPREE, scuba divers were getting ready to hit the water for the coral spawning dive. It really is incredible that in spite of all we don't know about the ocean, and marine life, we can predict down to the 15 minute interval, on a particular night, when a certain species of coral is going to spawn. *Colpaphyllia,* Giant brain coral, only spawn two nights a year, for a couple hours on each of those two nights, and we could predict it well enough to know that we had to start gearing up by 8:30 and be in the water by 9:00, if we wanted to witness the action.



Divers search the deep for signs of coral spawning. Severe seas had prevented the launching of the DeepWorkers.

I dove with GP Schmahl, the sanctuary manager, who quite quickly found a spawning coral head for us to sit and watch. He took quite a few photographs of the spawning in action. From the crevices in the surface of the brain coral, peachy colored globules, egg packets, are excreted, floating up and away into the water column. It was such a rare privilege to be able to witness this!

We moved around a bit, looking for other spawning corals and occasionally panning the darkness above the coral in hopes of spying a manta ray or turtle. We were rewarded with the sight of a beautiful young loggerhead, with maybe a four-foot carpace. We slowly swam along parallel to him, keeping our lights trained on him but maintaining a respectful distance so as not to startle him.

We'd been following the turtle for a couple minutes when one of the SPREE's other passengers (not affiliated with the sanctuary or the SSE mission) came swimming in at a fast clip with her video camera, lights blazing, straight at the turtle, eager to capture him on film. Not surprisingly, her rapid approach frightened the turtle, who reacted the way loggerheads often do. He swam straight at her, and rammed her camera with his head. Then he swam off into the night, frightened, but we hope uninjured.

Soon thereafter, I hit my no decompression limit, owing to my dive earlier in the evening. GP and I had agreed that he would stay down and I would go back to the boat on my own. I waved goodbye, and swam up to one of the lines hanging from the stern of the boat to a depth of about 60 feet. I hung out on the line at about 30 feet, where I had all the time in the world and plenty of air, turned off my light, and just got a kick out of being in the ocean, all on my own, surrounded by sparkling twinkling bioluminsecent dinoflagellates that fired off their green glow every time I moved my hand or fins. It was oh, so beautiful, and I stayed as long as I could because it was just magic.

Eventually, I got back on the boat and dumped my tank off, then jumped right back into the water and snorkeled around for the next hour or so. I think I made the divemasters a little nervous because they wanted to be able to keep track of me, but I was at least 20 yards away from the SPREE trying to get away from all the boat's many bright lights.

Baracuda are frequently spotted at the Flower Garden Banks.

Again, it was just so beautiful, and it felt so good, wrapped in these warm waters, alone in the dark but unafraid, and really not alone, either. Dozens of barracuda hung in the water all around me. I'd see a dark form nearby, turn on my light, and a barracuda would give me an irritated look and swim out of the light's range. Also huge throbbing school of chub, each probably about 8" in length. Hundreds of them. Maybe thousands. I would sense a dark pulsing cloud just a few feet from me, turn on my light, and be dazzled by this living, pulsating wall of life that would then pulse away from me and my offending light.

And the galaxies of stars, both above and below the surface. A beautiful clear night, with very little moonlight, and I would float on my back and stargaze, then turn over and wave my hands in the water and stargaze as my movements would ignite the bioluminescent display. Free dive down and do backflips and watch my own trail of light swirl around me. Wave my fingers and watch sparks fly from my fingertips. I felt a wonder and peace that is the essence of why I love being in and on the ocean, why I will keep coming back every chance I get, and why I will continue to do everything in my power to protect the fragile life that dwells here.

(top) **RETURN**

September 5, 1999

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Peter Vize, Scientist,
University of Texas

Another day of seas that are just too rough to permit us to dive the sub. It's frustrating, but it's part and parcel of this sort of project. It seems we used up a lot of our good luck in the last two sanctuaries, when we had an abundance of flat-calm days to dive the sub.

Scuba dives from the SPREE proceeded during the day, but many of us are holding out for tonight, our last chance to catch some of the corals, in particular *Colpaphyllia*, the giant brain coral, in the act of spawning.

Peter Vize was kind enough to provide a write-up of the dive he did on the night of September 3. Here's what he had to say about that night's activities:

The seas have picked up considerably, and launching the submarine is again impossible. Tonight is the predicted peak of the Flower Garden Bank coral spawning activity with at least five species expected to release. In order to observe tonight's spawning activity we will once again have to rely on the ROV on the FERREL and scuba observations from divers working off the nearby MV SPREE.

The ROV was launched at 7:45 PM, well before the expected beginning of tonight's activity. As we observed the reef from the video image projected from the ROV, divers on board the

SPREE are waiting to hear when spawning begins before they jump. As soon as we reach bottom there are gamete packets observed drifting in the current. We also observe a brain coral (*D.strigosa*) in ready to spawn mode -- the tentacles are retracted and each polyp contains a gamete packet in its mouth -- loaded and ready to go. We observed this colony for about 5 minutes but it did not release, probably because it was still a little early in the evening. We continued to pilot the ROV around the reef for the next hour, and although some gamete packets were passing by no actual spawning activity was observed.

Steve Gittings navigates the ROV through the Flower Gardens. As the fomer manager of the sanctuary, and with 75 ROV missions under his belt, he is a very well qualified pilot.

When the ROV had still not observed any activity by 9:00 the divers, including Sylvia, Emma, Gale, Kip, Ian and I transferred to the SPREE to prepare for scuba observations. After a RHIB had been crushed under the swim deck performing a transfer in even milder conditions last night, divers jumped from the RHIB and swam over to scurry up the boarding ladders on the stern of the SPREE. As we arrived the first team of scientific divers was just hitting the water. Equipped with large twin scuba tanks filled with a rich mix of nitrox these divers would be spending and hour and a half or more at around 75 feet of depth observing the spawning and collecting small samples of the gametes released.

Peter Vize familiarizes himself with the DeepWorker operations panel in preparation for his night dive, but high seas prevented a launch.

I geared up as quickly as possible with collecting equipment and hit the water at 9:30. As I dropped down to around 80 feet I could see the scientific divers up ahead in the calm clear waters on the bottom, quite a change from conditions up above. As soon as I reached them I saw the first colony go -- a large *D.strigosa* brain coral. I collected gamete packets by gently sweeping a fine soft mesh net over the colony and transferred them to a zip lock bag, which along with duct tape and cable ties are among the key ingredients required for all marine research. The bag is pre-labeled, and the sample number, time and depth are recorded on an underwater slate then transferred to a catch bag. As soon as we were finished another *strigosa* went, and then another, all within 10 minutes. I signaled the surface with my flashlight that the spawning had begun then turned back to collecting gametes.

At approximately 9:40 the first *Montastraea franksi* star corals began to release. As our main target for the night was brain corals this made things a little trickier, as we could no longer simply follow gamete trails and find the spawning coral on the other end. I saw three more *franksi* release over the next 15 minutes, but

uncharacteristically the brain corals had now stopped spawning. Another species that spawn in this time window is *Stephanocoenia interspta*, the another species of star coral. In this species colonies are of only one sex, and at 21:45 we observed a male releasing a cloudy haze of sperm. Shortly afterwards other males and females began to release. The female *Stephanocoenia* colonies release individual eggs, not packets or bundles as do some other species, and the tiny eggs floating upwards resemble the fine bubbles of champagne. Last year we observed a number of instances where adjacent male and female colonies released simultaneously, and I observed four more instances of such coordinated release over the next 30 minutes. Based on these observations it would appear that one of the two sexes triggers local colonies of the opposite sex to spawn. It will be very exciting to test this possibility experimentally next spawning season. *Stephanocoenia* continued to spawn for the next 30 minutes in large numbers, so far the most spectacular species of this particular event.

The largest coral colonies at the Flower Gardens are those of the mountainous star coral *(Montastraea faveolata)*. These enormous colonies can be 15 feet or more wide, and as the entire colony releases its gamete packets more or less simultaneously, are stunning to watch spawn. At 10:45, shortly before scheduled, and luckily shortly before it was time for me to head up for a long safety stop, I observed two massive *faveolata* heads release. The surrounding waters were so filled with gamete packets that I could hardly see as I was transferring collected spawn from my net to zip lock bags. There was one more species scheduled to release tonight, the boulder star coral *(M.annularis)*, but my bottom time was up and I headed back towards the ship.

In addition to the species described above, Sylvia, Emma and Kip observed and filmed *Madracis* colonies releasing sperm and also some feather duster worm spawning, and the ROV team back on the FERREL had recorded a similar pattern of spawning behavior on video for us to analyze later.

Deep water reefs such as these are magnificent habitats, and play host each summer to vibrant coral spawnings.

All in all it was a successful evening's work. We had documented and filmed six different species spawning, collected gametes from four species for DNA analysis, and enjoyed a spectacular dive. The sequence of spawning behavior observed was similar to that at the Flower Gardens in other years, and indicated that although smaller numbers of colonies had participated this year the spawning occurred exactly on the predicted dates.

Hopefully the weather will more cooperative for the final spawning window of the year, two nights later when the boulder brain corals, *Colpophyllia natans*, release their enormous gamete packets shortly after sunset.

Gale continues:

Tonight, our last night aboard the SPREE, we have shifted to the East Bank of the Flower Gardens. We geared up again at 8:30 PM, and all the divers were in the water by 9:00. Given the amount of *Colpophyllia* spawning I'd seen the night before, I wasn't expecting to see too much more spawning activity tonight, but I couldn't have been more wrong.

My dive partner, Miles, and I, hit bottom at about 75 feet, and almost immediately came across a giant brain coral releasing its big pink packets of eggs into the warm dark waters. We were promptly joined by scientists and photographers eager to capture both images and samples. We moved off to an area less populated with divers, and panned the dark waters with our flashlights.

A diver searches the Flower Garden Banks to catch a glimpse of the annual coral spawning event.

The beam of my light caught a dense cloud of egg packets, and I was able to trace them to their origin, another colony of giant brain coral. Slowly, the globules would form in the crevices and then separate and drift upwards and away. Without the frenzy of human activity around it, it was a very calm and beautiful sight.

We cruised the reef, checking out the other critters on night patrol. Everywhere, tiny pairs of beady red eyes would reflect the light from our flashlights: small shrimp living in among the corals, peering out at us. We spied a gorgeous black and white spotted drumfish out seeking a midnight snack, and too many other fish for me to begin to report.

All too soon, we had to head back towards the surface. Again, a long safety stop hanging on the lines under the ship was made more enjoyable by the presence of sparkling bioluminescent dinoflagellates that flashed and shimmered with our every movement. Tomorrow, we'll stop off at Stetson Bank for one last dive before we head back to shore for the open house and Student Summit events scheduled for the 7th.

(top) **RETURN**

September 7, 1999

Shelley Du Puy, Education Coordinator
Flower Garden Banks National Marine Sanctuary

The day was a great success, providing an opportunity for students and the public to see what the Sustainable Seas Expeditions are and how they are progressing.

A Student Summit kicked off the event with 150 students attending from Bellaire, Clute, Houston and Kingswood, Texas. Participants were welcomed by Colonel Buecher from the U.S. Army Corps of Engineers, host for the event. They were then treated to a presentation about the Sustainable Seas Expeditions by Dr. Sylvia Earle and heard about career opportunities from representatives of several marine and coastal oriented organizations. Several students from F.M. Black Middle School presented proposals for marine science projects to be completed during the coming year.

The highlight of the day was an opportunity to tour the NOAA Ship FERREL and a commercial dive vessel operated by Deep Work, Inc. The tours offered us "land lubbers" a brief glimpse into the mariner's lifestyle! Visitors were able to get a close up look at the DeepWorker 2000 submersibles. They also had a chance to see a recompression chamber where working divers decompress after extended deep dives.

A live video broadcast over the internet wrapped up the day. The broadcast featured a virtual tour of the FERREL, highlights from the first leg of the Expedition to the Flower Gardens, interviews with DeepWorker pilots, and an explanation of how the DeepWorker operates. An archive of the live broadcast will be available soon through this web site. Join us on September 16 at 1:00 PM Central Time for an on-line chat with Flower Garden Banks NMS personnel.

(top) RETURN

September 9, 1999

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Steve Gittings, Research Coordinator
NOAA's National Marine Sanctuary Program

Flower Garden Banks - East Bank

Last night, the FERREL and the MV FLING set out for the second leg of the Flower Garden Banks mission, departing for the East Bank with scientists and observers on board. The FLING, sister ship to the SPREE, is hosting a visit to the Banks for a number of conservation-minded oil industry representatives, many of whom are also scuba divers.

Scuba operations on the FLING started early in the morning, while on the FERREL, work began on pre-diving the subs in preparation for a two-sub dive. Sylvia Earle and Steve Gittings were preparing for a two-sub dive to investigate the brine seeps at the East Bank, in about 350 feet of water.

The expedition team encountered water spouts during their mission to the Keys.

I transferred to the FERREL from the FLING first thing in the morning, and assisted with pre-dive work. Seas were too rough to permit launch of the subs, so I returned to the FLING in time for an early afternoon scuba dive. As usual, the diving was magical. I accompanied Dr. Mary Wicksten, a marine biologist from Texas A&M University, whose special area of interest is marine invertebrates.

After our dive, I returned to the FERREL, where they had succeeded in getting the two subs launched for their scheduled dive, only slightly delayed by the morning's sea state. Steve Gittings had to surface early, owing to problems with through-water communications, but Sylvia Earle was able to complete a long

and very productive four-hour dive to 340 feet, which included some valuable fish observations, and documentation of important characteristics of the brine seeps unique to this single location in the Gulf of Mexico.

Here, Steve Gittings describes the dive:

In many ways our target is another world. There is no oxygen, and hydrogen sulfide levels would be lethal to anything you and I call living. The water there has seven times as much salt as Earth's seawater. Anything living that enters this place is instantly pickled, its carcass its only legacy, but those will last for years to come, a reminder to future visitors that here nature deals the cards and wins all ties. And in this place is a primordial soup, where bacteria rule...

But this trip is not extraterrestrial. It is a journey to our own underworld. The place we are searching for is called Gollum's Lake. At about 220 feet deep, on the southeast edge of the East Flower Garden Bank, a bit over 100 miles from shore, it is the only known ecosystem of its kind in continental shelf depths. It consists of a brine filled basin and an overflow canyon that cuts through the edge of this submarine mountain. It's only about 10 inches deep and a couple hundred feet across, but its impact is felt for miles.

The incredibly salty water of the lake sits in the bottom of the depression because it is much heavier than regular seawater. The brine probably originates from springs that flow from internal cavities of the bank. This seawater dissolves portions of a salt dome that rose up from11 miles below the seafloor to form the bank in the first place. A crater over a mile across and 30 feet deep just northwest of the lake, kin to sinkholes on land, testifies to many years of destruction of the East Flower Garden Bank from such forces below. We don't know where the springs are, and only have rough estimates of how much salt is being dissolved by the system. It is in search of answers to these questions that Sylvia Earle and I are planning this trip.

My first and only visit to the brine seep was in 1980, as a new graduate student looking for a project that would get me a Master's degree. Dr. Tom Bright , then a professor in Oceanography at Texas A&M University with a grant from NOAA, asked me to consider studying the animals that live in and on the hard bottom around the brine seep. Sounded interesting, I thought. I would consider it. Off I went with Tom and some other graduate students on my first cruise to the Flower Gardens, a place I had never heard of a month before, but which has occupied much of my life ever since. Then, to my surprise, Tom gave up a submersible dive to let me see the place first hand! I was hooked!

The brine seep was magical. A lake underwater! A stream underwater! A waterfall underwater! A layer of snow on the bottom?... Apparently I had a lot to learn.

Though nothing lives in the full strength brine of this lake, where there is no oxygen, an incredibly rich bacterial community thrives anywhere hydrogen sulfide and oxygen mix - along ripples protruding above the brine, along the shoreline of the lake, even on the surface of the brine pool. But nowhere have I seen anything like the overflow

canyon. For nearly 100 yards along the floor of this canyon, up the side walls, and on rocks on the canyon floor, thick mats of white cotton candy struggle to hold on against the incessant pull of the salty stream. The white is sulfur, deposited by the bacteria when they split the bond between hydrogen and sulfur atoms, releasing energy they will use to generate life-giving nutrition. Like plants use the energy in sunlight to initiate photosynthesis, these 'sulfide oxidizing' bacteria garner energy from chemicals already in their environment to launch a process called chemosynthesis. Many scientists believe chemosynthetic bacteria existed long before the process of photosynthesis evolved. Such life forms still abound in many environments we consider harsh, utilizing a number of chemicals as energy sources, including hydrogen sulfide and methane. These are remnants of a former time that provide a window to Earth's history.

Returning after 19 years to the brine seep provides an opportunity to compare new video records with those I made in 1980. We also want to measure the flow rate of the waterfall that flows from the lake into the canyon. This will allow us to estimate the volume of salt removed from beneath the bank each year to support this system. To measure this rate, we will attached a torpedo-shaped flow meter, more often used to measure flow through plankton nets, to a frame that can be placed in the brine stream. By orienting the meter facing upstream near the bottom of the waterfall, I can count the number of rotations in a known time period and convert the number to a rate of flow. Just in case something fails with the current meter, I also attach meter sticks made from flat pieces of aluminum to each of our subs. These can be placed into the stream to measure the flow directly (flow speed would be measured by observing the number of centimeters a particle travels along the stick each second). If we also measure the area of the waterfall, we can calculate the amount of salt removed through the lake, and then the volume of solid salt it would take to supply the system.

Past measurements suggested that between 10,000 and 20,000 cubic meters of salt dissolves from beneath the East Flower Garden Bank each year! Imagine losing a piece of ground equal to the size of a cube 75 feet on each side from below your neighborhood each year. The eventual result would be a collapse, forming a sinkhole. The Flower Garden Bank has a sinkhole over a mile across and 30 feet deep. Assuming the brine seep has been flowing at a constant rate since it began (not necessarily a good assumption), the system may have been operating for over 1,000 years.

The Dive

After several days of delays caused by weather, my disdain for electronic equipment was reinforced several times over when we finally got our chance to go to the brine seep.

One of the last steps of a pre-dive check is to confirm that the navigation and tracking systems are working. Entering the dry lab just before y dive, Dave Lott informed me that the navigation system had just crashed. Luckily, the tracking system still worked, so we decided that the dive could commence while repairs could be made to the navigation system.

Dave Lott troubleshoots the ROV and DeepWorker tracking and navigation system.

The ship crew made an excellent deployment of the sub. I was untied quickly and away from the ship safely. I was to wait for Sylvia's sub to be launched so we could descend together to our target depth of 275 feet. The sub's manipulator arm was holding onto the flow meter assembly that I intended to put into the brine stream to measure flow rate. While waiting for the other sub to be launched, the manipulator lost its grip on the meter and it fell to the bottom. As I watched it sink out of sight, I had two thoughts. Long ago, someone told me that anything that goes over the side of a ship is expendable. Fine for trawls, box cores and flow meters, but what about me and my little sub? My other thought was that I was fortunate to have a backup plan -- the two meter sticks! Both were still attached and I would use them instead and worry about the flow meter later.

Sylvia and I descended together in gorgeous water with over 100 feet of visibility. At about 200 feet, however, I heard a loud thud and felt as if I had been rear-ended. My first thought was that Sylvia and I collided. I admit to a momentary chauvinistic, and thoroughly unjustified thought about women drivers. But then I heard Sylvia call the surface to let them know that a float attached to my sub had imploded, releasing a large bubble of air.

This happened because of the pressure exerted by water with increasing depth. I had noticed before the dive that one float was a different type than the others on the sub, and I suspected that it was the one that imploded. We later determined that it was, in fact, that float, which was not pressure rated for that depth. Someone had used it on my sub because they didn't realize how deep we were planning to dive today. Still no real worries though. I was just a bit heavier than before.

I began to sink a bit faster because of the imploded float. Just before hitting bottom at 333 feet, I heard an alarm go off. I looked at the computer screen and saw that it was a ground fault, which indicates that water may have leaked into some electrical system. Before dealing with that problem, I wanted to adjust my buoyancy, so I pumped water out of my seat into the external hard ballast tank. This made the capsule more buoyant, but not enough to lift me off the bottom. The only reasonable alternative was to 'ride a bubble,' which means pumping some air into the external soft ballast tank to float the sub. Many research subs work this way, so the idea was not new, but it meant that I had to be careful during ascent so I wouldn't lose control of the sub as the air bubble expended with decreasing pressure.

Once the buoyancy problem was taken care of, it was time to deal with the ground faults. With help from the topside crew, we started doing some diagnostic work by shutting down certain electrical systems and turning them back on. At one point, we

shut the entire sub down for a few seconds to reset its computers. Nothing seemed to stop the alarms. We decided that the implosion may have affected some wiring on the outside of the sub. Because there didn't seem to be any real danger, we decided to continue the dive.

Not long after that, the computer controlling my cameras froze up. After a few attempts to reset it, it became obvious that there was more to that problem than we could deal with underwater. But I still had my meter stick, so on with the mission!

About the time we made that decision, my through-water communications began to weaken. Topside was having trouble hearing me, though I could hear them and Sylvia fairly well. It wasn't long before they couldn't hear me at all. Lost communications is a serious matter that often ends a dive. But because we had two subs in the water, Sylvia and I could communicate, as long as I could hear her and topside. Sylvia asked me to indicate whether I could hear by flashing my lights. I did, and after a series of such confirmations, we decided to continue the dive.

Off I went with my meter stick and my 'dive buddy' on a course that would take us to the brine seep, with ground fault alarms buzzing, limited ability to communicate, and riding a bubble of air. We drove along a course of 325 ° , hoping to make the 0.3 mile trip before anything else went wrong.

A few minutes later, I lost all comms. I couldn't hear the other sub or topside. This forced me into a lost comms procedure that dictates surfacing after 30 minutes. I stopped occasionally to make sure Sylvia was still with me, and attempted to talk into my headset many times, but it soon became obvious that today would not be my day to measure flow at the brine seep. With ground faults increasing in frequency, and no communications, it wasn't long before surfacing was my last resort.

I grounded the sub and turned toward DeepWorker 6 and signaled that I was ascending. We both started our ascent from about 300 feet. I used my vertical thrusters so I could ascend at a controlled rate. Rising above about 100 feet, the air in my soft ballast tank had expanded to the point of causing a fairly rapid ascent. I used downward thrust and dumped the air out of my soft ballast to control the ascent, constantly gauging my rate by watching my depth indicator and the other sub, and looking upward to make sure nothing was above me. The sub was very responsive and there was never any real danger. I reached the surface a couple hundred yards from the NOAA Ship FERREL and immediately received a call on my VHF radio. They knew I was ascending because Sylvia had told them. They also knew exactly where I was because of the tracking system.

The recovery went without a hitch. A little investigation led us to the discovery that the reason my comms unit had failed is that the battery had not been properly charged. After it was put on charge, someone had inadvertently unplugged the charger, so it quickly ran out of juice after I started my dive! Sometimes it's the simplest things that cause the greatest problems.

So what did the experience teach me? I guess there are several things. Avoid putting

anything electrical in seawater. If you can't avoid that, make sure your life support systems are mechanical, not electrical.

On my dive, at no time were any life support systems in jeopardy. Only the modern conveniences failed - cameras, comms units, and computers. Dive with another sub if you can. This is usually not possible, but in this case, even though my dive had to be aborted, Sylvia descended again and did make it over to the brine seep). Last, but not least, always have a backup plan. Don't count on one particular piece of equipment to do a job. That simple aluminum meter stick could be worth its weight in gold!

(top) **RETURN**

September 10, 1999

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Laddie Akins, Executive Director
Reef Environmental Education Foundation

Flower Garden Banks - East Bank

During the night, weather conditions again deteriorated, and the heavy swell this morning made sub ops impossible. The MV FLING had departed during the night, replaced by a 55-foot charter boat, the MAIN EVENT, which we will be using as a floating bunkhouse for the remainder of the mission.

Throughout the day, scuba ops from aboard the FERREL replaced submersible operations as our means of exploring the reef and documenting fish populations. In the evening, we launched the ROV to look at deeper fish populations at 140 feet.

Laddie Akins, our resident fish expert, describes today's operations:

Quite a swell has come up over last night. Emma Hickerson, Flower Garden Banks sanctuary research coordinator and SSE mission coordinator was to dive with me during dual sub ops to conduct fish surveys on the East bank. But, as every farmer knows, you can't predict what the weather will do. A five foot swell has come up with the 15 knot winds. The small chop on the surface isn't bad, but the heavy swell makes launch and recovery of the subs an unsafe proposition.

We're tied up to buoy number 3 and decide that we can get in some fish surveys on the shallow part of the Bank by using scuba. REEF volunteers have been conducting fish surveys in the Flower Gardens since 1994 and there are now more than 1,000 surveys from the banks. We are about to add 8 more over the next two dives. Dr. Sylvia Earle is joining Kip Evans, Emma Hickerson, GP Schmahl, Lt. Stacey Maenner (Field Operations Officer), and myself over the next two survey dives to document the diversity and relative abundance of as many species as we can find. We're on a treasure hunt for fish!

We drop in off the side of the FERREL to an amazing view. Over 130 feet of visibility,

a slight northerly current and great numbers of fish and corals welcome us into the blue. Under the ship's hull swim hundreds of Chubs - gray, football sized plankton feeders. Under the Chubs swim multitudes of lavender colored Creole fish, relatives of the seabass, that have also evolved to feed on the plankton above the reef. As the dive progresses closer to the reef we record small Yellowtail Damselfish, Redlip Blennies, and a great school of Horse-eye Jacks, among others.

Fifteen minutes into the dive, Kip waves a free hand in my direction and points emphatically forward. From the edge of visibility appears the graceful flight of an Atlantic Manta. Kip, Emma, Stacey and I all swim in formation with the slow winging of the 8 foot wide ray. This one, Emma says later, is a juvenile. They can reach over 20 feet when fully grown! Individual mantas can be identified by distinct markings on their backs and underbellies, similar to our fingerprint identities.

Jeff Childs, Marine Ecologist at Texas A&M, has been documenting the occurrence of these animals since 1994,and is producing a catalog of the species found in the Flower Gardens, so we sketch the ray's ID markings for inclusion into Jeff's work. Additional dives by Sylvia and GP, bring sightings of Longsnout Butterflyfish and Yellowheaded Jawfish. In all, during our two dives, we recorded over 70 species of fish from the top of the reef crest. The data will be transferred onto REEF survey report forms and scanned into the database for all to see on the **REEF Web site**.

As the day progresses, the winds drop but the swell does not diminish so quickly. At 5:00 p.m., the decision is made to launch the hardier, unmanned remotely operated vehicle (ROV) in exploration of a deep water ridge. The crest is at about 45 meters and the base at about 55. The ROV is fitted with both a three chip and a single chip video camera. Since it is controlled from the surface it also has a hard wire video connection that allows real time transmission of the video to a monitor on board the FERREL.

Workers deploy the ROV to supplement DeepWorker research in times of difficult sea state.

We all gather in the ship's science lab to watch as the ROV is lowered over the side and makes its way down toward the ridge. Ian Griffith, from Nuytco, is at the controls and he flies the ROV with hand controls much like the foot controls in place on the DeepWorkers. Left hand is up/down and crabbing left/right. Right hand is forward/reverse and turning left/right.

As the bottom takes shape on the video monitor, we begin to recognize familiar species. Creolefish, Creole Wrasse, Mountainous Star Corals, Cavernous Star Corals, and many species of sponge and algae. Ian flies the ROV and controls the camera while we give direction and comment about what we're seeing on the monitor.

Two very large Tiger Grouper saunter by. A Queen Trigger, uncommon in the shallow depths, makes her way around the high profile corals. A large school of Creole Wrasse readies for the evening migration to shallow waters. Dog and Gray Snapper move about warily. In all, 27 species of fish are documented during a 45 minute survey by the ROV. Along the way, bubbles from underground natural gas seeps make their way in small streams toward the surface. Oil companies are very interested in the rich gas reserves surrounding the banks, but they also are very much involved in the banks' protection as a national treasure. Proof that private industry can partner well with government in protecting our resources.

By late evening, winds have dropped to less than 5 knots and the swell is dropping nicely as the ROV is hauled back aboard. There were no sub dives today, but even in the adverse conditions, we were able to accomplish good work. And the excitement of both successful scuba and ROV operations keep spirits high. Every one is looking forward to great conditions and sub dives tomorrow.

Gale continues:

Tonight, we transited to the West Bank, in preparation for further assessment of fish assemblages. Conditions permitting, we hope to do a deeper dive in the afternoon, possibly to 300 feet.

(top) RETURN

September 12, 1999

G.P. Schmahl, Manager
Flower Garden Banks National Marine Sanctuary

Steve Ross

After days of bad weather, finally King Neptune has cooperated and given us a couple of days of perfect conditions. Deepworker dives were successfully carried out yesterday; and this morning Kip Evans and Steve Ross completed an extremely interesting dive.

Here, Steve Ross describes his plans for his DeepWorker dive:

After several training dives (Monterey and Key West) and the mission to FGBNMS, I still have only limited exposure to DeepWorker and SSE. However, I am encouraged that both the project (SSE) and the tool (DW) have great potential. Having worked in larger submersibles over the last 20 years and having conducted extensive SCUBA projects over 30 years, I was excited by the idea of being both scientist and pilot.

The DeepWorker design facilitates this combination, although communicating every 15 minutes, handling cameras, taking notes, navigating, and operating the sub keep one very busy. This tool's real value is in allowing observation and data collecting below depths of SCUBA gear, areas that are less well known or studied.

I found that high quality video and other observation was possible, that stable transects could be accomplished, and that all functions of pilot and scientists were feasible. I was able to interest Yellow Springs Instrument, Inc. in loaning a YSI 6600 to the project, allowing continuous recordings of temperature, salinity, depth, pH, dissolved oxygen, turbidity, and chlorophyll. This, along with various video/still cameras and other instrumentation, can make the DeepWorker into a sophisticated platform for scientific data collection in moderate depths (200-2000 ft).

I found the DeepWorker experience much like flying, except that the "plane" is tightly wrapped around you. It is maneuverable, responsive, and feels safe. This ability to precisely and quickly position the submersible and maintain a station or a transect set it apart from other submersibles, which are often bulky and drive like large boxes. Over time, my co-principal investigator Ken Sulak and I will be working to adapt this

vehicle to collect quantifiable, repeatable, and statistically valid data that can be used for long term monitoring (as well as short term evaluations) of community structure, diversity, habitat-species associations across a wide range of depths and bottom types. This objective is attainable, and we look forward to addressing it.

As the SSEs mission continues over the next 3 years, its challenge will be to demonstrate to the scientific community that we can enter a new era of undersea exploration using this technology. SSEs must demonstrate that high quality science can be produced from this platform. This will be a tough sell to a skeptical community, but it is possible. I commend Sylvia Earle for attempting this project and applaud the skilled Nuytco submersible crew for facilitating it.

GP continues:

The most exciting moment of Kip and Steve's dive was the arrival of two medium sized manta rays, performing their exquisitely beautiful underwater ballet for the two pilots. Kip breathlessly blurted over through-water comms that it was the most beautiful thing he'd ever seen. The rest of us topside could only wrestle with profound feelings of envy at the experience Kip and Steve were enjoying below. And then, they observed something which to our knowledge has never been observed by human eyes here before, and certainly has never been captured on video. The two mantas came towards each other, each moving in a large sweeping arc. Then, they appeared to actually collide, belly to belly. At the same time, something cloudy appeared in the water between them.

Reviewing the videotape later, Emma Hickerson was awestruck. "Kip, do you know what this is?" she asked excitedly. "They're mating! See that cloud? That's spawn!" What a triumph for Kip, to have been able to observe and record the event on video!

To say that I was anxious to have an opportunity to utilize the Deepworker to investigate the deeper reef communities is an understatement. I had often traveled to the edge of the coral dome on SCUBA, and peered wistfully over the dropoff to the depths below. This time, I would finally be able to explore what lay beyond.

Everything checked out on Deepworker 7, the sub that I had been assigned, and we were prepared to carry out a two submersible dive with myself and Dr. Quenton Dokken of Texas A&M University at Corpus Christi.

The focus of my interest is the sponge communities of the Flower Garden Banks. In spite of the fact that sponges are an obvious and important component of the coral reef ecosystem, they are not nearly as well known as the reef-building corals. On top of the reef, where most divers frequently visit, living coral dominates the seascape, and sponges are not all that common (unless you start looking under ledges and other nooks and crannies). However, at the base of the reef, sponges become much more numerous.

In addition, beginning at about 150 feet in depth, and extending out in all directions around the East and West Flower Garden Banks is a slowly sloping area which

contains little if any living coral. This zone was named the "Algal-sponge zone" by Dr. Tom Bright and other early researchers, because the most prominent organisms are nodules formed by several calcareous algae and a variety of sponges. The sponge community in this zone has not been well described. The purpose of my dive is to begin the characterization of the sponge communities in the deeper reef and "Algal-sponge" zone.

The dive plan was to explore the northern edge of the West Flower Garden Bank. We chose this area because it is one of the places on the reef that has a very steep dropoff from the coral reef top to the deeper zones.

Jim Gardner from the U.S. Geological Survey provided high-resolution bathymetric data that was used to plan DeepWorker and ROV dives.

This area fit well with both my and Quenton's objectives. Quenton is interested in changes in community composition with depth, so the steeper the dropoff, the easier it is to cover a wide depth range in a short distance. This fit my needs as well, because I could see the deeper reef communities and the adjacent "Algal-sponge" zone in close proximity. My sub, DeepWorker 7, was the first to be launched. I kept thinking of the Mercury astronauts, whose spacecraft were all named with a "7" (Freedom 7, etc.), and thought that maybe I needed a nickname, like "Buzz", "Gus" or "Deke".

Delusions of grandeur quickly subsided as the sub was placed in the water and I began running through a final check of the camera setup and life support systems in preparation for descent. As the sub bobbed on the surface of the water, the plexiglass dome would submerge briefly, giving me a quick glimpse of what was in store. The water clarity at the Flower Gardens is always good, with 80-100' visibility being very common. I could easily see down to the coral reef 70 feet below and could watch as DeepWorker 6 was being deployed. Once Quenton was safely in the water, final checks were completed and we were given permission to submerge.

The subs were deployed near the edge of the reef. We submerged to the reef and then oriented to where the reef quickly dropped off, giving way to a predominantly sandy area at its base, 150 feet down. We settled the subs down on the sand and made last minute adjustments to our ballast. This is very important, because the subs work best when they are essentially "neutral" in the water. That is, if you stop, you stay in place without floating up or sinking down. Being too heavy is especially bad, because we must be very careful not to bump into the coral reef, which could cause serious damage.

On the bottom, one of the first things we observed was a large, old anchor lodged at the very edge of the reef. Although the anchor itself was in the sand, a long anchor chain was draped up and over the coral reef. The anchor was probably 3 feet tall and obviously was from a fairly large vessel. Judging from the amount of encrustations on

it, it had been there many years. It was stark testimony to the problem of anchor damage, which is one of the major threats to coral reefs and which led to the installation of mooring buoys here to prevent vessels from anchoring.

After photographing the anchor, DeepWorker 6 and I began a systematic transect of the reef edge in this vicinity. Shortly, without warning, I was engulfed in a swirling mass of quickly moving color, which turned out to be a school of 60 or more Rainbow runners, a beautiful type of jack. Most other sub pilots had also reported similar experiences. Apparently jacks are attracted to all sorts of objects, and the DeepWorkers are no exception. They checked me out for several minutes, swimming around and around furiously until they suddenly swam away, just as quickly as they had appeared. I sat there sort of dazed, and looked up after them as they disappeared into the distant blue haze.

I was facing a hillside of almost solid coral stretching up to the shallow part of the reef, and to the right and left of me there were rocky outcrops which supported growths of a variety of coral, colorful sponges and an occasional white curly-que sea whip. Everywhere there were fish: groupers, snappers, wrasses of all types. And for a moment I forgot what I came here for. It reminded me of a quote by William Beebe, one of the early deepwater explorers who once wrote, "The sun filtered through the water like through the stained glass of the most exquisite cathedral. I had to stop and sit quietly to enjoy the beauty, before I could remember I was an ichthyologist." Or in my case, a "spongologist".

But duty called, and I shortly caught up with Quenton, who was busy photographing a series of outcrops that he would later analyze for species composition and percent cover. I began a list of the sponges of the area, but quickly found that although I recognized many of the species, there were a number that were not familiar to me. Identification of sponges can be very difficult, because the same species of sponge can grow in a variety of forms (encrusting, erect, vase-like, etc.). Also, it was difficult to see the natural color of the sponges, because as you go deeper in the water, much of the color is filtered out, leaving everything as some shade of blue. DeepWorker 7 was equipped with some very powerful lights, but I found that I still had to carefully maneuver the sub very close to the sponge for the lights to illuminate the specimen adequately.

The only way to make a positive identification of some sponges is to collect a piece of it and look at it under a microscope. Most sponge skeletons are made up of "spicules" which come in a variety of shapes and sizes. It turns out that the shape and size of spicules are uniquely characteristic in certain species and can be used in identification. Such sampling work will have to wait for a future mission, as we are not currently set up to collect samples, and we need to ensure that damage caused by sampling is kept to an absolute minimum.

After looking at the edge of the reef, DeepWorker 6 and I decided to travel out into the "Algal-sponge" zone. This zone starts at the base of the reef and goes out to about 250 feet of depth. We moved out into the area to a depth of about 185 feet. At first it was a little disappointing to me because the area looked relatively barren. The only obvious sponges were scattered colonies of the "Touch-me-not sponge"

(Neofibularia nolitangere) . This sponge lives up to its name and will inflict a severe itching rash to those who do not heed the caution.

However, upon closer inspection this zone was filled with interesting things. Interspersed among the algal nodules were at least a dozen species of sponges. Again, I recognized most of these species, but there are several that I will have to collect in order to identify them. One obvious feature in this zone were the rubble mounds created by the Sand Tilefish. These are pretty impressive when you see the large size of the rubble used compared to the size of the fish. We made a detailed photographic record of the bottom communities.

All too soon, we were given the instruction to come to the surface. As usual, visiting an area that you have never seen before raises more questions than it answers. I look forward to returning to this incredibly diverse area for further investigation.

(top) **RETURN**

September 13, 1999

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Today is the last day of our first field season. Phew! For those of us who have been aboard from the beginning back in April in San Francisco, this has been a very long, very full five months.

But of course, the work started much earlier than that April. Even as early as two years ago, Sylvia Earle was brainstorming with the folks at National Geographic about how best to make use of the tremendous opportunity the Goldman Fund was making available for her to create a project to promote her ocean conservation and exploration goals.

Since then, uncountable hours have gone into planning, pulling so much together, and implementing this project. Numerous folks behind the scenes in the NOAA Special Projects office, people like Tom LaPointe and Brian Johnson, their boss Dan Basta, and the entire web team there. Other folks from NOAA who have been traveling with the project all field season, quietly and effectively making things happen. People like John McDonough and Dave Lott and Laura Francis.

All the many fine folks we've worked with on all three ships. These guys worked unbelievably hard, and put in a lot of long days, to accomplish SSE's goals. National Geographic folks like Margaret Sears, and our itinerant photographer Kip Evans, and Sylvia herself. The tireless efforts of the Nuytco and DOER crew to keep the subs in tip top shape and run the dives. So many people, such herculean efforts, and by golly, we've accomplished a lot for our first field season!

We got a lot of science done, not only with the subs, but also the ROV, scuba dives, CTDs, net tows, and surface-based observations. We were able to get the message of the oceans out to the world via this website, open houses, student summits, media outreach, and numerous other projects.

And we've learned a tremendous amount about what works, what doesn't, and what we need to do to make next year even better. And to a large extent, that last was the most vital goal of the entire first field season. Our next mission will take us to the Hawaiian Islands Humpback Whale National Marine Sanctuary, and we'll be able to apply what we've learned this year to how we handle that mission, in January of

2000.

And so here we are, tired but pleased with the results of all these efforts, on the last day of the field season. We started the day with an ambitious plan to complete five dives, culminating with a dive by sanctuary manager GP Schmahl. Just as Ed Ueber was tickled to be the first sanctuary manager to complete the first dive of the first mission of the first year of SSE, GP could have had the distinction of being the last sanctuary manager, diving the last dive of the last mission of this first field season.

Sadly, it was not to be, as the weather once again kicked up and cut our diving day short. Emma Hickerson and Laddie Akins completed a two-sub dive first thing in the morning, but by the time they got back on deck, the weather had started to turn, and we were unable to get any other dives that day.

Emma and Laddie had a terrific last dive of the project, though. Their main purpose was to complete fish abundance surveys, and in that, they were very successful, completing several structured transects to assess the fish populations in the selected location on the East Bank. Their dive took them to as deep as 165 feet, and as they skirted the reef, they were very pleased and gratified to see, in addition to numerous other fish, a good many large grouper of various species.

Grouper are very vulnerable to overfishing pressures, because they take a long time to mature, and fishermen often take them just at their breeding time, when they "group" (hence the name grouper) to spawn. Throughout this project, we've been dismayed and concerned to see very few large adult grouper in areas where they should be, and used to be, abundant. That there were so many at this site was an encouraging sign. Needless to say, Sylvia has directed me not to be too specific about where these grouper were seen, lest some enterprising fisherman track them down and wipe them out!

After the subs were back on deck, we hesitated until we were sure the weather would not permit us to dive anymore for the day, then started the long 11 hour transit back to Galveston. And the great demobilization of 1999 began. So many computer systems and video decks and equipment for the subs, and on and on and on.... All this STUFF that had to be broken down, sorted, categorized, boxed up, and readied for shipping to the four corners of the country.

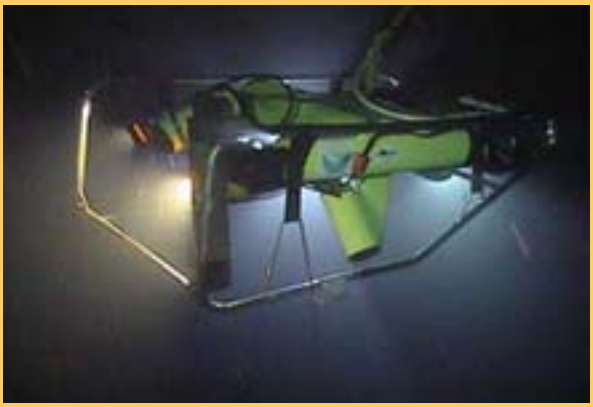
As for me, well, the log just goes on and on and on! I'll be going back through the log entries of the first field season, adding more written material, images, video clips, whatever I can get my hands on (with some help from Kip and Dan Basta's staff to sort and prepare the images).

I'll be going back to each of the sanctuaries we visited, to see what thoughts the managers and educators and scientists have, in hindsight, now that the first year of the project is over, and I'll be sharing their impressions with you here. Same for the other folks who have been a part of this project throughout. And I'll be documenting preparations for the next field season as well. I'll do my best to make it worth your while to keep stopping by to see what's new!

(top) RETURN

Summary of Investigations

On August 29, DeepWorker pilots Steve Gittings, Edie Widder, Peter Vize, and Emma Hickerson departed Key West on board the NOAA Ship Ferrel and steamed towards the Flower Garden Banks National Marine Sanctuary. Flat, calm seas and dolphin and whale spottings brought hopes for good weather during the missions. Unfortunately, the sea state took a downward turn about the time the Flower Garden Banks hit the radar screen. Although faced with unpredictably bad weather, and certain logistical problems, a total of 12 DeepWorker dives were conducted in the short time nature cooperated.



A remotely operated vehicle is deployed to document spawning. Weather and sea conditions did not permit scuba or DeepWorker dives to be conducted during this event. (Photo credit: FGBNMS)

Coral Spawning

On the peak spawning night for several species of coral, scuba and submersible operations were canceled due to weather conditions and sea states. Fortunately, an S2 Phantom remotely operated vehicle (ROV) could be deployed to document this event. Phil Otalora, Nuytco, flew the ROV for several hours as others crowded around the screen to witness the beauty of the "snowstorm" occurring beneath the water. Dr. Peter Vize, the principle investigator of the coral spawning project, made several good observations using the ROV as his window to the spawning. He recorded the deepest spawning observation to date, *Montastraea cavernosa* (a star coral) at 43 meters.

Unfavorable sea states disrupted submersible diving operations for the remainder of the first week, so scuba and ROV operations were continued. Spawn collections were made using scuba. Samples from blushing star coral, *Stephanocoenia* sp., verified that this species' eggs are fertilized prior to release from the female coral.

Geological Exploration

Emma Hickerson, research coordinator for the sanctuary, prepares for a dive. (Photo credit: Frank Burek)

During dives, DeepWorker pilots reported changes in topography to topside. The vertical incline of the reef crest on the west bank varied from around 50-80 degrees. Some portions were densely covered with well developed boulder and star corals. In other areas, it was clear that the reef had collapsed and toppled down to the sandy bottom. What was left was just rubble. On two occasions, pilots Emma Hickerson and Laddie Akins observed small canyon like formations with reef structures forming the canyon walls. These areas had sandy bottoms, as if some force had been moving down the crest like a river. Emma and Laddie followed the "rivers" up to 90 feet (30 m) to a sunken "bowl" shaped depression, approximately 30 feet (10m) across, with the "river" of sand forming a horseshoe around the top side, and returning down the crest on the other side of the "bowl". In the middle of the depression was well formed reef - star and brain coral - just lower than everything around it. This area appeared to have sunk, probably due to dissolution of the salt dome underneath. Hence, somewhere below, a brine seep like that on the east bank may exist.

On the east bank, Jim Gardner and Dave Lott used technology provided by the U.S. Geological Survey to navigate the ROV to points of interest in and around the brine seep. The ROV was also used to explore the north ridge of a graben area. The U.S. Geological Survey mapped the Flower Gardens in the winter of 1998 using high resolution multibeam sonars. The images were taken originally to test equipment but were spectacular and informative, stimulating further interest. A paper on this work was published in the recent dedicated issue of the journal Gulf of Mexico Science (for copies, email emma.hickerson@noaa.gov).

Fish Censuses

Emma and Laddie simultaneously piloted the two DeepWorker submersibles while conducting REEF (Reef Environmental Education Foundation) censuses of the fish they encountered in different zones. They began their surveys in the zone where the coral stops, between 150 and 170 feet (50-57 m). Red hind *(Epinephelus guttatus)*, not often seen on top of the reef crest, were abundant, propped up on their pectoral fins on top of coral heads. A dynamic school of cottonwick *(Haemulon melanurum)* congregated in a particular location of the reef edge and it was realized that it was a large cleaning station. Numerous juvenile Spanish hogfish *(Bodianus rufus)* flitted around the school

cleaning one fish, then the next. A large school of horse eye jacks *(Caranx latus)* took time out of their transit to swirl several times around Laddie's submersible. Emma recorded a total of 40 fish species during her survey around this small portion of the base of the west bank, including sunshinefish *(Chromis insolata)*, large amberjack *(Seriola dumerili)*, tiger grouper *(Mycteroperca tigris)*, and green razorfish *(Hemipteronotus splendens)*. Several carcharinid sharks were seen, but their species could not be identified.

The nurse shark (*G. cirratum)*was one of several shark species seen during the Expeditions. (Photo credit: Frank and Joyce Burek)

Tiger grouper, *Mycteroperca tigris*,and several other grouper species were seen around piles of reef rumble, perhaps preferred habitat. (Photo credit: Frank and Joyce Burek)

Next Laddie and Emma headed west over the sand, which was filled with yellow-headed jawfish *(Opistognathus aurifrons)* dancing over their holes. As they descended, the terrain changed to rubbly chunks of drowned reef. Several very large circular piles of rubble revealed large sand tile fish *(Malacanthus plumieri)* busily picking up chunks of the rubble and moving the rubble to the perimeter of their territory. With continued descent, the rubble turned to algal nodules, hiding all sorts of cryptic species. Emma hopes to return to this zone next year to collect some of these nodules to assess the contents -- likely micromolluscs, sponges, etc. The deepest depth reached by Emma and Laddie was about 260' (87m) where there were large outcroppings. A roughtongue bass *(Holanthias martinicensis)* was seen among the outcroppings.

On another DeepWorker dive, Emma and Laddie circumnavigated the west bank crest at 150-170 feet (50-57 m) and while surveying fish using the REEF roving diver technique they noted a healthy population of groupers -- tigers *(Mycteroperca tigris)*, yellowmouths *(M. interstitialis)*, blacks *(M. bonaci)*, and yellowfins *(M. venenosa)* -- and a comb grouper *(M. rubra)*, rarely seen on the east and west banks. Piles of reef rock, which had perhaps tumbled from the reef crest, seemed to be the preferred habitat for groupers. About a half dozen reef sharks were also observed in the area. Forty fish species were recorded during the dive.

One limitation of the DeepWorker, discovered during REEF roving diver surveys, is that it cannot get close enough to the substrate to allow the pilot to see the cryptic species.

Georeferencing

One of the major accomplishments of the missions at the Flower Garden Banks was the use of the tracking system. This system allowed pilots and topside technicians to georeference notable observations, such as the cleaning station with the cottonwicks,

an anchor, a cable, or a particularly large congregation of grouper, so that in future expeditions pilots and scientists will know where they have been and what to look for.

This water spout was only one of the weather hazards that plagued the Expeditions during its first week at the Flower Garden Banks National Marine Sanctuary. (Photo credit: FGBNMS)

(top) RETURN

A Teacher's View

U.S. Senator Bob Graham of Florida

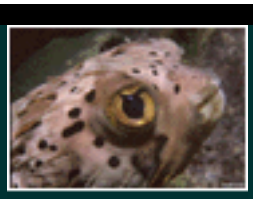
U.S. Senator Bob Graham of Florida (photo credit: Senator Graham staff)

In the fall of 1989, three successive freighter groundings ravaged the coral reefs of the Florida Keys and produced a national outcry for protective action. In order to address these and other threats to the United States' most extensive living coral reef system, then-U.S. Congressman Dante Fascell and I introduced the Florida Keys National Marine Sanctuary and Protection Act.

In the 10 years since, citizens of Monroe County have worked with the state and federal governments to develop a management plan for the marine sanctuary that accommodates a variety of commercial, recreational, research, and education activities while at the same time protecting the unique natural resources of the Keys.

The Florida Keys National Marine Sanctuary covers 2,800 square nautical miles and encompasses the third-largest coral barrier-reef system in the world. Extending from the southern tip of the Florida peninsula to a point just 90 miles north of Cuba, the Keys link Biscayne Bay National Park with Dry Tortugas National Park. They are an important part of the South Florida ecosystem, which also includes four national wildlife refuges and Everglades National Park.

The marine environment of the Keys supports one of the largest seagrass communities in this hemisphere and more than 6,000



GEOLOGY

POETRY

REFLECTIONS

CORAL SPAWNING

FISH CLEANING

NUTRIENT STRESS

A DIVER'S VIEW

species of plants, fish, and invertebrates. The diversity of this reef ecosystem is considered the underwater equivalent of the tropical rainforests. As a result, more than four million visitors come to the Keys each year to fish, swim, boat, snorkel, scuba dive, and enjoy the unique culture of the islands.

But the Keys still face challenges--such as the need for improved wastewater treatment--that will require our best efforts. The inadequate sewage systems on the islands allow pollutants to travel quickly into canals and nearshore waters. These pollutants also act as fertilizers by increasing algae growth and reducing visibility.

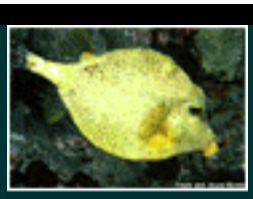
During one of Senator Graham's workdays, he accompanied a biologist on the boat to conduct research. (photo credit: Senator Graham staff)

The Florida Keys National Marine Sanctuary's water quality steering committee has drafted a water quality protection program to address problems like wastewater treatment and preserve the marine ecosystem of the Keys. For the next two weeks, the Sustainable Seas Expedition will visit the region to supplement those efforts.

This program, a collaborative effort of the National Geographic Society and the National Oceanic and Atmospheric Administration, will bring

state-of-the-art exploration equipment to the Florida Keys National Marine Sanctuary to document the quality of the water and the variety of organisms that inhabit the reef.

Expedition researchers will also participate in an open house, a live video uplink, and a live Web chat to inform local residents and sanctuary visitors of their findings.



A TEACHER'S VIEW

TEMPLATE

Senator Graham experiences what it is like to be a marine biologist in the Florida Keys. (photo credit: Senator Graham staff)

The greatest gift we can give to our children and grandchildren are environmental treasures that they can enjoy for years to come. The Florida Keys National Marine Sanctuary and the Sustainable Seas Expedition both constitute shining examples of private citizens working together with the government to achieve this goal by helping us understand and preserve our precious natural resources.

(top)

RET

Search

This search capability allows the reader to perform a standard word search through the Web pages of the Sustainable Seas Expeditions and will find all occurrences of words or phrases and present them to you in order of confidence. Simply type in a word or phrase in the search box below and click the 'Search' button. Advanced search features are found **below**.

What are you looking for?

Submit Query

Local Search: Search the documents at this site.

Advanced Query Tips

Here are some suggestions for getting the best results out of the Sustainable Seas search engine.

Search for Exact Phrase

When searching for phrases such as **Stellar sea lion** or **blue whale**, enclose the phrase in quotation marks, i.e., **"Stellar sea lion"**. Using the quotation marks tells the search engine to find those words, in that specific sequence.

Use More Words

The easiest way to narrow your search and the first thing you should try is to simply use more words in your query. The greater the detail you provide, the better the search engine is able to find precisely what you're looking for.

Use + to Require Words

Put a plus sign (+) in front of a search word to make sure that ALL of the documents it returns contain the word. Example search: immigrants +Russian.

Use - to Exclude Words

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Put a minus sign (-) in front of a search word to make sure that NONE of the documents it returns contain the word. Example search: whale -right -blue.

Use AND, OR, NOT, AND NOT, ( )

This search page supports full Boolean operators and syntax. You can use the AND, OR, NOT, and AND NOT operators, and parentheses ( ) for grouping . Example search: swimming AND (man OR woman).

Click here for **help on searching**.

TIP: If you plan on making multiple searches, you might wish to make a bookmark for this page.

(top)

This site is excited

Contact us

The Sustainable Seas Expedition is designed to bring the hidden wonders and treasures of our nation's ocean waters closer to the public, and in so doing, promote a conservation ethic. We encourage your comments and questions. We will read all comments, and will try to answer as many as we can. Email comments will be sent to mission participants who are most knowledgeable of the subject area.

Send your comments and questions to:

SSEcomments@noaa.gov

Contributors

This Sustainable Seas Expeditions Web site was built through the combined efforts of many people: authors, technical experts, editors, artists, educators, and visual specialists among many others. The list below identifies the many individuals who contributed to this site during the 2000 field season.

The contributors for the missions completed in 1999 are available for viewing.

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Web Site Comments from the 1999 Field Season

A full-scale model of the *DeepWorker 2000* submersible travelled around the country, bringing the Expeditions to the public.

Over the past year, we have received many wonderful letters from our readers. We thank them all for their good wishes, sincere questions, and helpful advice. We try to answer as many as we can. Please keep them coming.

Just as the Expeditions explore hidden underwater treasures, this quiet correspondence is one of the hidden treasures of the Web site team. We wanted to share some of it with you. Following are a few of the letters we have received. We thank the senders for their permission to print them.

From Bethany, Doing an Orca Whale Report

Hi! I am doing a report on the Orca whale. I am having a lot of trouble finding info. Please contact me and tell me if there is anything you can do. -- Thank you, Bethany, age 13

John (4th grade) hand drew these breaching ORCA whales.

Dear Bethany: Thank you for your interest in the Sustainable Seas Expeditions (SSE). First off, the Olympic Coast National Marine Sanctuary off of the state of Washington has a large population of Orca or killer whales and you may find some interesting information on their **Web site**. Jean-Michel Cousteau (son of the late Jacques Cousteau) has an organization called **Ocean Futures** and the Free Willy Keiko Foundation, which discusses how Keiko, the Orca whale, is an ambassador for marine mammals around the world. Lastly, sometime ago there was a killer whale battle with a great white shark off of San Francisco, CA that was documented by video. I imagine that browsing the Web and old newspaper articles on-line would provide more information about this event. Who do you think won the battle&emdash;the killer whale or the shark? Interesting stuff! / These are three very good locations to find out more information about the killer or Orca whale. Good luck with your report and keep posted on the Sustainable Seas Expeditions. You can join researchers,

educators and others as they write mission logs describing what it is like to be in a one-person submersible studying humpback whales and other marine life. You can also have your teacher and the entire class watch a live video broadcast of the Expeditions or participate in a Web chat with researchers from around the country. -- Claire Johnson, Sustainable Seas Expeditions

Oh my gosh THANK YOU this is just what I needed!!!!!!!! You guys definitely deserve recognition for your efforts!!!!! I will recommend you to my friends who are also doing reports on marine life and coral reefs!!!! Thanks again!!!!!!!! -- Bethany

---

From Ilyanna, A Question about Sonar Data

What GIS package did you use to visualize your sonar data? -- Curious Geographer, Ilyanna Budak

Dear Ilyanna: As to your GIS question, we are using an Imagenex sonar. It comes with a simple visualization package that allows us to replay the sonar view and output raster files. It is a relatively simple system--the image looks like something you might see on a commercial "fish finder". The pilots mainly use it to find features (e.g., boulders, outcrops, reef structures) in low visibility situations. It is not tied to any real world coordinates. -- Dave Lott, Geographer, NOAA/NOS Special Projects Office

---

High resolution National Geographic cameras outfitted on the *DeepWorker 2000* submersible. (Photo courtesy of Claire Johnson)

From John, About Underwater Photography Opportunities

Hello, I am very interested in staying posted to upcoming events. Please add me to your mailing list. I am a cameraman here in Houston, TX and am looking to expand my underwater photography experiences throughout my lifetime. This site seems to be very informing and interesting. Hope to hear from you soon. -- John M. Perry, Studios at the Lakes

Dear Mr. Perry: As you have probably noticed, we have completed the Sustainable Seas Expeditions (SSE) at the Flower Garden Banks National Marine

Sanctuary off of Galveston, TX in our first field season (September 1999). Perhaps the next time SSE is exploring and conducting research in the Flower Garden Banks you will be abreast of our upcoming Expeditions and there may be an opportunity to volunteer as a fish count diver or photographer. The best bet is to check out **NOAA sanctuaries Web site** and specifically, the **Flower Garden Banks sanctuary Web site** to communicate with the NOAA staff there on these types of potential opportunities in the future. Good luck in your underwater pursuits. -- Claire Johnson, Sustainable Seas Expeditions

You've been a great help and I thank you for your time. -- John Perry

---

From Noreen, On Additional Literature for Her School Library

Claire Johnson, SSE Project Specialist, answers questions about ocean monitoring and science.

Dear Sustainable Seas Expedition Staff: I recently read an article written in Discover magazine and was very interested in learning more about this exciting project. I have logged on to your Web site and have bookmarked the site for easy access. I am a middle school librarian and also have a middle schooler who has expressed an interest in becoming a marine biologist. I intend on bookmarking all 20 of our computers at school so all of the students at Neil A. Armstrong Middle School will have easy access to your site. I would like to know if there is any additional literature that we could receive at school to supplement the information on the site and if there are opportunities for our students to become more involved in the expedition process. I look forward to hearing from you. Thank you for your time and consideration in this matter. -- Sincerely, Noreen Moore, Library Media Specialist, Neil A. Armstrong Middle School

Dear Noreen: We are working to make the Web site more interactive for teachers and students, which would include student investigations and other related activities. During the interim, I will have a SSE Teacher Resource Book sent to the school address for immediate use. / As for active participation with the Expeditions, we offer many opportunities for student and teacher involvement. We begin the second field season at the Channel Islands and Monterey Bay National Marine Sanctuaries in June and July 2000, then continue on to the Florida Keys National Marine Sanctuary in August/September 2000. During these Expeditions

Students participate in the Sustainable Seas Expeditions onboard an oceanographic vessel.

there should be an opportunity for students to participate with Web chats and live broadcasts with Expedition staff and researchers. We will also be conducting Student Ocean Summits and Teacher Workshops at various locations around the country. Typically these events occur closer to the actual sanctuary sites, however we are attempting to expand our reach with these unique opportunities. If you would like more information or specifics about these opportunities, please call SSE Education Coordinator, Laura Francis at 805.963.3238. Thank you for your interest. -- Warm regards, Claire Johnson, Sustainable Seas Expeditions

---

From Sally, A Super Supermom

Dear Editors: I have three children (Amelia, 13, Katie 11, and Henry, 8) who have heard Sylvia Earle speak about the ocean and are very excited about her dive in the new submersible in the Olympic Coast National Marine Sanctuary. They were very disappointed today when we visited the Sustainable Seas Web site to look for updates about the mission's progress. -- Regards, Sally James

Dear Sally: I extend my apologies to you and your children regarding the Sustainable Seas Expeditions (SSE) Mission Log. SSE strives to captivate the general public and especially the children's interest regarding the fragile marine environment. Our Mission Log Editor has been having trouble getting information off of the Navy YTT ship that is deploying the *DeepWorker 2000* submersibles right now. Usually pilots, educators and other SSE personnel are able to email Mission Logs from the ship with digital images, however this particular Navy ship is not capable of this and FedEx has been the means of disseminating this information. Please be patient and check our Web site later today for some new postings on the Olympic Coast NMS SSE Mission. -- Thank you for your interest in our project, Claire Johnson, Sustainable Seas Expeditions

Dear Ms. Johnson: Your reply was just wonderful. The kids love it! Now they know, from reading the mission log, that a blown piston is a big deal and the ocean eats equipment and engines. -- Thanks, Sally

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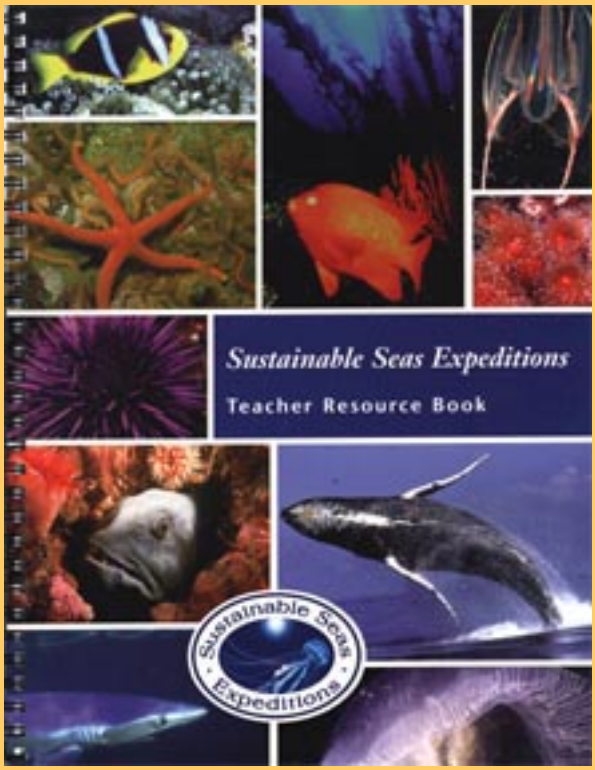
From Janet, About Materials for High School Students

Dear SSE Folks: This looks like a wonderful program. I was wondering if you are doing anything specific to reach high school students. I will try to arrange for my environmental science classes to participate in the programs and live chats, but times might be a problem for us. Do you have any manuals for this project that we can use? -- Thanks for your help, Janet in Japan



Sustainable Seas Expeditions Teacher Resource Book includes information on the National Marine Sanctuaries, student investigations, SSE and *DeepWorker 2000* submersible technology. **A PDF is available for download.**

Dear Janet: Thank you for providing positive feedback on the Sustainable Seas Expeditions (SSE) Web site. There are several ways that one can involve high school students with the Expeditions; one being through the live NASA Web chats or uplinks. However, you have mentioned a potential conflict in scheduled times. We have produced a 96-page SSE Teacher Resource Book that provides a wealth of information about the 12 national marine sanctuaries, *DeepWorker 2000* submersible technology, and various classroom activities. I would be more than happy to send a complimentary resource book, which includes a 2-sided SSE poster, to you for use with high school students provided you reply with your current mailing address. I hope that this would suffice for the time being. -- Best regards, Claire Johnson, Sustainable Seas Expeditions

Wow! That sounds wonderful. I'll also find out how to download and tape the on-line programs once school starts. -- Janet in Japan

---

From Rodney, About Volunteer Opportunities

Dear Expedition Coordinator: Does the Sustainable Seas Expeditions have a volunteer or an internship program? I would appreciate any information, which could be provided. -- Thank you for your time and

effort, Rodney Jeu

Dear Rodney: Thank you for your interest in the Sustainable Seas Expeditions (SSE) and browsing the official SSE Web site. There are many opportunities for involvement with SSE in a variety of capacities. For example, if you are a student, there is the possibility of getting your teacher and class involved with Student Ocean Summits that happen in various locations around the country, or logging on during one of the live satellite broadcasts during the actual Expeditions. Or you can tour the NOAA ships that are deploying the *DeepWorker 2000* submersibles during one of the many open houses held in the United States.

The Volunteer for the Coast Web site provides volunteer opportunities around the country.

As for volunteer and/or internship opportunities, I suggest that you browse the **Volunteering for the Coast Web site** to find an organization, which is able to accommodate for interns. Seeing as SSE visits national marine sanctuaries to conduct research and education projects, many of the specific sites have volunteer programs and this would be the best way to get yourself involved with the Sustainable Seas Expeditions. When the Expeditions come into a certain area (i.e. Channel Islands National Marine Sanctuary in June 2000) assistance is required and site interns often reap the benefits of participating in SSE activities. The volunteer Web site should provide some great contacts for you in your area and specifics on the National Marine Sanctuary Program and the opportunities they offer the general public can be found on their **Web site**. Another organization that uses volunteers that are SCUBA certified is **Reef Environmental Education Foundation** (REEF) and their Great American Fish Counts. SSE works with these types of organizations and being an active participant increases your chance to get involved with research happening on NOAA vessels among other opportunities. / Keep posted on the SSE Web site as we begin the second field season in the Channel and Monterey Bay National Marine Sanctuaries in June/July 2000 and the Florida Keys National Marine Sanctuary (NMS) in August/September 2000. I hope that this information is helpful to you in your pursuits of an internship related to the marine environment and exploration of this magnificent realm. All I can say is that persistence is frequently the answer. If you would like further information about SSE mailed to you, please reply to this message with your mailing address and I will send some info out to you. -- Warm regards, Claire Johnson, Sustainable Seas Expeditions

Dear Claire: Thank you very much for your reply. I've browsed the

volunteer Web site and have revisited the Sanctuaries Web site at your recommendation. It's good to see there are such opportunities to get involved. I am an active certified diver - PADI Divemaster, a volunteer diver at the Long Beach Aquarium of the Pacific, and have participated in a PADI underwater video shoot. These activities, especially those at the Aquarium, have provided invaluable exposure and learning experiences of our marine environment. I'm always looking at ways that I can be more involved and can contribute in these and other related areas. Persistence, as you said, is frequently the answer. Thank you again for your time and consideration. -- Best Regards, Rodney Jeu

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From Sean, On Great White Sharks

Hi SSE: I have heard a "rumor" that it is possible to see great white sharks in the vicinity of the Farallon Islands. Is this true and is it possible to be chartered so as to dive in a shark cage a la "Jaws"? If I am mistaken, or if there is another site, domestically, where I can pursue such as activity, please let me know. Thanks for your help. -- My best, Sean M. Mehegan

Dear Mr. Mehegan: Thank you for your interest in the Sustainable Seas Expeditions (SSE) and for browsing the official SSE Web site. In regards to your email message about great white sharks in the Farallon Islands, it is accurate, the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries are known for a large population of great white sharks. As for diving in a shark cage, I am not aware of any companies in the San Francisco area or other areas in the country that offer that unique opportunity. However, I was able to find some interesting shark related Web sites through Yahoo. I did not have a chance to look through them all, yet the few that I have tried seemed quite interesting! You may find some shark cage experiences listed among these sites:
<http://www.oceanstar.com/shark/>,
<http://www.angelfire.com/sharks/index.html>,
<http://www.metronet.com/~caw/white_death>,
<http://www.netzone.com:80/~drewgrgich/shark.html>,
<http://www.brunel.ac.uk:8080/~em93igj/sharks.html>,
<http://www.aloha.com/~lifeguards/sharintr.html>,
<http://www.io.org/~gwshark/sharks.html>, and
<http://www.ncf.carleton.ca/~bz050/HomePage.shark.html>.
Good luck with your pursuits and keep posted on the SSE Web site as we begin our second field season of exploration, research and education in the Channel Islands, Monterey Bay and Florida Keys National Marine Sanctuaries starting in June 2000. -- Claire Johnson, Sustainable Seas Expeditions

Claire: Thanks so much for taking the time to send me the address of the shark Web sites. I'll let you know if I find anything interesting. -- Sean Mehegan

From Avid Ocean Explorer, About Employment Opportunities

I love the Ocean and I want to help explore it. Do you need any divers, watermen, crew or any other help on any of your upcoming expeditions? I will work for food and sleep on deck if I can be at sea and help discover its secrets. -- Avid Ocean Explorer

The *DeepWorkers* await deployment off the stern of the McARTHUR as the Farallones loom in the distance.

Dear Avid Ocean Explorer: Thank you for your interest in the Sustainable Seas Expeditions (SSE) and browsing the official SSE Web site. There are many opportunities for involvement with SSE in a variety of capacities. For example, if you can tour the NOAA ships that are deploying the *DeepWorker 2000* submersibles during one of the many open houses held in the United States. / As for direct employment opportunities, we are not able to accommodate your request at this time. Currently our operations are run jointly with staff from the National Geographic Society and the National Oceanic and Atmospheric Administration (NOAA), along with commissioned officers from the NOAA Corps, among other collaborators that are too many to mention (i.e. NASA, Mote Marine Laboratory). *DeepWorker 2000* submersible pilots were selected through a call for collaboration process held in 1998, open to all researchers, educators and others from around the country. / For volunteer and/or internship opportunities, I suggest that you browse the **Volunteering for the Coast Web site** to find an organization, which is able to accommodate for interns. Seeing as SSE visits national marine sanctuaries to conduct research and education projects, many of the specific sites have volunteer programs and this would be the best way to get yourself involved with the Sustainable Seas Expeditions. When the Expeditions come into a certain area (i.e. Channel Islands National Marine Sanctuary in June 2000) assistance is required and site interns often reap the benefits of participating in SSE activities. The volunteer Web site should provide some great contacts for you in your area as should the **National Marine Sanctuary Program site** and the opportunities they offer the general public. Another organization that uses volunteers that are SCUBA certified is **Reef Environmental Education Foundation** (REEF) and their Great American Fish Counts. SSE works with these types of organizations and being an active participant increases your chance to get involved with research happening on NOAA vessels among other opportunities. / Keep posted on the SSE Web site as we begin the second field season in the Channel

Islands and Monterey Bay National Marine Sanctuaries in June/July 2000 and the Florida Keys National Marine Sanctuary (NMS) in August/September 2000. I hope that this information is helpful to you in your pursuits of employment related to the marine environment and exploration of this magnificent realm. If you would like further information about SSE mailed to you, please reply to this message with your mailing address and I will send some info out to you. -- Warm regards, Claire Johnson, Sustainable Seas Expeditions

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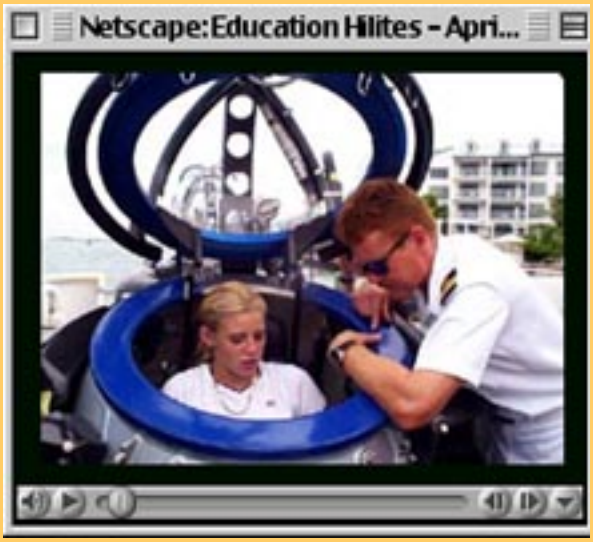

The **Video Gallery** provides streaming multimedia products of the Expeditions.

From Jesse & Alexia, Interested in Multimedia

Are the videos included on your web site in the multimedia section public domain or are they copyrighted? -- Thank you for your time, Jesse & Alexia

Dear Jesse & Alexia: Thank you for your interest in the Sustainable Seas Expeditions (SSE) and for browsing the official SSE Web site. There are two types of videos found in the multimedia section of the SSE Web site; the Sustainable Seas Expeditions video produced by the National Geographic Society is copyrighted along with the Interactive Virtual Tour of the Monterey Bay National Marine Sanctuary. The other videos currently found on the SSE Web site are public domain (e.g., Informal Tour of the NOAA ship McArthur and the Olympic Coast National Marine Sanctuary Student Ocean Summit video). If you have any further questions about the Sustainable Seas Expeditions, please do not hesitate to email back. -- Warm regards, Claire Johnson, Sustainable Seas Expeditions

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From Candy, An Advocate for the Flower Garden Banks Dive Site

Very disappointed not to find pictures of the Gardens and Banks one of the finest dive sites in the State of Texas! Have been there several times in the past 3 years and enjoyed a close encounter with a 40 ft. Whale Shark, numerous eagle rays, manta, barracuda, deer cowries, etc. July 9th got to closely observe the mating ritual of Ocean Trigger Fish. Please put some pictures up ASAP. If you can contact Jesse Canselmo of Houston, he is a professional photographer who has taken many excellent photos of the denizens of the deep! Love your site, great

for the kids. -- Candy J. Ryan

Sylvia encounters a 4 foot barracuda. Occasionally as many as 100 of these animals are seen schooling underneath the vessels moored at the Flower Gardens. They look menacing, but rarely pose any threat to divers, as long as they get the respect they warrant. (Photo courtesy of Emma Hickerson)

Dear Candy, Thank you for browsing the Sustainable Seas Expeditions (SSE) Web site. I have yet to have the chance to dive off the coast of Texas and in the Flower Garden Banks, however I have heard that it is wonderful! Our Expeditions to the Flower Garden Banks National Marine Sanctuary (FGBNMS) begin on Sept. 1st through Sept. 13th, 1999. Our Web site is updated on a near daily basis with mission log accounts from researchers, scientists and others on site working with submersible operations, etc. Seeing as we are just finishing up the last leg of the Gray's Reef National Marine Sanctuary SSE Mission off of Savannah, GA, and then venturing to the Florida Keys NMS, our Web site has been focusing on those specific areas. A week or so prior to the FGBNMS SSE Mission, our Web site will provide a wealth of information about the Flower Garden Banks area. Keep posted and check out our site again soon. Once we have this information posted, when there is a change over again it will be archived on our Web site for further browsing capabilities. We do have some great photographers working with us from National Geographic Society and NOAA, which provide the majority of our images. On a side note, there is a new coffee table book titled "Wild Ocean: America's National Parks Under the Sea" written by Dr. Sylvia Earle with great images of all the 12 national marine sanctuaries. -- Claire Johnson, Sustainable Seas Expeditions

Dear Claire, Thank you for your response. I know you will thoroughly enjoy the Gardens. Last year one of my students was on the Texas A&M research vessel in August for the coral spawn to take video. I hope you get the chance to see the same event. -- Best Regards, Candy

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From Mary Alice, About the Olympic Peninsula and Sanctuary

Greetings: I am a high school Oceanography/Marine Biology teacher who, together with my husband, will be vacationing on the Olympic coast of Washington next week. What can we see of the Olympic Coast Marine Sanctuary from the shore? I have been working on a "virtual tour" of the National Marine Sanctuary System to use with my students,

Broad rocky inter tidal zones and offshore islands create complete wildlife habitat-rich feeding zones for fish, and invertebrates as well as nest and perch habitats for watchful bald eagles and peregrine falcons. (Photo coutesy of Olympic Coast National Marine Sanctuary)

and I am anxious to actually see one for myself. The Flower Garden Banks NMS off the Louisiana/Texas coast is not accessible except to divers, so this will be my first "real" visit. If you could tell me who to speak to when we get there, or even if there is a visitor's center or anything to look for it would be helpful. We are leaving Wednesday June 30. Thank you for any suggestions you can offer. -- Sincerely, Mary Alice L. Cain, East Jefferson High School, Metairie, Louisiana

Dear Mary: Thank you for taking the time to find out more about the National Marine Sanctuary Program and all that it offers. Your visit to the Olympic Peninsula and the Olympic Coast National Marine Sanctuary (OCNMS) can be supplemented by calling the OCNMS office in Port Angeles, WA @ 360/457-6622. Nancy Beres is a good point of contact for additional information on the Sanctuary and she may be able to better direct you to a visitor's center of sorts. Off the coast of the peninsula, many different types of cetaceans can be found along with some great museums put together by local Indian tribes. Nancy or someone else at the OCNMS office should have significantly more information for you. / I am able to send you additional information about the Sustainable Seas Expeditions and the National Marine Sanctuary Program for your students. If interested, please send me an email with your contact information and I will send along a package of helpful information for teaching. -- Thanks again for your interest, Claire Johnson, Sustainable Seas Expeditions

Dear Claire: I appreciate your giving me a point of contact. I am going to call her this morning and see if we can set up something during our visit. It was also helpful to know that the local Indian tribes welcome visitors. We knew there were a number of tribal lands located along the coast, but were unsure about their reception of guests. We will be taking the ferry from Victoria to Port Angeles, so we will be in the area you mentioned. I would be grateful for any information about your program. I am developing my curriculum as we go along, and I am looking for material to make it relevant as well as exciting. Thanks again. We're packed up and leaving early tomorrow morning. -- Sincerely, Mary Alice

L. Cain

Dear Claire: Well, the wanderers have finally returned to the steamy south. We had a wonderful time in your part of the world. The Olympic peninsula is gorgeous. We made our way from Seattle up to Vancouver, over to the island to see Pacific Rim National Park. We drove down the entire coast of Washington, stopping at every western side entrance to the park. We saw the rainforests and could not believe the size of the trees. The Hall of Mosses was just as spectacular as everyone said. It was like being transported to another time in earth's history. You almost expected (maybe hoped) to see some strange creature peeking out from around every tree. The coast is so unspoiled. It was all really great. Well, I hope I haven't bored you with vacation stuff. I really appreciated the things you sent me, and I will put them to good use this fall. Keep in touch. -- Sincerely, Mary Alice Cain

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Nice Wishes from Nice People

My name is Ken Love and I have been following your work via the Internet...it's great and I wish you lots of success!! -- Ken Love

My wife and I enjoyed the opportunity to observe your underwater vehicles on display in Port Angeles. The willingness of members of your staff to share their enthusiasm about your work made the experience rather memorable for us. Thank you for sharing your work with us land folk! -- Bob & Sue

Children are the reason we have these events. Through our actions we can encourage them to become stewards of the earth's resources.

SSE Folks: Thanks for the great Web site. It's been keeping me entertained and informed for quite awhile. Wish I could have visited the team in Monterey, but was unaware of the project or the outreach until the Monterey Bay National Marine Sanctuary portion had been completed. Best wishes to all involved. -- J. Yasaki

I am the Public Information Officer of the North Carolina Aquariums and have been following the Sustainable Seas Expeditions with great interest. Your Web site is fantastic! -- Public Information Officer

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To submit additional comments, please send an email to:

SSEcomments@noaa.gov

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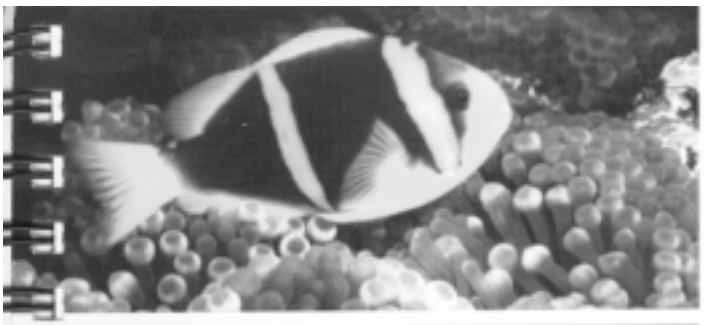
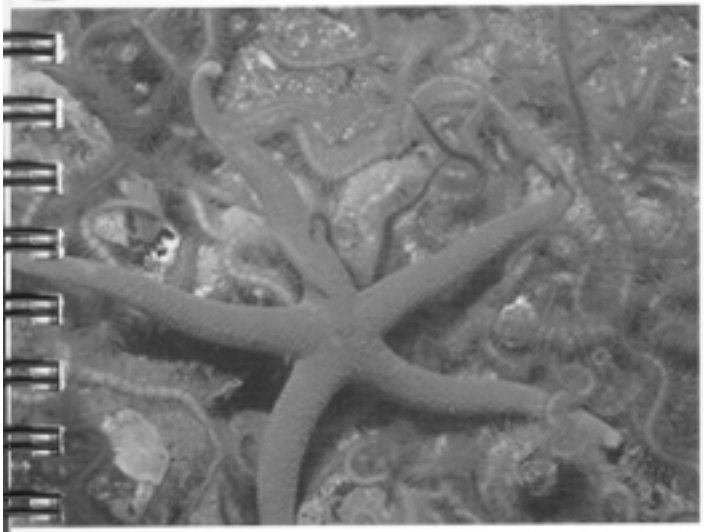
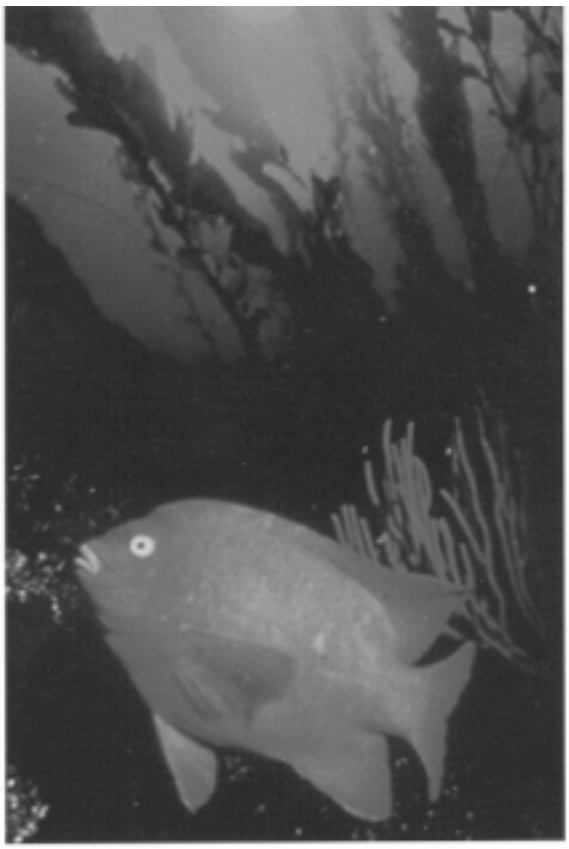
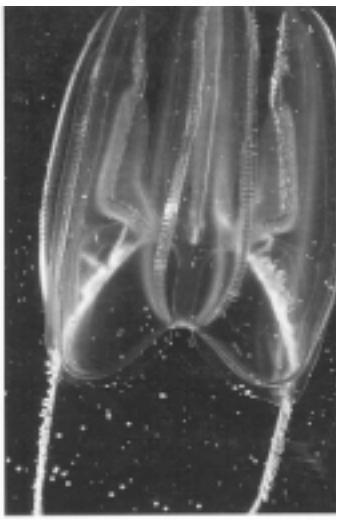
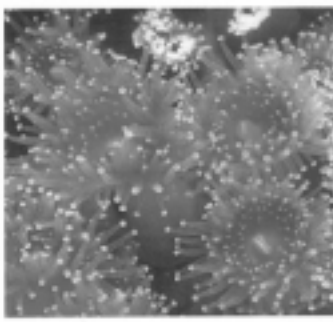
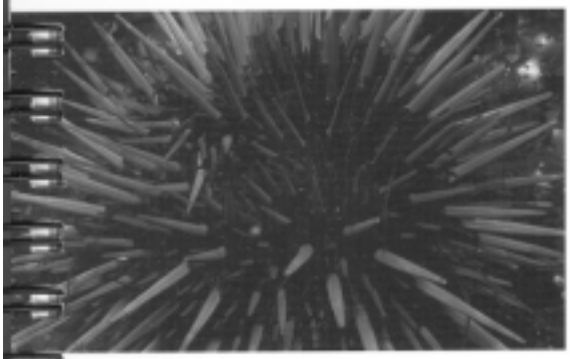
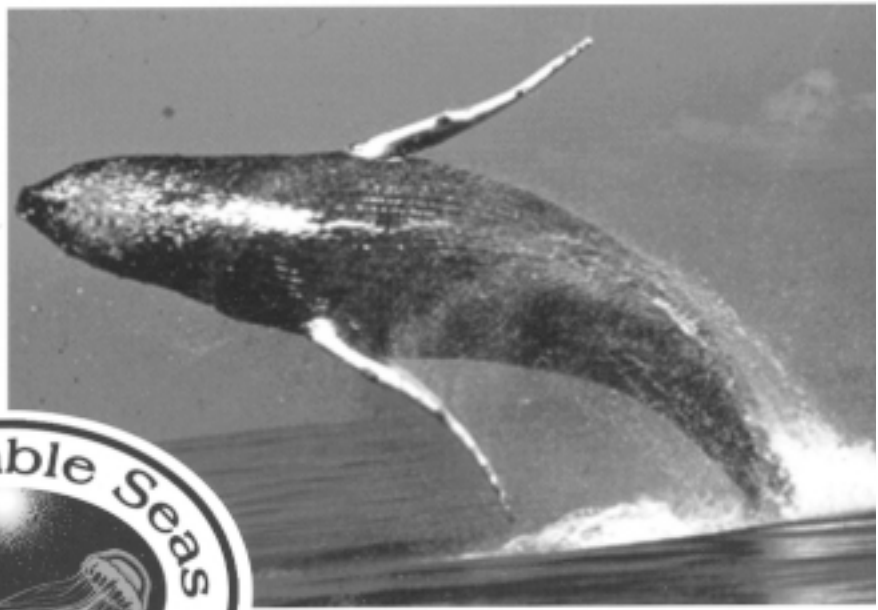
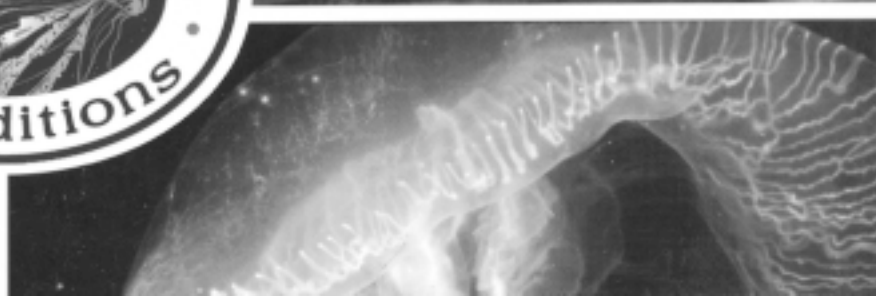







Sustainable Seas Expeditions

Teacher Resource Book



Sustainable Seas Expeditions

Teacher Resource Book

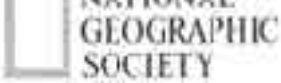


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Table of Contents

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Introduction to Sustainable Seas Expeditions

Kelp forest © JAMES FORTE

by Dr. Sylvia Earle

NATALIE FOBES © 1998 NATIONAL GEOGRAPHIC SOCIETY

Dr. Sylvia Earle

Throughout my career as a scientist and ocean explorer, I have dreamed of making ocean exploration and research accessible to more people. Blessed, as I have been, with the ability to go into the ocean, see its marvels and puzzle over its mysteries, I come back from every dive longing for others to have such experiences. Children, fellow researchers, politicians, poets—anyone and everyone should have a chance to explore this ocean planet. With new insights personally gained, there is hope that we will be inspired to do what it takes to protect the natural systems that support us.

In 1998, the National Geographic Society invited me to become their "Explorer-In-Residence." Partly, I think, because of my experiences. But also because of my dream to use research and exploration as a way to energize as many new "Ocean Citizens" as possible. A little later, the National Geographic Society, the National Oceanic and Atmospheric Administration (NOAA), and the Richard & Rhoda Goldman Fund announced an exciting and unprecedented mission into the oceans. With a five million dollar grant from the Goldman Fund and additional support from the Society, the *Sustainable Seas Expeditions*, a five-year project of ocean exploration and conservation focusing on NOAA's national marine sanctuaries, was launched.

These 12 marine sanctuaries represent the best of the best of our nation's marine environments. Like our country's other crown jewels—the national parks—they are a legacy of our people and our ideals. They are the inheritance that we pass on to our children, and they to theirs. The sanctuaries contain some of the most important working parts of our ocean life support system—the sheer abundance of species, the processes that sustain us, the substances of tomorrow's medicines, and perhaps, the very secrets of life itself.

Ranging from American Samoa to New England, they include Pacific and Atlantic haunts of whales, sea lions, sharks, rays, and turtles; the overwhelmingly complex communities of coral reefs and lush kelp forests; the remains of numerous historically-valuable shipwrecks including the Civil War *Monitor* off North Carolina—and who knows what else.

Beginning in April 1999, I will lead the expeditions to these protected areas, using DeepWorker 2000, a tiny one-person submersible capable of exploring 600 meters (2,000 feet) beneath the surface. This innovative submersible technology will let us:

- Conduct the first sustained piloted exploration of the sanctuary system to depths of 600 meters (2,000 feet).
- Capture on tape and film the natural history of each sanctuary's algae, plants, and animals.
- Pioneer new methods to monitor and document the long-term health of the marine sanctuaries.

Ultimately, with state-of-the-art exploration made possible by the DeepWorker, people will see images and video of the ocean's deep realms. From inside this small craft, DeepWorker pilots will experience and share a sense of the ocean from within, the way astronauts reported their view of Earth from space, and opened new horizons for us all. These small spacecraft-like submarines are magnets to children and veteran explorers alike. By seeing the DeepWorker subs up close at open houses and other public events, *Sustainable Seas Expeditions* will fuel imaginations and foster support for marine sanctuaries and conservation of our oceans.

The depths of our ocean are as uncharted as the vast interior of North America when President Thomas Jefferson sent Lewis and Clark to explore and record the unknown resources of the American West. *Sustainable Seas Expeditions* can produce significant discoveries and extraordinary educational experiences for millions through books, videos, and the Internet. In addition, the data gathered during the *Expeditions* will provide stronger foundations for marine research and conservation policies.

Whatever else we achieve, the ultimate success will be to dispel ignorance about the sea. Of all the ocean's problems, what we don't know poses the greatest threat. My goal is to push that frontier of ignorance further and deeper—and to return to the surface brimming with knowledge. Because with knowing comes caring, and with caring comes the hope that an ocean ethic will arise that will secure a sustainable future for ourselves, our children, and for the seas.

The success of the *Sustainable Seas Expeditions* depends on many fellow ocean explorers. To date, the Society and NOAA have been joined by the United States Navy, National Aeronautics and Space Administration (NASA), Monterey Bay Aquarium Research Institute (MBARI), Mote Marine Laboratory, Center for Marine Conservation, the National Science Teachers Association, and SeaWeb—and the list continues to grow. Join me and the 60 other DeepWorker pilots and scores of support technicians, vessel crew members, scientists, resource managers, and other *Sustainable Seas Expeditions* team members as this dream becomes reality.

Sustainable Seas Expeditions Web Sites

Orange sea star with brittle stars © JAMES FORTE

Two web sites host information about *Sustainable Seas Expeditions*. The official *Expeditions* site reports day-to-day activities. The second site, NOAA's national marine sanctuaries web site, contains a wealth of information about the sanctuaries and *Sustainable Seas*. These sites offer dynamic research tools that students and teachers can use to explore our nation's marine sanctuaries and follow *Sustainable Seas Expeditions* exploration and research as it happens. The major components of the two sites follow.

1. **The *Sustainable Seas Expeditions* Web Site** (http://sustainableseas.noaa.gov)

   This site hosts the most current day-to-day activities taking place during the *Sustainable Seas Expeditions* missions. It includes features such as:

   About Sustainable Seas—Describes the *Sustainable Seas Expeditions* program;

   Technology—Showcases the DeepWorker submersible and other technology such as NOAA ships and camera equipment;

   Online Calendar—Provides schedules of events including *Expeditions* schedules, open houses, Sanctuary Summits, web chats, webcasts, and other opportunities at the sanctuaries;

   Mission Logs—Reports the ongoing story of *Sustainable Seas Expeditions* including events, discoveries, and adventures of the mission participants; background essays about each expedition; interviews with sanctuary managers; site characterizations of each sanctuary; and natural and cultural resources of the region.

2. **The National Marine Sanctuaries Web Site** (http://www.sanctuaries.noaa.gov)

   This site provides comprehensive information about NOAA's national marine sanctuaries. It includes general information about the marine sanctuaries program, specific information about the sanctuaries, and links to each one. This site also includes an entire section on *Sustainable Seas Expeditions*. Features of this site include:

   Science Investigations—Describes in detail the individual *Sustainable Seas Expeditions* missions at each sanctuary, the scientific projects related to these dives, and profiles of the scientists;

   Maps and Data—Provides maps and data collected by *Expeditions* scientists which students can use in tracking the scientific investigations or plotting and monitoring real data. Maps of sea surface temperature will be available for each sanctuary as well as

three-dimensional renderings of DeepWorker's undersea path;

Education—Provides an updated calendar of *Sustainable Seas Expeditions* education and outreach activities at each sanctuary, descriptions of Sanctuary Summits and student projects, teacher workshops, sample activities, and an extensive resource and reference list;

Photo Gallery—Displays stunning images that tell the story of each sanctuary. Images are categorized into The Living Sanctuary, Habitats, *Sustainable Seas Expeditions*, and People in the Sanctuary. The Gallery will also include a collection of student drawings.

NATIONAL MARINE SANCTUARIES

Student drawing

Background Information

Siphonophore

The following articles provide background information that will be helpful when working with your students on the Investigations that follow. Each Investigation references one or more articles; some activities require students have their own copies of them to review.

NOAA's National Marine Sanctuaries

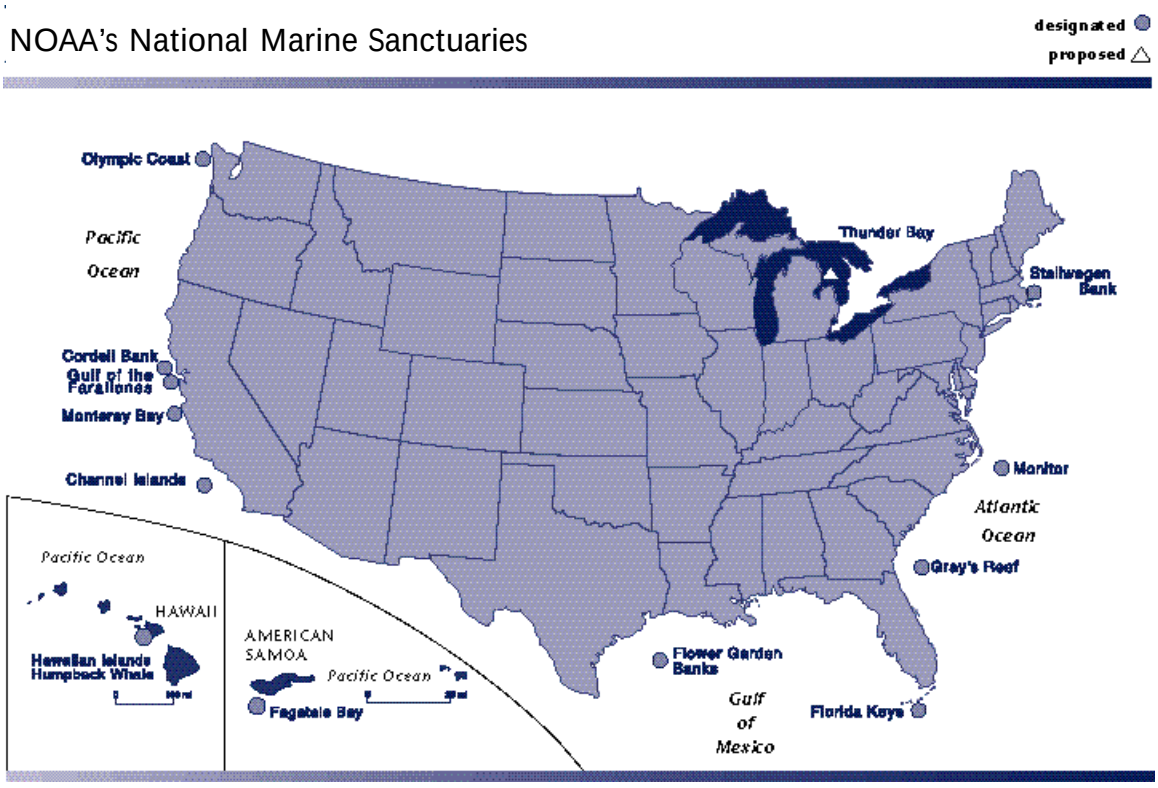
"Today, marine sanctuaries are places in the sea, as elusive as a sea breeze, as tangible as a singing whale. They are beautiful, or priceless, or rare bargains, or long-term assets, or fun, or all of these and more. Above all, sanctuaries are now and with care will continue to be 'special places.' Each of us can have the pleasure of defining what that means."

—Dr. Sylvia Earle

WHAT ARE MARINE SANCTUARIES?

In 1972, as Americans became more aware of the intrinsic ecological and cultural value of our coastal waters, Congress passed the Marine Protection, Research and Sanctuaries Act. This law authorizes the Secretary of Commerce to designate our most cherished marine waters as national marine sanctuaries, in order to protect and manage their priceless resources.

In the years since that time, 12 national marine sanctuaries have been created. They include nearshore coral reefs and open ocean, rich banks and submarine canyons, intertidal areas, and sheltered bays. National marine sanctuaries range in size from less than a neighborhood (Fagatele Bay, American Samoa—0.6 square kilometers or 0.25 square miles) to larger than the state of Connecticut (Monterey Bay—13,800 square kilometers or 5,328 square miles). Sanctuaries harbor a dazzling array of algae, plants, and animals. These protected waters provide a secure habitat for species close to extinction; and they protect historically significant shipwrecks and archaeological sites. They serve as natural classrooms for students of all ages and as living laboratories for scientists.



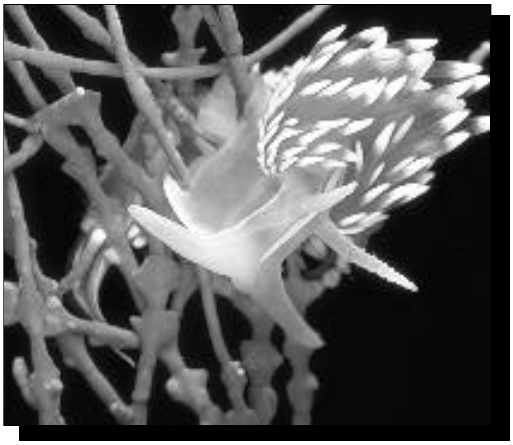
Sanctuaries are cherished recreational spots for diving, wilderness hiking, and sport-fishing. They also support valuable commercial industries such as marine transportation, fishing, and kelp harvesting. The perpetual challenge of managing these areas is maintaining the critical balance between environmental protection and economic growth.

SANCTUARIES FOR ALL

But a sanctuary's true definition lies in the eyes of the beholder. To a scientist, a sanctuary is a natural laboratory. To a motel operator along the shore, it is a national commitment to keep the nature of the ocean healthy, and thus attractive to visitors. To schoolchildren of the area, a sanctuary is a special playground—a place to explore and discover. To environmental engineers charged with restoring damaged ecosystems, a sanctuary is a yardstick against which they can gauge "good health." Fishermen, however, might see the sanctuary as a threat to traditional freedoms, yet upon reflection, realize that it is the best hope for maintaining their way of life.

Trying to meet these needs leaves many unanswered questions. How large does a sanctuary need to be in order to protect the ecosystems that lie within? How much pressure can an ecosystem sustain from activities bordering its boundaries? How many fish can we take while ensuring a healthy population for the long term?

National marine sanctuaries represent our riches as a nation. They are treasures that belong to every citizen, and to every generation of citizens to come. We have the right to enjoy them and—just as importantly—the responsibility to sustain them for the long-term.



Nudibranch

Exploring—For Answers

EXPLORERS FROM THE BEGINNING

We are all explorers. Our first journeys begin before we can move, when, as infants, our field of vision begins to take in the shapes and forms around us, patterns of light and dark on the walls, the features of our mother and father's faces. Gradually, our senses sharpen and we acquire halting mobility, the ability to crawl to the grass's edge, to toddle toward a puddle, to enter a nearby wood. As our means to travel become more sophisticated, we venture further abroad—a bicycle, we discover, carries us for kilometers; a city bus, across town; the family station wagon, across the state; a backpack, into the wilderness. And as we grow physically in our capability to go places, our minds begin journeying too.

Gradually, we come to know the lore of travel, of exploration. We learn about the Great Explorers—Winken, Blinken and Nod in their shoe; Huckleberry Finn on his Mississippi River; Odysseus over the "wine-dark seas"; Marco Polo to the palaces of Cathay; Lewis and Clark across the distant Rockies; Neil Armstrong to the moon. In turn, we become them. We listen raptly to their exploits, pore over their journals, memorize their footsteps—and missteps—challenge ourselves to meet their challenges and grow the personal boldness it takes to enter into explorers' lives.

TIMES CHANGE

All too soon, however, the universal explorer in most of us begins to stay at home. We turn our attention to practical matters; perhaps we become satisfied with that at hand. Our concentration narrows and we master finer skills. We learn our lessons and come to value personal safety above risk, security above uncertainty. Internally, we map a landscape of the familiar and live most of our lives within it.

But not everyone. There is a certain lure that motivates explorers beyond. Sir George Mallory, the British mountaineer who explored—and vanished—in the Himalayas, was motivated to climb Mt. Everest "because it's there." But for others, needs emerge greater than their own—something honorable to their nation, or to humanity as a whole. As we close the 20th Century, it is clear that the world's oceans—explored and charted for hundreds of years—require a new kind of exploration if they are to survive as our planetary life-support systems.

EXPLORING THE SEAS

This new exploration is not about conquest of territory, or sovereignty over the ocean's wealth. It is the conquest over our ignorance of ocean ecosystems, and particularly, the deeper realms of our most precious marine areas, the national marine sanctuaries. ***Sustainable Seas Expeditions***, led by Dr. Sylvia Earle and Francesca Cava, continue the legacy of ocean exploration of Alexander the Great (reported to be the first person to descend into the sea to observe fish), of British scientists aboard the H.M.S ***Challenger*** (who discovered 4,417 new species in the 1870s), and Jacques Piccard (who manned the Trieste 10,912 meters, or 35,800 feet, deep in the Pacific in 1960).

The three-dimensional world under water represents one of the most challenging environments of all in which to work. Although we have adapted to nearly all conditions on Earth's surface, extreme cold, crushing pressure, and darkness deprive us of access to what amounts to nearly 90 percent of biosphere by volume. Even with technology, we gain mere glimpses of this interior living space on our planet. We snatch samples with collecting bottles or dredges suspended on cables; we probe with sound, studying pattern in the echoes; we pilot robot submarines with cameras. We skim the ocean's upper surface with scuba systems. Occasionally, we deploy the several dozens of submersibles in existence for the purpose of going and looking, in person.

We have explored less than one percent of the deep ocean floor and know less about many aspects of geophysical systems in the ocean than we know about the weather on Mars. This is particularly true in the dimly lit midwaters (below 100 meters, or 330 feet) and in the ocean abyss. We are only beginning to understand the geologic processes forming seafloor at the mid-ocean ridges, the communities of organisms that feed solely on chemicals produced in volcanic eruptions or gas seeps. But these features are pinpoints in an area covering 70 percent of our planet. Our experience studying them close at hand would be equivalent to having spent several hundred hours visiting five or six active volcanoes scattered about the continents.

KIP EVANS

Diver in kelp forest

THERE IS STILL MORE TO LEARN

Our explorations of the ocean's living systems are in their infancy. Of all the animal kingdom's phyla, many describe residents of the ocean. We know very little of this dazzling array of living things. Life evolved in the sea and few lifeforms were able to survive without water supporting their bodies. The sea continues to be our life support system and our own health is connected to it.

The species we know best are those we take most freely and which have the greatest utility for us as food, fertilizer, or other material use. In most cases, that knowledge is driven only by scarcity imposed by overuse. We take the time to understand only after we have brought a stock or species to the brink of extinction. What do we know of most marine invertebrates? What are the key species that bind deep ocean communities together? What are the pieces that simply cannot be removed without system collapse? These are questions with embarrassingly few complete answers.

FUTURE OF THE SEA

For most of our history, life in the oceans has been out of sight and out of mind. Yet dangerous signs of damage are now plainly visible. Biodiversity in our oceans is threatened; habitats are being altered; our actions on land are making the seas a sink for toxic chemicals. We need to explore the oceans in order to understand the intricate connections between our actions and the oceans' health. We need windows into this foreign world, observers who can visit and record, discover and monitor, watchers who can go and return, sharing the results of their explorations with the vast majority, who will never have such an experience.

Our best explorers have been those who purposely brought all of us along with them. Naturalist William Beebe, plumbing the ocean depths off Bermuda in 1934 in his bathysphere, broadcast live via the NBC Radio Network and followed with detailed articles in ***National Geographic*** magazine. The television era allowed millions to be with Astronaut John Glenn as he circled the Earth three times. The tickertape parade he enjoyed after that historic space exploration was as much a spontaneous celebration of our collective journey around the planet as it was the recognition of a new explorer-hero.

AN OPPORTUNITY TODAY

The ***Sustainable Seas Expeditions*** are your explorations—of your national marine sanctuaries. The inventors, technicians, researchers, ships' crews, pilots, and support staff who comprise the ***Sustainable Seas*** team are the tools by which you, too, embark on this historic exploration project.

Meet DeepWorker

AN OCEAN EXPLORER'S DREAM

DeepWorker 2000 is a one-person submersible about the size of a small car. This remarkable vehicle can dive to a depth of 600 meters (2,000 feet) and provide life-sustaining oxygen for its pilot for up to 100 hours (in an emergency—normal operations rarely exceed 12 hours). Without tethers or connecting lines to its support ship, DeepWorker gives its pilot amazing mobility and the gift of time—a precious commodity for humans in the underwater environment.

Because DeepWorker is a directly operated vehicle—or DOV—it moves independently of its surface support ship. The sub is driven by a trained pilot who may be a scientist, a technician, an explorer, or even a journalist, teacher, or poet. The sub's simple, yet sophisticated technology means that the pilot and the passenger are combined—one person can pilot the craft and still carry out observations and scientific experiments. Eliminating the second occupant from the sub reduces its weight, complexity, and the expense of operation.

DeepWorker's small size and light weight make it more mobile than most other submersibles. Measuring just over two meters long (eight feet), it fits easily on a truck or trailer for traveling overland. At the dock, it can be loaded on a ship with a relatively small crane; and at the dive site, the 1,300 kilogram (1.3-ton) sub can be launched with many types of common equipment. Older, heavier systems require dedicated launch machinery and usually dive only from a specially-constructed support ship. DeepWorker can be supported by many ships.

KIP EVANS, © NATIONAL GEOGRAPHIC SOCIETY

DeepWorker 2000

A TOUGH PLACE TO WORK

The physical environment under water requires any submersible vehicle to have five important features: a hull that resists collapse; a propulsion system for mobility; a ballast system to control ascent and descent; a life-support system for its occupant or occupants; and navigation and communication systems for orientation in the darkness and staying in touch with the surface.

PRESSURE HULL

The pressure hull, or external structure, of a deep diving submersible must be built to withstand incredible pressures. For every 10 meters (33 feet) a sub descends into the ocean, another 6.6 kilograms (14.7 pounds) of pressure is added to every six square centimeters (one square inch) of the capsule. At 600 meters (2,000 feet), the depth reachable by DeepWorker, the pressure is over 404 kilograms per six square centimeters (890 pounds per square inch). In order to resist collapsing under pressure, most submersibles are spherical. Forces applied to a sphere are equally distributed throughout its circumference, giving this shape incredible strength.

Most subs, including deep-diving craft like DeepWorker, Alvin, and Deep Flight, are not perfect spheres. If a portion of the sphere must be removed to accommodate other design features, such as battery pods or to create space for a pilot's comfort (like a leg-tube, or viewing dome) the strength can be replaced by inserting a thick, strong ring around the hole and attaching a cylinder or semi-spherical shape. Like spheres, cylinders resist pressure by distributing forces through the circumference. However, they are not as strong as spheres.

DeepWorker actually consists of several spherical, cylindrical, and semi-spherical pressure hulls. The main hull is a sphere (in which the pilot sits) with an attached cylinder on the bottom (for the pilot's legs) and an acrylic dome on top for viewing. The two battery pods (lower starboard and port sides), the junction box (lower rear), and the oxygen and air tanks (mounted on the back in a float pack) are cylinders. The acrylic dome also serves as a hatch to enter and exit the sub.

PROPULSION

DeepWorker is powered by two battery pods, each containing 10 high-ampere, deep-cycle batteries (similar to the ones used in motor homes). The sub can reach speeds of up to three knots. The batteries power two horizontal thrusters (for forward and reverse movement) and two vertical thrusters (for lateral movement), which are controlled by foot pedals inside the sub. To operate the sub, a pilot pushes on the pedals: the right pedal moves the craft in the horizontal direction. Toe down is forward. Heel down is reverse. A twist to the right turns you right and to the left turns you left. The left foot moves the craft down (toe down) or up (toe up). A twist to the right makes the sub walk sideways ("crabbing") to the right; twist to the left and it crabs left. Crabbing is like turning all four tires on a car 90 degrees—great for parallel parking or for moving sideways to examine the face of an underwater cliff.

BALLAST

In order to regulate its position up and down in the water and to remain a certain depth without rising or sinking, DeepWorker uses two forms of ballast systems—"soft" ballast and "hard" ballast.

Other submersibles use what is called a "soft" ballast system in which compressed air is released into an external tank to increase the craft's buoyancy and bring it back to the surface. At deep depths, air becomes so compressed by water pressure that it can take an entire tank to lift the sub off the bottom. In these systems, such as the DeepRover submersible, pilots must limit their up and down movements at depth to conserve air for the final ascent.

DeepWorker uses soft ballast together with another ballast system known as "hard" ballast. In the hard ballast system, colored water is contained within an enclosed small bladder outside the sub. After the pilot dumps all the air from the soft ballast tank in order to lower the sub below the surface, the sub remains slightly buoyant. To sink, the pilot opens a valve to allow a small amount of the colored water into the sub, which adds weight. The water begins to fill a tank in the pilot's seat, and the sub descends. When the sub is neutrally buoyant (neither sinking nor rising), the pilot shuts off the valve. This ingenious design allows the pilot to remain neutrally buoyant at any depth. Pilots can tell when they are neutrally buoyant by looking at minute particles drifting outside in the water column. When the sub hangs motionless in relation to the tiny organisms and debris that make up the "marine snow," the sub is neutrally buoyant.

LIFE SUPPORT

Water is essential for life. Yet, for many animals including humans, it is extremely toxic to breathe. Thus, the greatest limit to our ability to work in the ocean is the fact that we can't obtain enough oxygen from water to stay alive. Fortunately, inventors, engineers, and adventurers have figured out how to get oxygen into our lungs, and how to remove poisonous carbon dioxide from the air we exhale—even when we are on the bottom of the sea. Life support systems aboard DeepWorker include two separate oxygen systems and two carbon dioxide removal systems—one of each for normal use, the other as backup. These life support systems create a normal breathing environment inside the sub—at pressures comparable to your living room.

DeepWorker carries two oxygen cylinders outside of its main pressure hull and two mechanical controllers inside the hull where the percent of oxygen is monitored electronically. High pressure tubes and valves carry the

oxygen in special "through-hull" fittings into the main hull. A special regulator reduces the flow of oxygen to a trickle—about equal to the amount the pilot consumes in non-aerobic activity. As the pilot breathes in, oxygen goes into the lungs, replaced by oxygen regulated to trickle into the cabin. As the pilot exhales into the cabin, a small fan forces the air through a chemical filter, called a scrubber, removing dangerous carbon dioxide. Pilots frequently monitor the oxygen content of the cabin (it should be 20.8 percent), the pressure of the oxygen entering the hull, the pressure of the oxygen in the regulator, and the operation of the scrubber fan. In event of a failure of the primary system, the pilot simply switches to the backup.

Oxygen bottles and scrubber chemicals are changed after every dive, but DeepWorker's life support systems could provide nearly 100 hours of time under water if necessary.

NAVIGATION AND COMMUNICATION

On board, an integrated navigation system constantly sends signals to the support ship on the surface, tracking DeepWorker's whereabouts. Pilots overcome the natural limits of seeing long distances under water by using sonar—computer-sorted echoes that actually create visual images of the underwater landscape from sound. Powerful headlights illuminate the depths close to the sub. Other instruments determine the sub's depth and altitude off the bottom. To communicate with the mother ship, two communication systems are used: VHF radio while DeepWorker is on the surface; and a thru-water system that sends sound waves through the water to receivers on the ship above. Pilots and the surface support teams communicate regularly to confirm relative locations and the status of DeepWorker's life support and electrical systems.

DEEPWORKER'S TOOLS

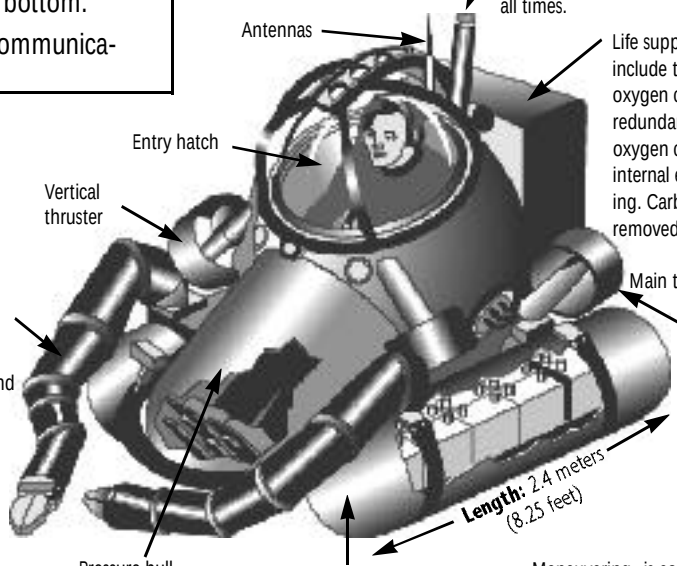
In addition to DeepWorker's design and life support systems, the sub also uses specialized equipment to document marine life, habitat characteristics, and to monitor physical factors such as temperature, the amount of light penetrating the sea, and water quality. Equipment for collecting this data includes:

- cameras (video and still);
- external lights that can be turned on and off;
- a CTD instrument that continuously records conductivity (to determine salinity), temperature, and depth;
- manipulator arms capable of reaching to 3.6 meters (12 feet);
- cable cutters on the arms to cut free from entanglement;
- suction samplers to collect sea water and animals;
- core samplers; and
- sample baskets for transporting organisms.

DeepWorker 2000

SPECIFICATIONS
Weight in air: 1,300 kilograms (1.3 tons)
Operating depth: 600 meters (2,000 feet)
Payload: 114 kilograms (250 pounds), including pilot
Life Support: 100 hours
Speed: 3 knots
Crew: 1 pilot

COMMUNICATION SYSTEMS include a modified Imaginex sonar, which allows standard scanning and ultra-high resolution for short range. Ocean sounds are recorded with a directional hydrophone. Video cameras allow the pilot to record the dive. VHF and thru-water communications allow contact with surface support personnel.



Sustainable Seas Expeditions Research

Over the next five years, the ***Sustainable Seas Expeditions*** will provide a unique opportunity to seek greater insight into what makes some of our nation's most important natural resources tick. ***Sustainable Seas Expeditions*** will use new submersible technology to undertake deep exploration of the nation's national marine sanctuaries to depths up to 600 meters (2,000 feet). The ***Expeditions*** will photodocument the natural history of each sanctuary's algae, plants, animals, and cultural resources, build on existing site characterizations, and in some cases, produce the best information to date on these protected areas.

Over the course of the project, ***Sustainable Seas Expeditions*** will help establish permanent monitoring field stations within the sanctuaries, and conduct other underwater investigations. These projects are critical to effective marine protection and conservation.

"***Sustainable Seas Expeditions*** has the potential to produce stunning scientific discoveries and extraordinary educational experiences for millions of people," said John Fahey, president of the National Geographic Society. "The data we gather will provide stronger foundations for marine research and for more sound marine conservation policies. Through new knowledge, we have the opportunity to create a 'sea change' in how Americans perceive—and care about—their coastal and ocean resources."

Putting ***Sustainable Seas Expeditions*** research into perspective requires understanding three important goals of the research projects:

- Understanding what is there by systematic exploration, mapping, and species inventories—a process known as site characterization;
- Looking at a place over time and making spatial comparisons to understand what changes are taking place, and why—a process known as monitoring;
- Assessing the potential of new tools, like Deepworker, in research and management of marine sanctuaries.

SITE CHARACTERIZATION

In order to understand any natural environment and make wise decisions that lead to its protection, sanctuary managers need several critical pieces of information. These include knowing what is there (the "parts" of an ecosystem such as the algae, plants, animals, water temperature, and so on), the ecosystem's condition in the past—or at least its condition now—and enough understanding of how the ecosystem works to predict future conditions given certain variables. These are all elements of what sanctuary managers call "site characterizations." Many of the sanctuaries will be conducting site characterizations as part of their ***Sustainable Seas Expeditions*** projects. (A more detailed description of these projects can be found beginning on page 16.)

Site characterizations provide managers with information that helps them make effective decisions when it comes to determining human activities in protected areas; setting agendas for research, monitoring, education, outreach, and enforcement programs; and using the most appropriate methods to restore an area, should that be necessary.

Site characterizations are detailed reports that contain information on an area's biological and physical environments, cultural history, and human use patterns. They chronicle the history of discovery and use, the record of scientific investigations, the pressures being placed on natural and

cultural resources, and the nature of attempts to protect the resources. Properly done, they are complete sources of current information for an area of particular interest.

When conducting site characterizations, there are a number of ways scientists document the presence and abundance of species relative to the environment's physical factors. One method is conducting vertical and horizontal transects.

Vertical transects in the sea are useful to define the ocean's layering system of physical and biological parts. Imagine dropping a line from one point in the water column down to another. Physical factors are then observed and recorded at various points along this line, or transect. Increments along the transect are usually evenly spaced, and when combined with similar transects in other locations, may reveal changes taking place due to water currents, upwelling, and other phenomena.

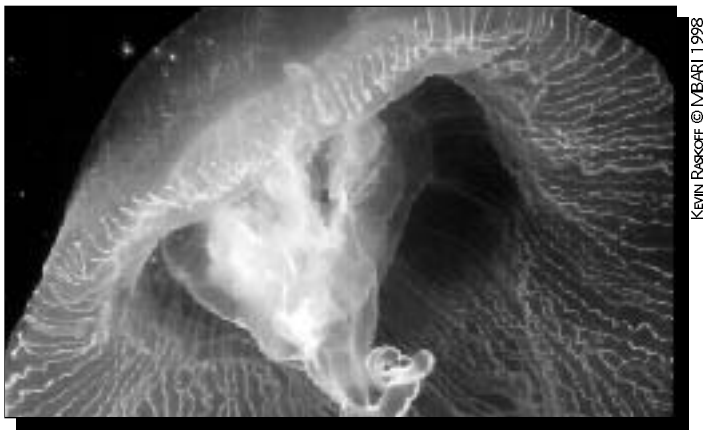
Horizontal transects are conducted similarly. These are most often used along the seafloor or at a particular depth. For instance, a horizontal transect at a depth of 600 meters might look for distribution of fish species close to a canyon wall compared to fish species at the same depth further from the wall.

Given the constraints of time and money, these techniques provide researchers with methods to construct models of an ecosystem while only studying small portions of it. The models help us understand how an ecosystem functions. They may describe the flow of energy through a system or they may allow us to predict the effects of natural or human-caused events on an ecosystem.

MONITORING

Monitoring programs are designed to detect changes spatially and over time—changes in physical conditions, changes in distribution or abundance of organisms, or changes caused by human actions and natural events.

Physical factors such as temperature and salinity measured as baseline data can form the foundation of a monitoring program. So can the presence or absence of a species, or age groups of a single species or entire groups of species. Habitats can be monitored to observe changes in structure, such as physical disturbance. In a monitoring project, observations are made or samples are taken—like "snapshots" of the habitat—on a regular basis, at various intervals depending on the type of information needed. Periodic reports of data compare snapshots against each other and against the baseline data. This information helps resource managers evaluate trends (systematic changes over time) or perturbations (sudden changes).



KEVIN RASKOFF © MBARI 1998

Deepwater jelly

Although the causes of these changes may not be apparent as a result of monitoring, they alert managers and suggest ways of studying, in closer detail, the causes of change.

ASSESSING RESEARCH TOOLS

In addition to supporting sanctuary site characterization and monitoring needs, the five-year ***Sustainable Seas Expeditions*** project and the newly developed submersible technology offer the scientific community a chance to evaluate the use of the new one-person sub. Nuytco Research Ltd. developed the lightweight DeepWorker submersible (900 kilograms, or 2,000 pounds) to operate almost as easily as remotely operated vehicles (ROVs), which are unmanned, underwater robots often used at these depths. As Nuytco founder Phil Nuytten puts it, the concept was to "take the ROV operator out of the control shack and put him in the ROV." With the potential of new discoveries beckoning and a new national commitment to assess and understand our ocean planet, the ***Sustainable Seas Expeditions*** promise new knowledge and new ways to gather knowledge over the next five years.

Diver explores coral formation

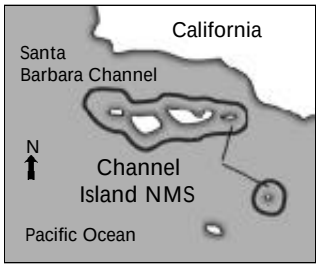
Harbor seal © W. E. Townsend

Sanctuaries and Their 1999 Investigations

A Look at the Sanctuaries

The nation's sanctuaries encompass sites that are either biologically, culturally, recreationally, aesthetically, or historically significant. In some ways similar to the national parks on land, each one has its own character, and each sanctuary is many things to many people, adding to their charm.

Channel Islands California



The waters that swirl around the five islands contained within NOAA's Channel Islands National Marine Sanctuary combine warm and cool currents to create an exceptional breeding ground for many species of algae and animals. Nearby forests of giant kelp provide a nutrient-rich environment for teeming populations of fish and invertebrates. Every year, over 27 species of whales and dolphins visit or inhabit the sanctuary including the rare blue, humpback, and sei whales. Seabird colonies and pinniped rookeries flourish on the islands; while overhead, Brown Pelicans and Western Gulls search the water for food.

Habitats

Kelp forests
Seagrass meadows
Rocky shores
Pelagic, open ocean
Sandy beaches
Deep rocky reefs

© Thomas M. Carey

Garibaldi in kelp forest

Key Species

California sea lion
Elephant seal
Harbor seal
Blue whale
Gray whale
Dolphins
Blue shark
Brown Pelican
Western Gull
Abalone
Garibaldi
Rockfish

Cultural Resources

Chumash Indian artifacts

Protected Area

4,294 square kilometers (1,658 square miles)

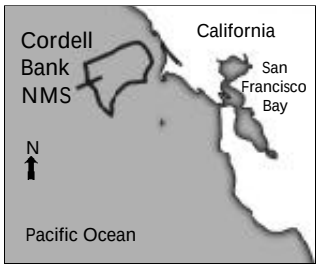
Sustainable Seas Expeditions Projects

The primary objective during the first year will be characterization of benthic habitats and their associated flora and fauna, including relationships between physical features and deep water biological communities. Future long-term moni-

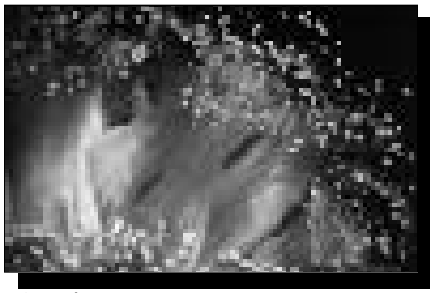
toring sites will be established to track the health of these deep sea areas.

Benthic habitats in and around reserves closed to fishing will be areas of focus. Experiments are currently being conducted and additional studies are being planned to test the effectiveness of reserves as nurseries for fishes. Additional projects include collecting data on the spawning grounds of market squid, an important fishery resource in the area.

Cordell Bank California



A region of astonishing productivity, NOAA's Cordell Bank National Marine Sanctuary surrounds a 6-by-14-kilometer (4-by-9-mile) submerged granite island on the very edge of the continental shelf. Lying just off the northern California coast, the Bank rises to within 35 meters (115 feet) of the sea surface with depths of 1,830 meters (6,000 feet) only a few kilometers away. The prevailing California Current flows southward along the coast and the upwelling of nutrient-rich, deep ocean waters stimulates the growth of organisms at all levels of the marine food web. Many marine mammals and seabirds rely on this area as their feeding ground.



Strawberry anemone

Habitats

Rocky subtidal
Pelagic, open ocean
Soft sediment continental shelf and slope
Submerged island

Key Species

Krill	Blue whale
Pacific salmon	Hydrocoral
Rockfish	Albatross
Humpback whale	Shearwater

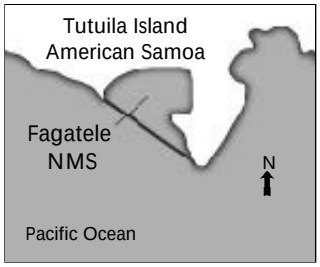
Protected Area

1,362 square kilometers (526 square miles)

Sustainable Seas Expeditions Projects

Investigations in the first year will focus on site characterization. The primary objective will be to survey the top of Cordell Bank and assess algae, invertebrate and fish populations, and habitat. A second objective will be to investigate fishing impacts on the Bank. (Cordell Bank has been identified as one of the most critical and fragile fisheries habitats in California.) Only the tops of the highest pinnacles have been mapped, and Cordell Bank remains relatively unexplored. Year-one missions will help inventory and characterize sanctuary resources by describing community structure at Cordell Bank and establishing monitoring sites and transects for baseline and long-term studies.

Fagatele Bay American Samoa



Located 14 degrees south of the equator, NOAA's Fagatele Bay comprises a fringing coral reef ecosystem nestled within an eroded volcanic crater on the island of Tutuila. Nearly 200 species of coral are recovering from a devastating crown-of-thorns starfish attack in the late 1970s which destroyed over 90 percent of the corals. Since then, new growth has been compromised by two hurricanes, several tropical storms, and coral bleaching. This cycle of growth and destruction is typical of tropical marine ecosystems.


Kip Evans
Sea stars

Habitat

Tropical coral reef

Key Species

Surgeon fish
Crown-of-thorns sea star
Blacktip reef shark
Hawksbill turtle
Giant clam
Parrotfish

Cultural Resources

3,000-plus-year-old thriving Polynesian culture originated in Samoa

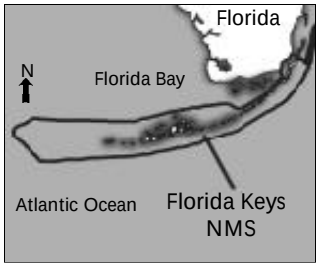
Protected Area

0.6 square kilometers (0.25 square miles)

Sustainable Seas Expeditions Projects

No projects planned for this year.

Florida Keys Florida



The Florida Keys marine ecosystem supports one of the most diverse arrays of underwater algae, plants, and animals in North America. Although the Keys are best known for coral reefs, there are many other significant interconnecting and interdependent habitats. These include fringing mangroves, seagrass meadows, hardbottom regions, patch reefs, and bank reefs. This complex marine ecosystem is the foundation for the commercial fishing and tourism-based economies that are so important to Florida.

Habitats

Coral reefs
Patch and bank reefs
Mangrove-fringed shorelines and islands
Sand flats
Seagrass meadows

Key Species

Brain and star coral
Sea fan
Loggerhead sponge
Turtle grass
Angelfish
Spiny lobster
Stone crab
Grouper
Tarpon

Cultural Resources

Historic shipwrecks

Historic lighthouses

Mangroves

Protected Area

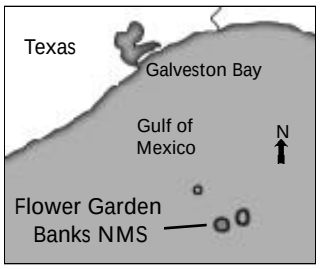
9,515 square kilometers (3,674 square miles)

Sustainable Seas Expeditions Projects

Investigations in the first year will focus on assessment of the fate and effects of artificial reefs and exploration and characterization of coral reef habitat that cannot be researched by conventional diving techniques. Several artificial reefs, which are usually large sunken vessels, recently have or will soon be established in the sanctuary. Use of such reefs in resource management is controversial. Some believe artificial reefs increase fish populations or lessen human use of natural reefs. Others believe they detract fish from their natural communities or are equivalent to dumping waste in the ocean. There is a lack of long-term monitoring data for artificial reefs in the sanctuary to support or refute these arguments. Investigations will establish a baseline for future monitoring of long-term stability and ecological impacts of these artificial reefs.

Deep water exploration of coral reefs will be conducted to expand present knowledge of sanctuary resources and provide information important to understanding ecosystem health. This work will focus on three reef areas including Tortugas Banks which is proposed as a Special Protection Area. Data will serve as a baseline to monitor future changes.

Flower Garden Banks Texas/Louisiana



One hundred sixty-one kilometers (100 miles) off the coasts of Texas and Louisiana, a trio of underwater salt domes emerge from the depths of the Gulf of Mexico. Lush gardens of coral blanket the domes. This premiere diving destination harbors the northern-most coral reefs in the United States and serves as a regional reservoir of shallow-water Caribbean reef fishes and invertebrates. For a few nights each August, in association with the full moon, the corals undergo a mass spawning, releasing billions of gametes into the water in a spectacular display.

Habitats

Coral reefs
Pelagic, open ocean
Algal-sponge communities
Sand flats
Artificial reef
Brine seep

Key Species

Star coral
Brain coral
Manta ray
Hammerhead shark
Loggerhead turtle

Protected Area

145 square kilometers (56 square miles)

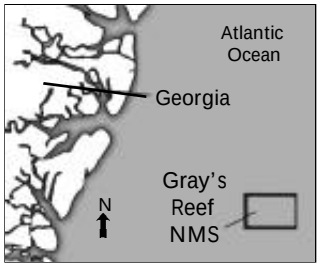
Sustainable Seas Expeditions Projects

Investigations in the first year will focus on reproductive biology of mass spawning corals and characterization of deep habitats, specifically brine seeps and grabens. (Grabens are areas of collapsed substrate.) Since 1990, coral spawning research has focused on identifying participating organisms, recording their behavior, and capturing genetic material for fertilization and development studies. Researchers are now interested in determining gene flow among reef sites throughout the western Caribbean and Gulf of Mexico. Year-one missions will conduct uninterrupted observations throughout the coral spawning period, conduct observation of coral spawning in habitat deeper than previously observed, and collect gamete samples.

Studies of the Banks' deep habitats are currently limited to work conducted in the 1970s. Areas of special interest include brine seeps and grabens. The Flower Garden Banks are surface expressions of underlying salt domes, pushed up as portions of 160-million-year-old salt layers rise through the seabed. Seawater percolating through the porous carbonate bank to the level of the salt dome produces brine seepage, most notably on the East Flower Garden Bank where water is seven times saltier than overlying seawater. The unusual chemistry of brine seeps gives rise to bacterial-based food chains we know little about. As salt layers dissolve, grabens form. The DeepWorker will be used in a comprehensive exploration of these unique habitats. Missions will likely significantly increase the number of species reported to date.

Coral spawning

Gray's Reef Georgia



Just off the coast of Georgia, in waters 20 meters (66 feet) deep, lies one of the largest near-shore sandstone reefs in the southeastern United States. The area earned sanctuary designation in 1981, and was recognized as an international Biosphere Reserve by UNESCO in 1986. NOAA's Gray's Reef National Marine Sanctuary consists of sandstone outcroppings and ledges up to three meters in height, with sandy, flat-bottomed troughs between. Because of the diversity of marine life, Gray's Reef is one of the most popular sport fishing and diving destinations along the Georgia coast.

Habitats

Calcareous sandstone
Sand bottom communities
Tropical/temperate reef

Key Species

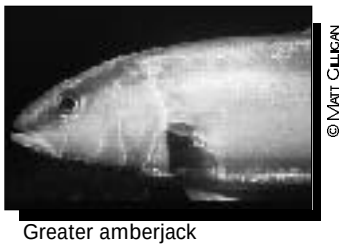
Northern right whale	Angelfish
Loggerhead turtle	Barrel sponge
Grouper	Ivory bush coral
Black sea bass	Sea whips

Protected Area

60 square kilometers (23 square miles)

Sustainable Seas Expeditions Projects

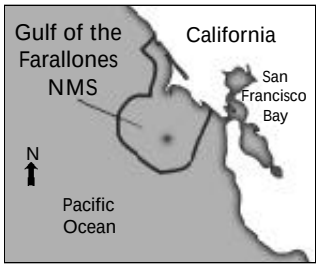
Investigations in the first year will focus on studies of paleoenvironmental and archaeological resources and characterization of deep water fishes. Previous undersea exploration at Gray's Reef has found rich and unexpected potential for significant new finds of both a paleontological and archaeological nature. These findings include fossilized remains of nearly 12 extinct mammals from the last glacial period (the Pleistocene).



Greater amberjack

Fish surveys will be conducted using standard survey methods and data forms developed by Reef Environmental Education Foundation (REEF). The REEF Fish Survey Project is designed to provide information necessary to assess the long-term trends of fishes in popular recreation areas such as national marine sanctuaries. DeepWorker and scuba diving missions will collect data on the presence/absence, frequency of occurrence, and relative abundance of fishes in the sanctuary.

Gulf of the Farallones California



NOAA's Gulf of the Farallones National Marine Sanctuary includes nurseries and spawning grounds for commercially valuable species, at least 33 species of marine mammals, and 15 species of breeding seabirds. One quarter of California's harbor seals breed within the sanctuary. The Farallon Islands are home to the largest concentration of breeding seabirds in the continental United States. The sanctuary boundaries include the coastline up to mean high tide, protecting a number of accessible lagoons, estuaries, bays, and beaches for the public.

Habitats

Sandy beaches	Pelagic, open ocean
Rocky shores	Esteros
Mud and tidal flats	Salt marsh
Rocky subtidal	

Deep benthos, continental shelf and slope

Key Species

Dungeness crab	Common Murre
Gray whale	Ashy Storm-petrel
Steller sea lion	White shark
Short-bellied rockfish	Pacific sardine

Cultural Resources

Shipwrecks
Fossil beds

Protected Area

3,250 square kilometers
(1,255 square miles)

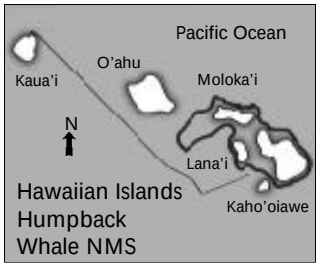
© W.B. Evans

California sea lion

Sustainable Seas Expeditions Projects

Investigations in the first year will focus on site characterization. The primary objectives will be to characterize subtidal habitats and assess algae, invertebrate, and fish populations. Previously, the presence of white sharks has prevented systematic investigations of the subtidal environment in this area. DeepWorker will be used to establish transects for documenting species composition and abundance. Special attention will be given to assessing red abalone abundance and creating a species list of subtidal algae.

Hawaiian Islands Humpback Whale Hawaii



The shallow, warm waters surrounding the main Hawaiian Islands constitute one of the world's most important humpback whale habitats. Scientists estimate that two-thirds of the entire North Pacific humpback whale population migrates to Hawaiian waters each winter to engage in breeding, calving, and nursing activities. The continued protection of humpback whales and their habitat is crucial to the long-term recovery of this endangered species.

Habitats

Humpback whale breeding, calving, and nursing grounds
Coral reefs
Sandy beaches

Key Species

Humpback whale
Pilot whale
Hawaiian monk seal
Spinner dolphin
Green sea turtle
Trigger fish
Cauliflower coral
Limu

Cultural Resources

Native Hawaiian practices
Native Hawaiian fish pond
Archaeological sites
Historic shipwrecks

Protected Area

3,367 square miles (1,300 square miles)

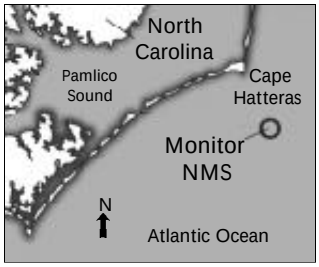
© Dan Salden

Humpback whale

Sustainable Seas Expeditions Projects

No projects planned for 1999.

Monitor North Carolina



On January 30, 1975, the nation designated its first national marine sanctuary. The site was the wreck of the USS *Monitor*, a Civil War vessel that lies 26 kilometers (16 miles) southeast of Cape Hatteras, North Carolina. The *Monitor* was the prototype for a class of U.S. Civil War ironclad, turreted warships that significantly altered both naval technology and marine architecture in the nineteenth century. The *Monitor* was constructed in a mere 110 days. At 70 meters (230 feet) deep, it is beyond reach for most people to visit. However, this artificial reef provides a home for many animals, including sea anemones, sea urchins, and a host of fishes.

Amberjacks living in the wreck

Habitats

Pelagic, open ocean
Artificial reef

Key Species

Amberjack
Black sea bass
Red barbier
Scad
Sea anemones
Dolphin
Sand tiger shark
Sea urchins

Cultural Resources

The remains of the Civil War ironclad USS *Monitor*

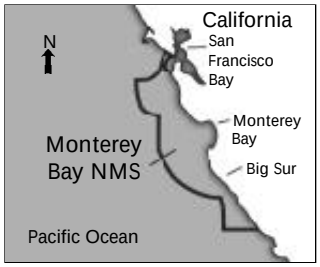
Protected Area

2.6 square kilometers (1 square mile)

Sustainable Seas Expeditions Projects

No projects planned for 1999.

Monterey Bay California



Monterey Bay, the largest of NOAA's marine sanctuaries, hosts a rich array of habitats. Within its boundaries lie rugged rocky shores, lush kelp forests, and one of the deepest underwater canyons on the west coast. The canyon cuts more than 3,500 meters (2 miles) deep and reaches nearly 100 kilometers (60 miles) out to sea. Sanctuary habitats abound with life, from tiny plankton to huge blue whales. With its great diversity of habitats and life, the sanctuary is a national focus for marine research and education programs.

Habitats

Sandy beaches
Rocky shores
Kelp forests
Submarine canyon
Pelagic, open ocean
Wetlands

Key Species

Sea otter
Gray whale
Market squid
Brown Pelican
Rockfish
Giant kelp

Cultural Resources

Indian midden sites
Naval airship USS *Macon*

Protected Area

13,798 square kilometers (5,328 square miles)

Monterey coastline

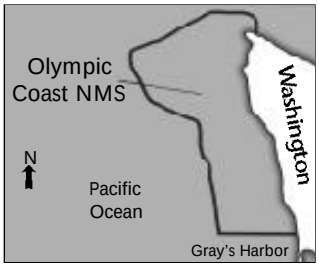
Sustainable Seas Expeditions Projects

Investigations in the first year will focus on monitoring fish populations at Big Creek Ecological Reserve (BCER); characterizing mid-water and deep sea day-night activity patterns in the Monterey Canyon; and studying the ecology of prickly sharks. A baseline of benthic habitats and fauna has already been established for BCER, but long-term monitoring is critical in evaluating this reserve's effectiveness. Relative abundance, species composition, and size structure of fishes relative to depth and habitat type in BCER and adjacent unprotected areas will be quantified.

The distribution and abundance of midwater fish and invertebrates will be assessed, comparing observations from DeepWorker with those made from a remotely operated vehicle, the Ventana.

The ecology of prickly sharks (*Echinohinus cookei*) will also be investigated. Monterey Canyon is the only place that prickly sharks have been observed and tagged in large numbers. It is not known whether prickly sharks reside in the canyon or stop there along a migratory route. Also, very little is known about the sharks' behavior and habitat preferences.

Olympic Coast Washington



NOAA's Olympic Coast National Marine Sanctuary spans 8,570 square kilometers (3,310 square miles) of marine waters off the rugged Olympic Peninsula coastline. The sanctuary averages approximately 56 kilometers (35 miles) seaward, covering much of the continental shelf and protecting habitat for one of the most diverse marine mammal faunas in North America. It is also a critical link in the Pacific Flyway. The sanctuary boasts a rich mix of cultures, preserved in contemporary lives of members of the Quinault, Hoh, Quileute, and Makah tribes.

Habitats

Rocky and sandy shores
Pelagic, open ocean
Seastacks and islands
Kelp forests

Key Species

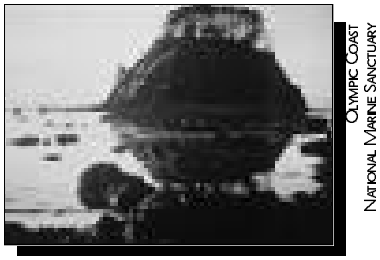
Tufted Puffin
Bald Eagle
Northern sea otter
Gray whale
Humpback whale
Pacific salmon
Dolphin

Cultural Resources

Native American petroglyphs and villages
Historic lighthouses
Shipwrecks

Protected Area

8,572 square kilometers (3,310 square miles)



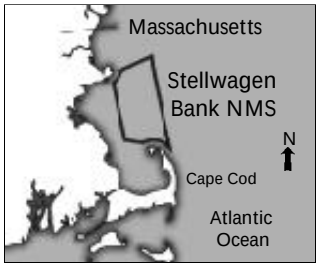
Tskawahyah Island

Sustainable Seas Expeditions Projects

Investigations in the first year will focus on locating and exploring habitats and species in the deep sea and assessing the impacts of varying degrees of commercial fishing. Little is known about deep sea fisheries, yet commercial fishing is one of the most significant activities in this sanctuary. Researchers will expand on work already begun to map trawlable and untrawlable habitats and estimate fish densities in them. First, fish attraction and avoidance experiments will be conducted to test the validity of undersea video fish counts. Fish and invertebrate populations will also be surveyed. Investigators hope to compare control, lightly trawled, and heavily trawled sites.

Researchers will also characterize physical and geological features and associated biological communities of areas that have not been well studied, such as submarine canyons, faults, diapirs, and other parts of the continental shelf. The unique physical and chemical features of these deep sea habitats will likely give rise to unusual biological communities.

Stellwagen Bank Massachusetts



Formed by the retreat of glaciers from the last Ice Age, Stellwagen Bank consists primarily of coarse sand and gravel. Its position at the mouth of Massachusetts Bay forces an upwelling of nutrient-rich water from the Gulf of Maine over the bank—leading to high productivity and a multi-layered food web with species ranging from single-celled phytoplankton to the great whales.

Habitats

Sand and gravel bank
Muddy basins
Boulder fields
Rocky ledges

Key Species

Northern right whale
Humpback whale
White-sided dolphin
Storm Petrel
Northern Gannet
Bluefin tuna
Atlantic cod
Winter flounder
Sea scallop
Northern lobster

Cultural Resources

1898 wreck of the steamer *Portland*
Middle Ground fishing area

Protected Area

2,181 square kilometers (842 square miles)

Sustainable Seas Expeditions Projects

Investigations in the first year will focus on deep-water fish characterization and day-night activities of fishes at deep boulder reefs. Deep boulder reefs are a common habitat within the Gulf of Maine, particularly in Stellwagen Bank. Previous and ongoing studies have shown that boulder reefs support unique fish communities. Preliminary observations suggest that species composition and activity patterns change from day to night, even at reefs as deep as 100 meters. DeepWorker will be used to collect data on species composition and behavior of fishes using deep boulder reefs during day and night.

Wolffish

Sustainable Seas Expeditions in Your Classroom

Humpback mother and calf © DAVE MATILLA

As an educator, you and your students are invited to join us—and perhaps even guide us—in our underwater missions. You can follow the *Sustainable Seas Expeditions* and mission logs on the Internet; discuss ocean science, policy, and management in your classroom; engage students in designing their own submersibles; or see the DeepWorker submersible up close at one of the open houses.

Your most important role, however, is to foster within students the questioning attitude that is at the heart of the explorer. A new generation of ocean citizens occupies our classrooms now. Among them are the technicians, scientists, civic leaders, and voters of tomorrow—those who inherit our oceans' problems and will be challenged to find their solutions. Among them also are the next ocean explorers, those whose curiosity, personal motivation, and commitment will carry them beyond what we know now.

For your students, the *Sustainable Seas Expeditions* are an exciting application of science and geography in action. For teachers, the *Expeditions* provide a way of using the National Science Education Standards and the National Geography Standards to truly involve your students in their own learning. The teaching ideas suggested here, as well as in other *Expeditions*-related education materials developed by the National Science Teachers Association, the National Geographic Society, and NOAA's national marine sanctuaries, build on the content and methods of these two standards documents.

These *Expeditions* are an opportunity to engage students in the excitement of real-time exploration—the heart of the study of geography and science. These inquiry-based disciplines work together to increase our understanding of Earth and its systems. Integral to most activities are the geography standard skills—asking geographic questions; acquiring geographic information; then organizing, analyzing, and answering these geographic questions.

Integral also are the methods of inquiry teaching, of assessment, and of systems thinking that form the core of the science education standards. As students explore the oceans, sampling the diversity of life and undersea topography at each of our 12 marine sanctuaries, we hope that these methods allow them to link the world beneath the surface of the sea to their view of the blue planet.

Adapt the activities as necessary to best meet the needs of your students and the specific location in which you live. Some of the activities, such as conducting a vertical transect and studying features of a particular sanctuary, can be adapted to your area by replacing the data provided with that from your local sanctuary.

INVESTIGATION 1

What Are Marine Sanctuaries?

In this Investigation, students develop their understanding of what a marine sanctuary is and consider the criteria used in defining these special places.

BACKGROUND INFORMATION

NOAA's National Marine Sanctuaries

ACTIVITY

Special Places in the Sea

LEARNING OBJECTIVES

Students will:

- Define what a marine sanctuary is in their own words;
- Compare and contrast the national marine sanctuaries for similarities and differences in ecosystems, human use, water temperature, currents, and undersea topography;
- Articulate why we need national marine sanctuaries.

STANDARDS

Geography Standard 1

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Geography Standard 8

Characteristics and spatial distribution of ecosystems on Earth's surface

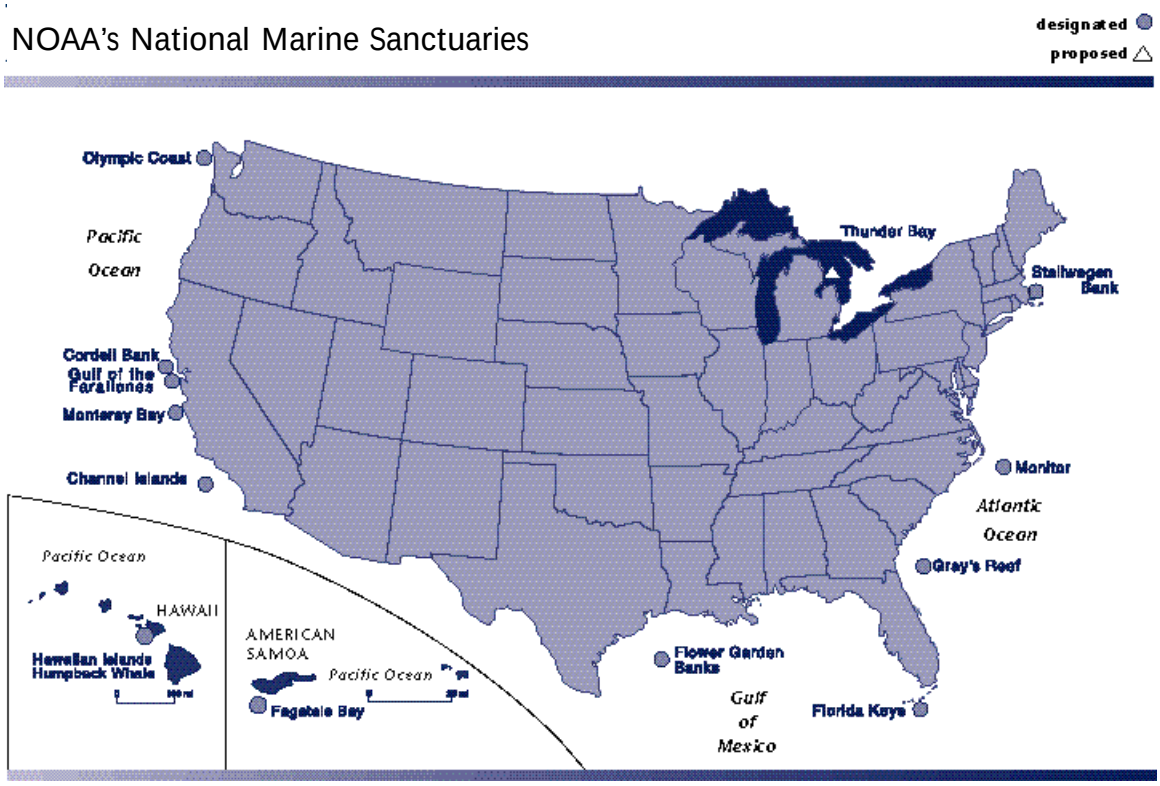
Science Education Standards

How to identify worthwhile and researchable questions, plan an investigation, execute a research plan, and draft a research report

Developing self-directed learners

ACTIVITY

Special Places in the Sea



Guiding Question

What characteristics define a marine sanctuary?

Materials

- ❑ Student Sheet 1: United States Map , one for each student group
- ❑ Student Sheet 2: Exploring the Sanctuaries , one for each student group
- ❑ Copy of sanctuary descriptions from Sanctuaries and Their 1999 Investigations (pp. 16–26) for each student group
- ❑ Longitude, latitude, and web site address for each of the 12 national marine sanctuaries (page 32)
- ❑ ***Sustainable Seas Expeditions*** poster
- ❑ Access to the Internet
- ❑ Paper for student journals or lab notebooks

Procedure

Part 1: What is a Marine Sanctuary?

1 On the board or overhead projector, write the words "marine sanctuary." Tell students that 12 national marine sanctuaries have been set aside in the United States since 1972.

2 Using the National Marine Sanctuaries Background Information sheet as a guide, describe to your students why marine sanctuaries were established and how they are managed. Start them thinking about what marine sanctuaries are—establishing what they already know and encouraging them to ask and answer their own questions about sanctuaries and the marine environment.

3 Discuss with students the role of national parks, both on land and at sea, as special places that preserve algae, plants, and animals, the habitats in which they live, unique landforms, and recreational opportunities for people. Compare the establishment of the first national park, Yellowstone, in 1872 to the establishment of the first national marine sanctuary, ***Monitor,*** about one hundred years later.

4 After the discussion, divide your class into groups of three or four students each. Give each group a United States Map and the name, longitude, and latitude of one or more of the 12 sanctuaries. (A point has been chosen for each site.) Ask students to locate their sanctuaries on the Map.

Part 2: What Makes Each Sanctuary Special?

1 Hand out an Exploring the Sanctuaries sheet to each group. Using this as a guide, have groups predict what biological, physical, and geographical features they might find at the latitude and longitude of their mapped sanctuaries. Encourage students to identify what they don't know and to record questions in their lab notebooks concerning what they would like to learn more about. These questions may serve as a starting point for Investigation 3, Planning an Expedition .

2 Have students collect data about their sanctuaries that address their questions. Give each group the sanctuary description and web site address for their sanctuaries. Have them revisit the questions on the Exploring the Sanctuaries handout and in their lab notebooks to build on what they already know and form a more complete description of their sanctuaries. How do their predictions compare to their findings?

3 Have groups present what they have learned to the rest of the class. Encourage students to describe the sanctuary they studied and make comparisons with other sanctuaries. Some discussion questions might include:

What did students expect to find in terms of key habitats, species, ocean currents, water temperature, geological features, and human uses?

What was some of the reasoning behind their expectations?

How did their research change their knowledge of their marine sanctuary?

Why do they think their area was designated as a sanctuary?

Part 3: Defining Sanctuaries

Based upon the students' presentations and discussions, continue the discussion to further explore what characteristics define a sanctuary.

How do the features of one sanctuary compar to another? Which have coral reefs? Why? Which have kelp forests?

(This can be a lengthy discussion where students begin to look at what defines a sanctuary. Point out, if students haven't already, the diversity among sanctuaries with respect to habitat types, water temperature, ocean currents, geology, human use, and so on.)

What is the unifying concept among all the different sanctuaries? What defines a sanctuary?

What kinds of areas should qualify as a sanctuary?

(As part of this discussion, have students reflect on the reasons why their sanctuaries were designated as such. Are all designated for the same reasons? For more information, refer to the resources listed under National Marine Sanctuary Program on page 90.)

What activities should be allowed in a sanctuary? What are the pros and cons of des ignating certain areas as multi-use or single use? What are the pros and cons of setting aside areas where no activities are allowed at all? What permitted activities do students agree/disagree with? What are the pros and cons of these? What points of view do different stakeholders have regarding this issue?

(Have students role play different sanctuary users such as commercial fishermen, recreational divers, and so on.)

What are the benefits of designating areas as sanctuaries? What are the limitations? When considering the size of a sanctuary, how big is big enough?

Why do we need sanctuaries? Are sanctuaries enough to maintain the health of the sea? Are there other methods that would benefit the sea; for example, the corridors employed by the National Park Service that provide routes for animals on land to move from one area to another?

To expand this discussion and compare management strategies between the Great Barrier Reef Marine Park in Australia and our national marine sanctuaries, refer to the Great Barrier Reef's web site (http://www.gbrmpa.gov.au/). In particular, look at the headings: "Managing the Great Barrier Marine Park" and "Corporate Plan 1997–2001."

Part 4: Revisit Their Understanding

1 After completing one or more of the other Investigations in this packet, revisit this exercise to see how students' concepts of a marine sanctuary have changed as a result of their own investigations. If students use a journal or lab notebook to record their work, this activity will provide them with a means of self-assessment.

National Marine Sanctuaries:
Latitude and Longitude* / Web Site Addresses

Channel Islands National Marine Sanctuar y
34° N 119° W http://www.cinms.nos.noaa.gov

Cordell Bank National Marine Sanctuar y
38° N 123° W http://www.nos.noaa.gov/ocrm/nmsp/nmscordellbank.html

Fagatele Bay National Marine Sanctuar y
14° S 170° W http://www.nos.noaa.gov/nmsp/FBNMS

Florida Keys National Marine Sanctuar y
24° N 81° W http://www.fknms.nos.noaa.gov

Flower Garden Banks National Marine Sanctuar y
27° N 93° W http://www.nos.noaa.gov/ocrm/nmsp/nmsflowergardenbanks.html

Gray's Reef National Marine Sanctuar y
31° N 8° W http://www.graysreef.nos.noaa.gov

Gulf of the Farallones National Marine Sanctuar y
37° N 12° W http://www.www.nos.noaa.gov/nmsp/gfnms/welcome.html

Hawaiian Islands Humpback Whale National Marine Sanctuar y
21° N 157° W http://www.t-link.net/~whale

Monitor National Marine Sanctuar y
35° N 75° W http://www.nos.noaa.gov/nmsp/monitor or
http://www.cnu.ed/~monitor

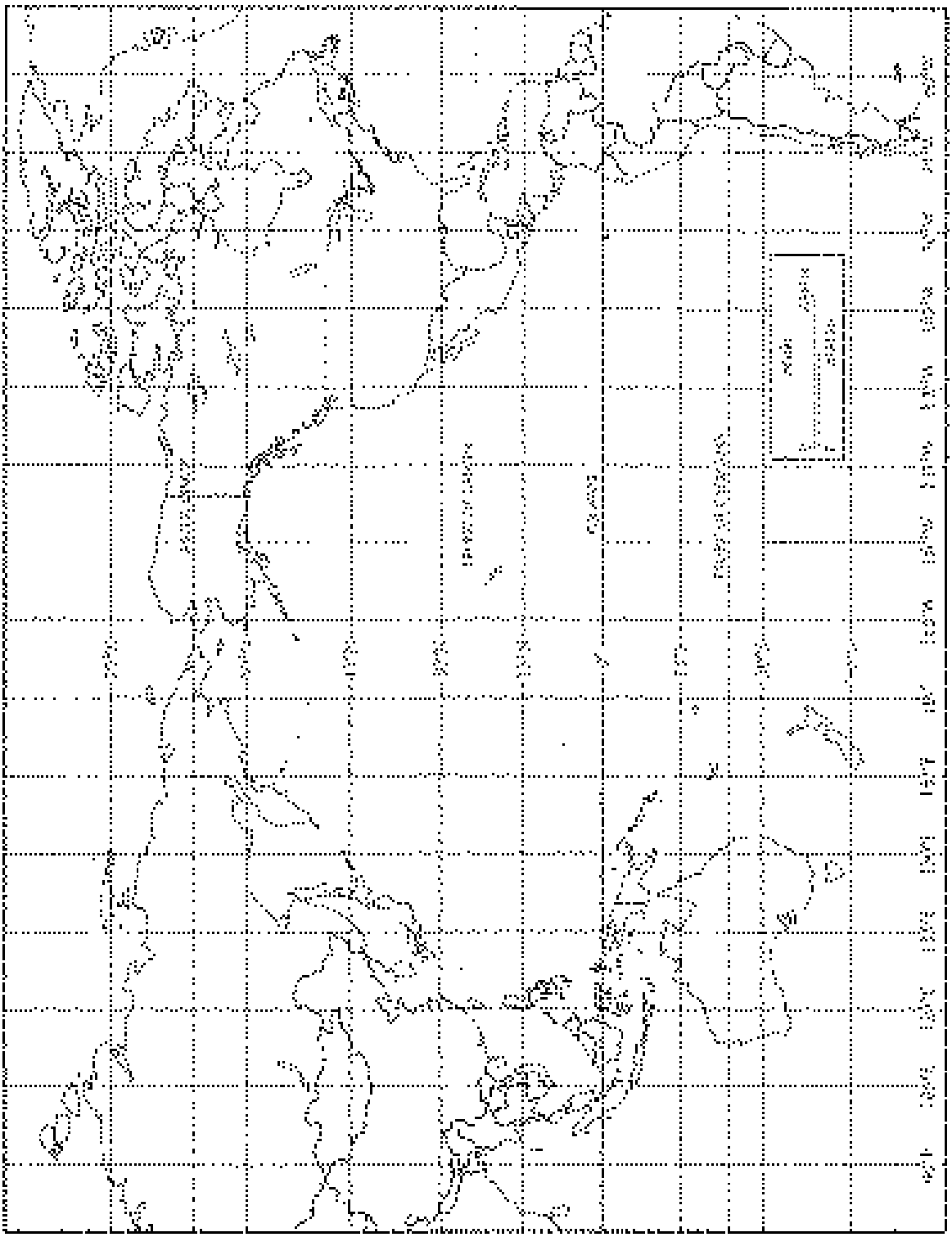
Monterey Bay National Marine Sanctuar y
36° N 122° W http://www.mbnms.nos.noaa.gov

Olympic Coast National Marine Sanctuar y
48° N 124° W http://www.nos.noaa.gov/ocrm/nmsp/nmsolympiccoast.html

Stellwagen Bank National Marine Sanctuar y
42° N 70° W http://vineyard.er.usgs.gov/

*Latitude and longitude are measured from a point near the center of the sanctuary.

UNITED STATES MAP



Geographical Features:

- What major cities are within 150 kilometers (100 miles) of your sanctuary and what are their populations? How accessible is the sanctuary? Can you drive there?

- What are the important geological features of this site? What geological processes helped shape the sanctuary and its surrounding area?

Historical Perspectives:

- What historical features are part of the sanctuary? Are there shipwrecks, Native peoples, or archaeological artifacts? How was the area important to early people?

Physical Characteristics:

- How can you characterize the physical conditions of the sanctuary?

Biological Aspects:

- What habitats are found in the sanctuary? What kinds of algae, plants, and animals live in these places? What species are found in more than one habitat? What species might migrate through this sanctuary during certain times of year?

Human Use:

- How do people use the sanctuary? What are the real and potential threats and benefits from those uses?

Goals of the Marine Sanctuary:

- Why do you think this area was designated as a national marine sanctuary? What activities should be allowed? What are some of the current local issues?

INVESTIGATION 2

A Closer Look at One Sanctuary

Purple sea urchin LAURA FRANCIS

In this Investigation, students take a closer look at Stellwagen Bank National Marine Sanctuary. After becoming familiar with a topographic map of the area, students select a transect along the seafloor to study some of the geological, biological, and physical features that are present.

ACTIVITY

Conducting a Transect Along the Seafloor: Stellwagen Bank National Marine Sanctuary

LEARNING OBJECTIVES

Students will:

- Use a topographic map as a tool for recognizing geophysical features of the seafloor;
- Create a depth profile from a topographic map;
- Use a transect as a tool for quantifying geological, physical, and biological features along the seafloor;
- Correlate species with habitat type in Stellwagen Bank National Marine Sanctuary.

STANDARDS

Geography Standard 1

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Science Education Standards

Develop abilities necessary to do scientific inquiry

Develop understanding of populations and ecosystems

ACTIVITY

Conducting a Transect Along the Seafloor:

NOAA's Stellwagen Bank National Marine Sanctuary

Guiding Question

If you were to plan a research cruise in Stellwagen Bank National Marine Sanctuary using DeepWorker, what transect would you study? Based upon the habitat types along your transect, what species would you expect to find?

Discussion

As a result of extensive studies of the seafloor in Stellwagen Bank National Marine Sanctuary, much is known about its topography and sediment types. Sediment type is one of many factors that define the kinds of algae and animals living in a particular area. By knowing these sediment types and the habitats preferred by different species, scientists can predict what organisms they might find in an area. Using DeepWorker and other scientific equipment, scientists can compare their predictions with actual findings.

In Stellwagen Bank National Marine Sanctuary, most topographic features and sediment types were formed by glacial processes. Glacial ice containing rock debris moved across the region, scouring its surface and depositing sediment to form basins, banks, knolls, ledges, and other features. Today, storm currents and waves from the northeast continue the process. These currents erode sand and mud from the shallow banks and transport them into the basins. Stellwagen Bank and Jeffreys Ledge are shallow banks (20-40-meter water depth) covered with sand and gravel. Tillies Basin, the area students will focus on, was formed by icebergs scraping along the bottom. It is covered with mud.

Materials

- ❑ Student Sheet 3: Topographic Map of Tillies Basin Area , one for each group
- ❑ Student Sheet 4: 3-D map of Tillies Basin Area , one for each group
- ❑ Student Sheet 5: Benthic Habitat Types in the Tillies Basin Area , one for each group
- ❑ Student Sheet 6: Animal Species in the Tillies Basin Area , one for each group
- ❑ Metric ruler
- ❑ Graph paper with x- and y-axis
- ❑ Access to the Internet (optional)

Procedure

1 Give each student a copy of the topographic map for the Tillies Basin Area. Discuss with your students the different features on the map (contour lines represent different landforms such as basins, knolls, ledges, and

banks) and how geologists create these maps. What are some ways scientists might use these maps?

2 Explain to students that scientists conduct transect studies as one way to characterize the geological, physical, and biological characteristics of an ecosystem. Tell students that they are going to plan a research cruise in the area of Tillies Basin using DeepWorker. Have them select a horizontal transect on their maps that they would be interested in studying. How do you determine the length and depth of a transect? The transect should be a straight line from one point on the map to another. Using a ruler, have

HOW ARE SEAFLOOR MAPS CREATED?

Most of our knowledge about seafloor topography comes from soundings: sending sound waves into the water and measuring the time it takes for them to bounce off the ocean floor and return. From these soundings, scientists can create a map of the seafloor.

The device used to send sound waves is called an echo sounder, or sonar. Towed behind a ship, it bounces about 120 narrow beams of sound, also called "pings," off the seafloor several times per second. Another instrument collects the sound that echoes back. The ship passes back and forth over a given area, much the way you mow a lawn, sending these many beams of sound as it goes. A computer on board the boat calculates the depth based on the time it takes for the echo of the beam to return to the surface. Sound travels through the ocean at an average speed of 1,460 meters (4,800 feet) per second. (Sound travels about five times faster through water than it does through air.) To calculate the depth, divide the total amount of time it takes for a ping to hit the bottom and bounce back by two. (You divide by two because the total includes the trip down and back.) Then multiply that figure by 1,460. For instance, if it takes two seconds for sound to return to the ship, the water must be 1,460 meters deep.

At the same time, the sonar gathers information about the composition of the ocean floor by measuring the strength of the returning signal.
For example, mud absorbs sound, therefore a muted echo indicates a muddy bottom. A strong echo indicates a rocky bottom. Scientists supplement these sonar images with videos, still photographs, and samples of the ocean floor.

each student draw a straight line on the map to indicate the location of the transect. Are all points along the transect within the depth range of DeepWorker?

3 To help illustrate the underwater topography along a transect, have students make profile charts. On a separate piece of paper, have them create a "T" table: one column for distance from the starting point of their transect (Point A) and one for depth of the seafloor. Then have them collect data at every centimeter along their transect using the scale 1cm = 1 km. For example, measuring one centimeter on the ruler from Point A (which is equal to one kilometer from the starting point of their transect), the contour line indicates depth is 25 meters. At two centimeters (or two kilometers from Point A), the depth is 30 meters. (See example below.)

The information for this activity may be substituted with that from another sanctuary. For example, the web site for NOAA's Florida Keys National Marine Sanctuary, http://www.fknms.nos.noaa.gov, has information about the coral reef habitat including the physical conditions under which reef development has been observed.

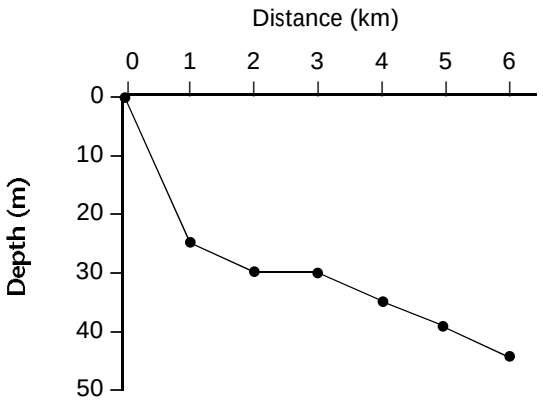
MAPPING THE SEAFLOOR DATA
TRANSECT IN STELLWAGEN BANK NATIONAL MARINE SANCTUARY

Distance from start (Point A) of transect (m)	*Depth of seafloor (km)*
0 km	0 m
1 km	25 m
2 km	30 m
3 km	30 m
4 km	35 m

4 Once students have collected data along their transects and created data tables, have them create profile charts to show the underwater topography. If computer graphing capabilities are not available, hand out graph paper and have students title and label their graphs: distance (km) along the bottom or X axis, and depth increments (m) along the side or Y axis. Students can refer to their data tables for ranges of values.

5 Have students use their data tables to plot the points on their profile charts, then draw a profile by connecting the points on the chart.

Sample Profile Char t



6 Students can compare their profile charts to the 3-D map in these materials or the seafloor map of Stellwagen Bank on the Internet (www.vineyard.er.usgs.gov/. Click on "New Maps of the Stellwagen Bank National Marine Sanctuary Region on CD-ROM.") Have them match the geophysical features along their transects.

7 Give each student a copy of the Benthic Habitat Types handout. Have them determine what kinds of sediments they would find along their transects and indicate these on their maps. Encourage students to ask questions about their findings; for instance, "Where did these sediments come from?," "How did they get here?," "Why are they distributed as they are in different zones?" Students may not have answers to these questions, but asking them is an essential part of doing science and is the first step in scientific inquiry. Their questions may be further addressed in Investigation 3, Planning an Expedition .

8 Give each student a copy of the Animal Species handout. Based on the sediments found along their transects, what species would they expect to find? What is their reasoning to support these expectations?

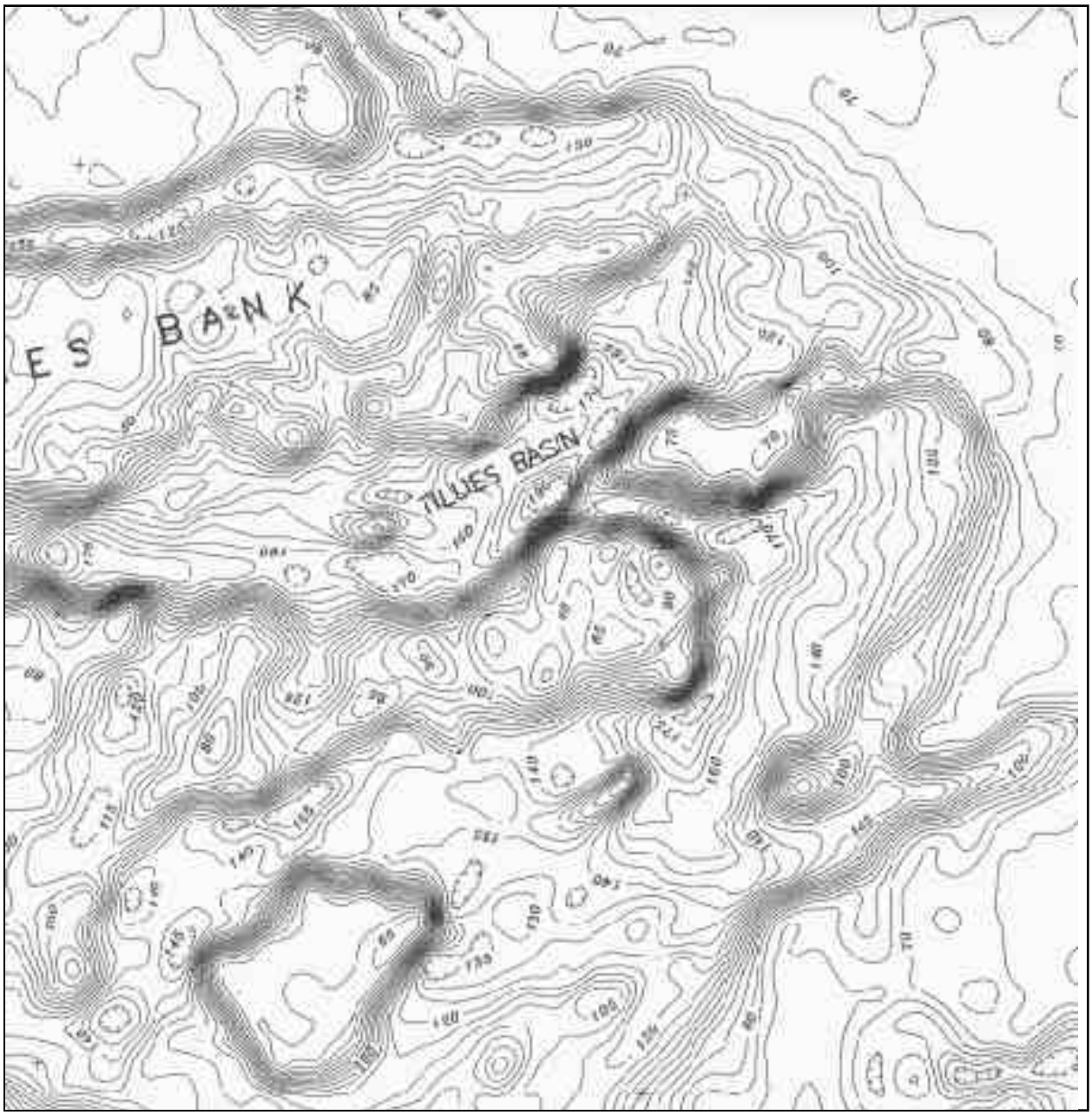
9 Discuss with students the relationships among the organisms, their physical surroundings, and their geographical location. What physical conditions does each organism favor? Does the organism's predators and prey favor the same conditions? What kinds of patterns can be seen among organisms, physical conditions, and their geographical location?

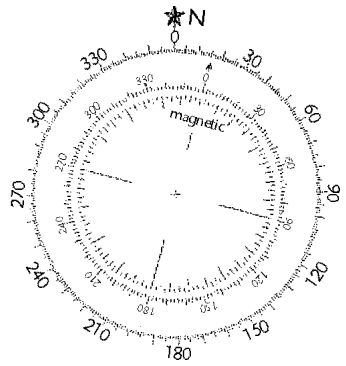
10 If you have access to the Internet, have students refer to the ***Sustainable Seas Expeditions*** web site to follow the research being conducted in Stellwagen Bank National Marine Sanctuary. What species are the ***Sustainable Seas Expeditions*** researchers finding? How do these findings compare with the predictions made by students?

11 Have students write a detailed description of their findings. If they were able to follow the ***Sustainable Seas Expeditions*** research project on the web, have them draw conclusions about their predictions and the actual findings.

One of the fishes inhabiting NOAA's Stellwagen Bank National Marine Sanctuary is the center of study for an Expeditions investigation. Redfish (Sebastes fasciatus) congregate in a particular area near Tillies Basin. A related fish, the rockfish (Sebastes caurinus) inhabits a similar habitat in NOAA's Monterey Bay National Marine Sanctuary. By comparing the day and night habits of these two fish, scientists hope to find relationships between them which might prove useful when making decisions to best protect their populations.

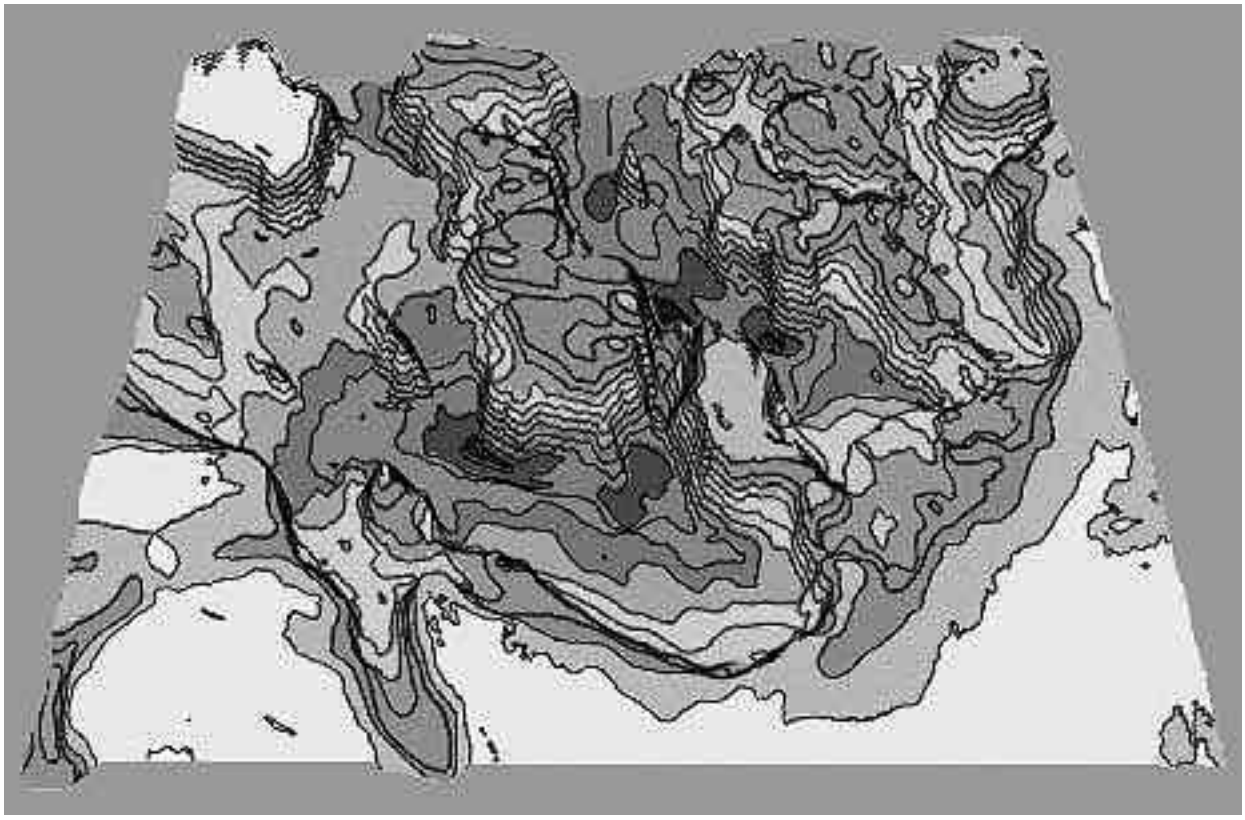
TOPOGRAPHIC MAP OF TILLIES BASIN AREA

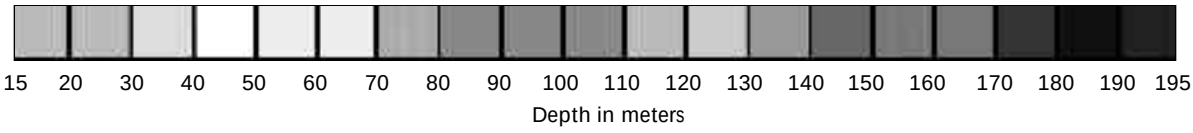




Sustainable Seas Expeditions

3-D MAP OF TILLIES BASIN AREA





View Direction	From the south
View Distance	25 km from image center
Elevation of View Point	35 degrees above map surface
Vertical Exaggeration	10X
Contour Interval	10 m
Quadrangle Dimensions	East–West: 15.7 km (8.42 nm) North–South: 13.4 km (7.15 nm)
Southwest Corner	42° 26.50' N, 70° 24.67' W
Northeast Corner	42° 33.67' N, 70° 13.33' W

Note: To view this map in full color, visit the following web site:

http://vineyard.er.usgs.gov/arc/newweb/newweb/sbtopo/html/quad11.html

Sustainable Seas Expeditions

BENTHIC HABITAT TYPES IN THE TILLIES BASIN AREA

Boulder Fields

- Areas with accumulations of small to large rocks of varying height (usually considered to be greater than 256 mm (10 inches) in diameter.
- Found along Jeffreys Ledge in the northern part of the sanctuary; in parts of the Tillies Bank/Basin Area and areas to the east; and on the western rim and southwest corner of Stellwagen Bank. Coordinates for four boulder fields are: 42° 35.25N/70° 33.00W; 42° 35.97N/70° 17.59W; 42° 35.65N/70° 13.30W; and 42° 29.47N/70° 13.97W.

Gravel/Cobble Fields

- Areas with accumulations of gravel and/or cobble (usually considered to be about 2 mm to about 76 mm in diameter).
- Found on Jeffreys Ledge; on eastern Stellwagen Bank; and on Tillies Bank.

Coarse Sand

- Areas with expanses of sand characterized by grain diameters of 0.5 mm to 1 mm in diameter.
- Found along the top and southwest corner of Stellwagen Bank and on the southern rim of Jeffreys Ledge.

Fine Sand

- Areas with grains of about 0.1 mm to 0.25 mm in diameter.
- Found along the western edge and southern portion of Stellwagen Bank; off the south-western flank of Stellwagen Bank; and in the channel between Stellwagen Bank and Cape Cod.

Mud/Silt

- Areas with extremely fine particles, usually between 0.004 mm to 0.07 mm in diameter.
- Found in the low-lying basins and deep holes throughout the sanctuary including Stellwagen Basin and Tillies Basin.

Sustainable Seas Expeditions

ANIMAL SPECIES IN THE TILLIES BASIN AREA

Common Name: American lobster
Scientific Name: *Homarus americanus*
Habitat Preference: boulders, gravel, sand
Prey: shrimps, amphipods, bivalves, echinoderms, small fish
Predators: large demersal fish, humans
(eaten by lots of marine creatures when young)

Common Name: Sand shrimp
Scientific Name: *Crangon septemspinosa*
Habitat Preference: sand, mud
Prey: algae, phytoplankton, detritus, marine worms, copepods, other small crustaceans
Predators: demersal fish (cod, cusk, flounders, hakes, pollock, sculpin, sea raven, skates, spiny dogfish), herring, striped bass, sea turtles

Common Name: Northern (pink) shrimp
Scientific Name: *Pandalus borealis*
Habitat Preference:: mud
Prey: algae, phytoplankton, detritus, marine worms, copepods and other small crustaceans
Predators: demersal fish, herring, striped bass, sea turtles, humans

Common Name: Surf clam
Scientific Name: *Spisula solidissima*
Habitat Preference: sand
Prey: phytoplankton, small detritus
Predators: marine worms, gastropods, sea stars, large crustaceans (crabs and lobsters), some demersal fish (cod, cusk, wolffish), humans

Common Name: Sea scallop
Scientific Name: *Placopecten magellanica*
Habitat Preference: sand
Prey: phytoplankton, small detritus
Predators: marine worms, gastropods, sea stars, large crustaceans (crabs and lobsters), some demersal fish, humans

Common Name: Sea stars
Scientific Name: *Solaster endeca* (smooth sunstar), *Crossaster papposus (*spiny sunstar), *Asterias vulgaris (*northern sea star), *Leptasterias sp.*
Habitat Preference: gravel, sand
Prey: bivalves, small crustaceans, worms, other echinoderms, detritus, carcasses, tunicates, hydroids, sea anemones, sponges
Predators: sea stars, wolffish, pout, cod, worms

Common Name: Hydroids
Scientific Name: *Corymorpha sp.* (solitary), *Tubularia crocea* (pink-hearted)
Habitat Preference: gravel, sand
Prey: zooplankton, phytoplankton, small detritus
Predators: nudibranchs, echinoderms, demersal fish (cod, haddock, flounders, sculpins)

Common Name: Nudibranchs
Scientific Name: *Coryphella spp.* (red-gilled), *Aeolida papillosa* (maned)
Habitat Preference: gravel, sand
Prey: (selective by species) hydroids, sea anemones, cerianthids, corals, bryozoans, sponges
Predators: sea stars, crabs, lobster, some demersal fish

Common Name: Northern cerianthid
Scientific Name: *Cerianthus borealis*
Habitat Preference: mud
Prey: small zooplankton, detritus, small animals that get caught on tentacles
Predators: nudibranchs, sea stars, some bottom-feeding fish (cod, flounder, haddock)

Common Name: Sea anemones
Scientific Name: *Urticina felina* (northern red), *Metridium senile* (frilled)
Habitat Preference: mud
Prey: zooplankton, detritus, small animals that get caught on tentacles
Predators: nudibranchs, sea stars, bottom-feeding fish (cod, flounder, haddock)

Common Name: Sponges
Scientific Name: *Isodictia palmata* (palmate), *Polymastia spp.* (yellow globular)
Habitat Preference: boulders, gravel
Prey: phytoplankton, protozoa, small detritus
Predators: nudibranchs, sea turtles, sea urchins, sea stars

Common Name: Bryozoans
Scientific Name: *Bugula turrita*
Habitat Preference: boulders, gravel
Prey: phytoplankton, protozoa, small zooplankton, small detritus
Predators: nudibranchs, sea spiders, by-catch of haddock, pout, wolffish

Common Name: Mysid shrimp
Scientific Name: *Neomysis americana*
Habitat Preference: mud, sand
Prey: phytoplankton, benthic algae, detritus
Predators: benthic fish, squid

Common Name: Amphipods
Scientific Name: *Gammarus annulatus*
Habitat Preference: mud, sand
Prey: phytoplankton, benthic algae, detritus
Predators: benthic fish, squid, larger crustaceans

Common Name: Sand dollars
Scientific Name: *Echinarachnius parma*
Habitat Preference: sand
Prey: benthic algae, bryozoans, encrusting sponges, small detritus
Predators: sea stars, wolffish, ocean pout, cod, cusk, sculpin

ANIMAL SPECIES IN THE TILLIES BASIN AREA

Common Name: Green sea urchin
Scientific Name: *Stronglyocentrotus droebachiensis*
Habitat Preference: sand
Prey: benthic algae, small detritus
Predators: sea stars, wolffish, ocean pout, cod, cusk, sculpin, humans

Common Name: Squid
Scientific Name: *Illex illecebrosus* (shortfin squid), *Loligo pealei* (longfin squid)
Habitat Preference: open water, sand and gravel (depressions at night)
Prey: small fish (herring, mackerel, sand lance), krill, amphipods, mysids
Predators: toothed whales, bluefin tuna, bluefish, cod, sharks, dogfish, humans

Common Name: Goosefish
Scientific Name: *Lophius americanus*
Habitat Preference: sand, mud
Prey: most fish, squid, crustaceans, worms, occasional bird
Predators: goosefish, large sharks, young preyed upon by many pelagic species, humans

Common Name: Sculpins
Scientific Name: *Myoxocephalus octodecemspinosus* (longhorn sculpin), *Myoxocephalus scorpius* (shorthorn sculpin), *Hermitripterus americanus* (sea raven)
Habitat Preference: gravel
Prey: demersal fish, squid, crustaceans, mollusks, echinoderms, worms, also scavenges on carcasses
Predators: goosefish, other sculpin

Common Name: Atlantic cod
Scientific Name: *Gadus morhua*
Habitat Preference: boulders, gravel, sand, mud
Prey: demersal fish, crustaceans, mollusks, echinoderms, anemones and hydroids, squid, worms, bryozoans
Predators: goosefish, sea raven, young eaten by many bottom fish, humans

Common Name: American sand lance
Scientific Name: *Ammodytes americanus*
Habitat Preference: sand
Prey: zooplankton (especially copepods), worms, larval fish and invertebrates
Predators: most pelagic and demersal fish, squid, marine mammals, sea birds

Common Name: Herring
Scientific Name: *Clupea harengus*
Habitat Preference: open water, gravel for egg laying
Prey: small fish, zooplankton (especially copepods), amphipods, mysids, shrimps, worms
Predators: many pelagic and demersal fish, squid, marine mammals, sea birds, humans

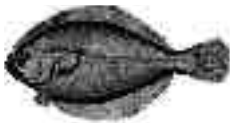
Common Name: Wolffish
Scientific Name: *Anarhichas lupus*
Habitat Preference: boulders
Prey: echinoderms, crustaceans, mollusks
Predators: goosefish, sea raven, young preyed upon by other bottom fish, humans

Common Name: Haddock
Scientific Name: *Melanogrammus aeglefinus*
Habitat Preference: boulders
Prey: mollusks, echinoderms, anemones and hydroids, worms, squid, sand lance, crustaceans
Predators: bluefish, cod, goosefish, sea raven, sharks, humans

Common Name: Spiny dogfish
Scientific Name: *Squalus acanthias*
Habitat Preference: gravel, sand
Prey: small fish (pelagic and demersal), squid, crustaceans, bivalves, worms, jellyfish, salps
Predators: goosefish, other dogfish, large sharks, humans

Common Name: Acadian redfish
Scientific Name: *Sebastes fasciatus*
Habitat Preference: boulders
Prey: mollusks, crustaceans, squid
Predators: cod, goosefish, spiny dogfish, sea raven, hakes, humans

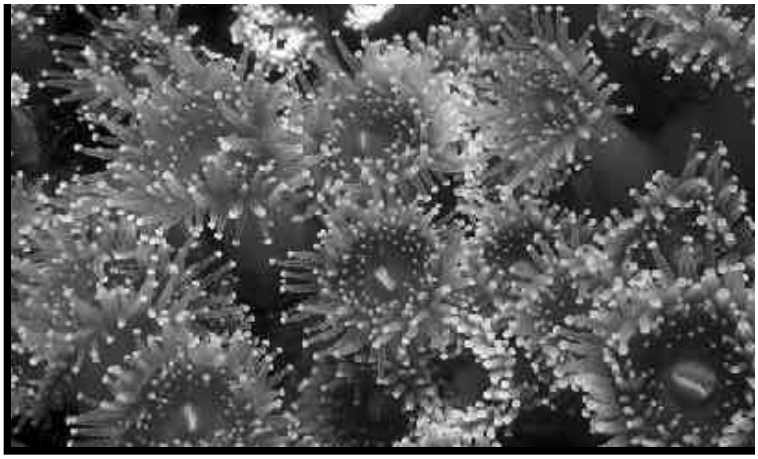
Common Name: American plaice
Scientific Name: *Hippoglossoides platessoides*
Habitat Preference: mud, sand
Prey: small mollusks and crustaceans, small fish, anemones and hydroids, worms
Predators: cod, goosefish, sea raven, skates, dogfish, humans



Common Name: Skates
Scientific Name: *Raja erinacea* (little), *Raja ocellata* (winter)
Habitat Preference: sand
Prey: small fish, squid, crustaceans, mollusks, anemones and hydroids, echinoderms, worms
Predators: sharks, goosefish, humans

INVESTIGATION 3

Planning an Expedition



Club-tipped anemone LAURA FRANCIS

In this Investigation, students design their own scientific expeditions to the sea using the goals of *Sustainable Seas Expeditions* **as a guide. They begin by conducting a simulated vertical transect as an example of one method scientists use in oceanic research.**

BACKGROUND INFORMATION

Exploring—For Answers
Sustainable Seas Expeditions Research
Meet DeepWorker
Sanctuaries and Their 1999 Investigations

ACTIVITIES

Sample Mission: Vertical Transect
Planning Your Expedition

LEARNING OBJECTIVES

Students will:

- Conduct a simulated vertical transect in the sea as one method of doing research;
- Plan and design a scientific investigation that meets the goals of ***Sustainable Seas Expeditions*** and recognizes the capabilities of DeepWorker.

STANDARDS

Geography Standard 3
How to analyze the spatial organization of people, places, and environments on the Earth's surface

Geography Standard 18
How to apply geography to interpret the present and plan for the future

Science Education Standards
Recognize and develop abilities necessary to design and conduct scientific investigations

ACTIVITY Sample Mission: Vertical Transect

Guiding Question

What is a vertical transect? How do scientists use this method to determine the layering system of physical and biological parts in the ocean?

Discussion

Scientists often face the problem of trying to accurately interpret a natural system based upon the limited data they are able to collect in the field. Caught between their limited budgets and time constraints, scientists seek methods of sampling which provide the most reliable picture with the least number of samples. Practical restrictions and logistics prevent collecting and mapping every physical feature and organism encountered. Taking such a thorough approach is not necessary; and it would have significant ecological impacts on the community being studied. Using the information provided by a limited number of samples, scientists attempt to construct reliable models of algal, plant, and animal communities.

During ***Sustainble Seas Expeditions,*** scientists may try to determine how the ocean is stratified by collecting information about the chemical and physical properties of sea water as a function of depth in a vertical transect. The use of a small research submersible like DeepWorker allows a scientist to collect samples in the water column while simultaneously conducting a video survey of animals encountered at a site.

In this activity, students conduct a simulated vertical transect, providing them with an example of one sampling method that they may consider for their scientific investigations. The data represents a vertical transect in Monterey Bay, but may be replaced with data from other locations.

Materials

- ❑ Student Sheet 7: Dive Mission Cards , one set for the class
- ❑ Student Sheet 8: Water Sample Cards , one set for the class
- ❑ Student Sheet 9: Photographic Survey Cards, one set for the class
- ❑ Student Sheet 10: Wild Cards , one set for the class
- ❑ Student Sheet 11: Dive Plan and Pre-Dive Logistics sheet, one for each group
- ❑ Student Sheet 12: Monterey Bay National Marine Sanctuary Char t, one for each group
- ❑ Internet access (optional)
- ❑ Computer graphing program (optional) or copies of Student Sheet 13: Graph Grid and colored pencils

Procedure

1 Student "pilots" will conduct a simulated dive aboard the DeepWorker 2000 into Monterey Submarine Canyon to a maximum depth of 600 meters (2,000 feet).

2 Organize the cards as follows: Dive Mission Cards and Wild Cards in separate containers to be selected by students randomly; Water Sample Cards and Photographic Survey Cards arranged into separate piles according to depth (beginning at the surface and making separate piles for each depth down to 600 meters). Each pilot begins by drawing a Dive Mission Card that describes the research objective. (Dive Mission Cards describe vertical transects of various depths.) Pilots then decide how to complete the vertical transect. For example, a pilot could take single samples at either even or random spacing between collection sites; or they could collect multiple samples at one depth. The pilot must then write and file a Dive Plan that specifies the sampling technique to be used.

3 The pilot locates a dive site in the canyon on the Monterey Bay National Marine Sanctuary Chart. Under Pre-Dive Logistics, each pilot records the depth of the water column at the site as well as the distance from Monterey Coast Guard Pier to the dive site. A general description of the site's bathymetry should also be included. Have pilots select a Wild Card prior to their dive.

4 The pilot collects a Water Sample and makes a Photographic Survey at intervals during the descent according to the Dive Plan. Samples are available at 50-meter intervals starting at the surface and ending on the floor of the canyon at a depth of 600 meters.

5 A pilot may only collect a total of 10 samples each due to the limited dive time available. As many as four samples may be collected from one particular depth.

6 Pilots must "return to the surface" and process the data collected by constructing a graph that illustrates the stratification of the sea. Use the Graph Grid if a computer graphing program is not available. Colored pencils may be used to distinguish between pressure, temperature, salinity, and dissolved oxygen data.

7 The pilot refers to posters, slide sets, and on-line sources for illustrations of organisms identified on the Photographic Survey Cards. Have pilots draw and label pictures of organisms encountered in their lab notebooks.

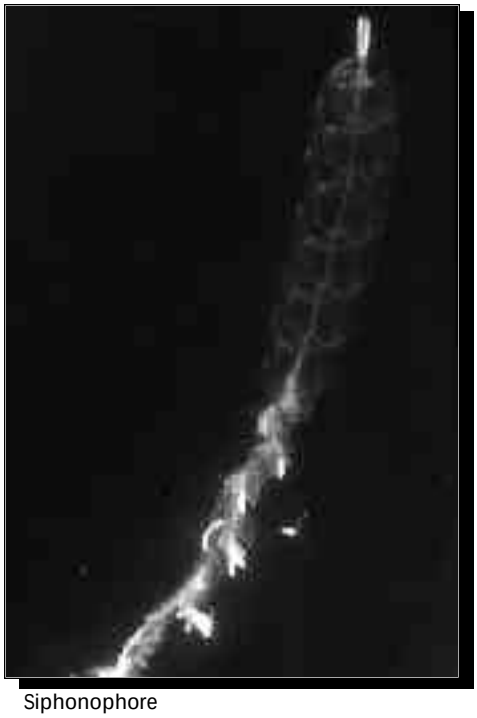
DIVE PLAN AND PRE-DIVE LOGISTICS SHEET

Dive Plan: The Dive Mission Card called for me to make a vertical transect from the surface to 400 m and allows me to take 10 water samples. I plan to take one sample every 50 meters while descending from the surface to 400 meters and to take the tenth (and final) sample upon returning to the surface because there is likely to be greater variability in water chemistry at the water/air interface. Pressure, temperature, salinity, and dissolved oxygen data will be collected at each site.

Pre-Dive Logistics: My dive site is located in Monterey submarine canyon 10.7 miles (17.8 kilometers) northwest (335°) of the Monterey Coast Guard pier. This area is west of the head of the canyon in 376 fathoms (2,256 feet/688 meters) of water. The approximate latitude and longitude of the dive site are (36° 47' N and 122° 59'W). The bathymetry of the canyon in this location indicates a steep dropoff.

Conclusion

Discuss how this activity compares to actual data collecting and how the sampling techniques could be improved. What are the potential sources of error inherent in this experiment's design? What correlations exist between the physico-chemical factors plotted on your graph and the organisms encountered? How do student profiles compare to each other? What are advantages and disadvantages of different sampling techniques?



George I. Matsumoto © MBARI 1991

Siphonophore

Sources of Deep Sea Animal Images and Other Information

Web Sites

http://www.virtual-canyon.org
Refer to the Identification Guide located in the Control Room and in the Galley of the ***Western Flyer***

http://www.discovery.com/stories/nature/creatures/creatures.html

http://bigjohn.bmi.net/yancey/
Click on "Deep-Sea Pages" at top of page

http://bonita.mbnms.nos.noaa.gov/sitechar/phys22.html
Site characterization for Monterey Bay National Marine Sanctuary

Slide Sets

Midwater animals and tools—20 slides for $15.00
Available from Monterey Bay Aquarium Research Institute
(To order, call MBARI at 831-775-1700.)

Benthic animals—20 slides for $15.00
Available from Monterey Bay Aquarium Research Institute
(To order, call MBARI at 831-775-1700.)

MBARI facilities and tools—20 slides for $15.00.
Available from Monterery Bay Aquarium Research Institute.
(To order, call MBARI at 831-775-1700.)

DIVE MISSION CARDS

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 100 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 350 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 350 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 150 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 150 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 200 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 200 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 250 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 250 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 300 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 0 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 300 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION CARDS

DIVE MISSION
Complete a vertical transect of the water column from 50 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 250 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 200 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 300 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 250 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 350 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 300 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 200 meters to 300 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 350 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 100 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 150 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 200 meters to 350 meters. You may collect a total of ten samples.

DIVE MISSION CARDS

DIVE MISSION
Complete a vertical transect of the water column from 200 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 250 meters to 350 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 250 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 300 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 200 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 250 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 300 meters to 400 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 350 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 200 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 250 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 300 meters to 450 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 350 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 2o0 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 250 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 300 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 350 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 200 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 250 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 300 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 350 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION CARDS / WATER SAMPLE CARDS

DIVE MISSION
Complete a vertical transect of the water column from 400 meters to 500 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 400 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 450 meters to 600 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 400 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 450 meters to 550 meters. You may collect a total of ten samples.

DIVE MISSION
Complete a vertical transect of the water column from 500 meters to 600 meters. You may collect a total of ten samples.

WATER SAMPLE
Depth: 0.0 meters
Pressure: 1.0 atmosphere
Temperature: 13.2° C
Salinity: 33.0 o/oo
Dissolved oxygen: 5.2 mL/liter

WATER SAMPLE
Depth: 0.0 meters
Pressure: 1.0 atmosphere
Temperature: 13.1° C
Salinity: 32.9 o/oo
Dissolved oxygen: 5.1 mL/liter

WATER SAMPLE
Depth: 50.0 meters
Pressure: 6.0 atmosphere
Temperature: 12.5° C
Salinity: 33.0 o/oo
Dissolved oxygen: 5.3 mL/liter

WATER SAMPLE
Depth: 0.0 meters
Pressure: 1.0 atmosphere
Temperature: 13.0° C
Salinity: 33.1 o/oo
Dissolved oxygen: 5.0 mL/liter

WATER SAMPLE
Depth: 0.0 meters
Pressure: 1.0 atmosphere
Temperature: 12.9° C
Salinity: 33.0 o/oo
Dissolved oxygen: 5.1 mL/liter

WATER SAMPLE
Depth: 50.0 meters
Pressure: 6.0 atmosphere
Temperature: 12.4° C
Salinity: 33.2 o/oo
Dissolved oxygen: 5.2 mL/liter

WATER SAMPLE CARDS

WATER SAMPLE
Depth: 50.0 meters
Pressure: 6.0 atmosphere
Temperature: 12.6° C
Salinity: 33.4 o/oo
Dissolved oxygen: 5.4 mL/liter

WATER SAMPLE
Depth: 100.0 meters
Pressure: 11.0 atmosphere
Temperature: 11.9° C
Salinity: 33.3 o/oo
Dissolved oxygen: 5.6 mL/liter

WATER SAMPLE
Depth: 150.0 meters
Pressure: 16.0 atmosphere
Temperature: 11.7° C
Salinity: 33.4 o/oo
Dissolved oxygen: 5.7 mL/liter

WATER SAMPLE
Depth: 50.0 meters
Pressure: 6.0 atmosphere
Temperature: 12.3° C
Salinity: 33.2 o/oo
Dissolved oxygen: 5.3 mL/liter

WATER SAMPLE
Depth: 100.0 meters
Pressure: 11.0 atmosphere
Temperature: 12.1° C
Salinity: 33.4 o/oo
Dissolved oxygen: 5.7 mL/liter

WATER SAMPLE
Depth: 150.0 meters
Pressure: 16.0 atmosphere
Temperature: 11.4° C
Salinity: 33.5 o/oo
Dissolved oxygen: 5.8 mL/liter

WATER SAMPLE
Depth: 100.0 meters
Pressure: 11.0 atmosphere
Temperature: 12.0° C
Salinity: 33.5 o/oo
Dissolved oxygen: 5.5 mL/liter

WATER SAMPLE
Depth: 150.0 meters
Pressure: 16.0 atmosphere
Temperature: 11.5° C
Salinity: 33.5 o/oo
Dissolved oxygen: 5.8 mL/liter

WATER SAMPLE
Depth: 200.0 meters
Pressure: 21.0 atmosphere
Temperature: 11.0° C
Salinity: 33.7 o/oo
Dissolved oxygen: 5.9 mL/liter

WATER SAMPLE
Depth: 100.0 meters
Pressure: 11.0 atmosphere
Temperature: 11.8° C
Salinity: 33.4 o/oo
Dissolved oxygen: 5.6 mL/liter

WATER SAMPLE
Depth: 150.0 meters
Pressure: 16.0 atmosphere
Temperature: 11.6° C
Salinity: 33.6 o/oo
Dissolved oxygen: 5.9 mL/liter

WATER SAMPLE
Depth: 200.0 meters
Pressure: 21.0 atmosphere
Temperature: 11.1° C
Salinity: 33.6 o/oo
Dissolved oxygen: 6.0 mL/liter

WATER SAMPLE CARDS

WATER SAMPLE
Depth: 200.0 meters
Pressure: 21.0 atmosphere
Temperature: 10.9° C
Salinity: 33.7 o/oo
Dissolved oxygen: 5.8 mL/liter

WATER SAMPLE
Depth: 250.0 meters
Pressure: 26.0 atmosphere
Temperature: 10.5° C
Salinity: 33.8 o/oo
Dissolved oxygen: 5.3 mL/liter

WATER SAMPLE
Depth: 300.0 meters
Pressure: 31.0 atmosphere
Temperature: 10.0° C
Salinity: 34.0 o/oo
Dissolved oxygen: 3.7 mL/liter

WATER SAMPLE
Depth: 200.0 meters
Pressure: 21.0 atmosphere
Temperature: 11.0° C
Salinity: 33.8 o/oo
Dissolved oxygen: 6.0 mL/liter

WATER SAMPLE
Depth: 250.0 meters
Pressure: 26.0 atmosphere
Temperature: 10.4° C
Salinity: 33.8 o/oo
Dissolved oxygen: 5.2 mL/liter

WATER SAMPLE
Depth: 300.0 meters
Pressure: 31.0 atmosphere
Temperature: 10.1° C
Salinity: 33.8 o/oo
Dissolved oxygen: 3.8 mL/liter

WATER SAMPLE
Depth: 250.0 meters
Pressure: 26.0 atmosphere
Temperature: 10.6° C
Salinity: 33.7 o/oo
Dissolved oxygen: 5.3 mL/liter

WATER SAMPLE
Depth: 300.0 meters
Pressure: 31.0 atmosphere
Temperature: 10.0° C
Salinity: 33.9 o/oo
Dissolved oxygen: 3.8 mL/liter

WATER SAMPLE
Depth: 350.0 meters
Pressure: 36.0 atmosphere
Temperature: 9.6° C
Salinity: 34.0 o/oo
Dissolved oxygen: 2.6 mL/liter

WATER SAMPLE
Depth: 250.0 meters
Pressure: 26.0 atmosphere
Temperature: 10.5° C
Salinity: 33.9 o/oo
Dissolved oxygen: 5.4 mL/liter

WATER SAMPLE
Depth: 300.0 meters
Pressure: 31.0 atmosphere
Temperature: 9.9° C
Salinity: 33.9 o/oo
Dissolved oxygen: 3.9 mL/liter

WATER SAMPLE
Depth: 350.0 meters
Pressure: 36.0 atmosphere
Temperature: 9.7° C
Salinity: 34.0 o/oo
Dissolved oxygen: 2.5 mL/liter

WATER SAMPLE CARDS

WATER SAMPLE
Depth: 350.0 meters
Pressure: 36.0 atmosphere
Temperature: 9.5° C
Salinity: 33.9 o/oo
Dissolved oxygen: 2.7 mL/liter

WATER SAMPLE
Depth: 400.0 meters
Pressure: 41.0 atmosphere
Temperature: 9.0° C
Salinity: 33.9 o/oo
Dissolved oxygen: 1.2 mL/liter

WATER SAMPLE
Depth: 450.0 meters
Pressure: 46.0 atmosphere
Temperature: 8.7° C
Salinity: 34.1 o/oo
Dissolved oxygen: 0.7 mL/liter

WATER SAMPLE
Depth: 350.0 meters
Pressure: 36.0 atmosphere
Temperature: 9.4° C
Salinity: 34.0 o/oo
Dissolved oxygen: 2.6 mL/liter

WATER SAMPLE
Depth: 400.0 meters
Pressure: 41.0 atmosphere
Temperature: 8.9° C
Salinity: 34.0 o/oo
Dissolved oxygen: 1.3 mL/liter

WATER SAMPLE
Depth: 450.0 meters
Pressure: 46.0 atmosphere
Temperature: 8.8° C
Salinity: 34.0 o/oo
Dissolved oxygen: 0.8 mL/liter

WATER SAMPLE
Depth: 400.0 meters
Pressure: 41.0 atmosphere
Temperature: 9.0° C
Salinity: 34.1 o/oo
Dissolved oxygen: 1.1 mL/liter

WATER SAMPLE
Depth: 450.0 meters
Pressure: 46.0 atmosphere
Temperature: 8.7° C
Salinity: 34.1 o/oo
Dissolved oxygen: 0.7 mL/liter

WATER SAMPLE
Depth: 500.0 meters
Pressure: 51.0 atmosphere
Temperature: 8.5° C
Salinity: 34.3 o/oo
Dissolved oxygen: 0.6 mL/liter

WATER SAMPLE
Depth: 400.0 meters
Pressure: 41.0 atmosphere
Temperature: 9.1° C
Salinity: 34.0 o/oo
Dissolved oxygen: 1.2 mL/liter

WATER SAMPLE
Depth: 450.0 meters
Pressure: 46.0 atmosphere
Temperature: 8.6° C
Salinity: 34.2 o/oo
Dissolved oxygen: 0.6 mL/liter

WATER SAMPLE
Depth: 500.0 meters
Pressure: 51.0 atmosphere
Temperature: 8.6° C
Salinity: 34.2 o/oo
Dissolved oxygen: 0.6 mL/liter

WATER SAMPLE CARDS

WATER SAMPLE
Depth: 500.0 meters
Pressure: 51.0 atmosphere
Temperature: 8.5° C
Salinity: 34.2 o/oo
Dissolved oxygen: 0.5 mL/liter

WATER SAMPLE
Depth: 550.0 meters
Pressure: 56.0 atmosphere
Temperature: 8.3° C
Salinity: 34.3 o/oo
Dissolved oxygen: 0.6 mL/liter

WATER SAMPLE
Depth: 600.0 meters
Pressure: 61.0 atmosphere
Temperature: 8.1° C
Salinity: 34.5 o/oo
Dissolved oxygen: 0.5 mL/liter

WATER SAMPLE
Depth: 500.0 meters
Pressure: 51.0 atmosphere
Temperature: 8.4° C
Salinity: 34.1 o/oo
Dissolved oxygen: 0.7 mL/liter

WATER SAMPLE
Depth: 550.0 meters
Pressure: 56.0 atmosphere
Temperature: 8.2° C
Salinity: 34.4 o/oo
Dissolved oxygen: 0.4 mL/liter

WATER SAMPLE
Depth: 600.0 meters
Pressure: 61.0 atmosphere
Temperature: 8.0° C
Salinity: 34.4 o/oo
Dissolved oxygen: 0.3 mL/liter

WATER SAMPLE
Depth: 550.0 meters
Pressure: 56.0 atmosphere
Temperature: 8.3° C
Salinity: 34.3 o/oo
Dissolved oxygen: 0.5 mL/liter

WATER SAMPLE
Depth: 600.0 meters
Pressure: 61.0 atmosphere
Temperature: 8.0° C
Salinity: 34.3 o/oo
Dissolved oxygen: 0.4 mL/liter

WATER SAMPLE
Depth: 550.0 meters
Pressure: 56.0 atmosphere
Temperature: 8.4° C
Salinity: 34.2 o/oo
Dissolved oxygen: 0.5 mL/liter

WATER SAMPLE
Depth: 600.0 meters
Pressure: 61.0 atmosphere
Temperature: 7.9° C
Salinity: 34.4 o/oo
Dissolved oxygen: 0.4 mL/liter

PHOTOGRAPHIC SURVEY CARDS

PHOTOGRAPHIC SURVEY
Depth: 0 meters
Common Name:
Bristlemouth
Scientific Name:
Cyclothone signata
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 50 meters
Common Name:
Market squid
Scientific Name:
Loligo opalescens
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 100 meters
Common Name:
Giant larvacean
Scientific Name:
Bathochordaeus charon
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 0 meters
Common Name:
Krill
Scientific Name:
Euphausia pacifica
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 50 meters
Common Name:
Fangtooth
Scientific Name:
Anoplogaster cornuta
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 100 meters
Common Name:
Crystal amphipod
Scientific Name:
Cystisoma fabricii
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 0 meters
Common Name:
Siphonophore
Scientific Name:
Nanomia bijuga
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 50 meters
Common Name:
Silver hatchetfish
Scientific Name:
Argyropelecus lychnus
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 100 meters
Common Name:
Cockatoo squid
Scientific Name:
Galiteuthis phyllura
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 0 meters
Common Name:
Blue Shark
Scientific Name:
Prionace glauca
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 50 meters
Common Name:
Pacific grenadier
Scientific Name:
Coryphaenoides acrolepis
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 100 meters
Common Name:
Black prince copepod
Scientific Name:
Gaussia princeps
Habitat: Midwater

PHOTOGRAPHIC SURVEY CARDS

PHOTOGRAPHIC SURVEY
Depth: 150 meters
Common Name:
Giant red mysid
Scientific Name:
Gnathophausia ingens
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 200 meters
Common Name:
Red octopus
Scientific Name:
Octopus rubescens
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 200 meters
Common Name:
Arrowworm
Scientific Name:
Pseudosagitta sp.
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 150 meters
Common Name:
Cock-eyed squid
Scientific Name:
Histioteuthis heteropsis
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 200 meters
Common Name:
Hammerhead larvacean
Scientific Name:
Oikopleura villafrancae
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 250 meters
Common Name:
Pacific sergestid
Scientific Name:
Sergestes similis
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 150 meters
Common Name:
Rabbit-eared comb jelly
Scientific Name:
Kiyohimea usagi
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 200 meters
Common Name:
Pacific dreamer anglerfish
Scientific Name:
Oneirodes acanthias
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 250 meters
Common Name:
Dinner plate medusa
Scientific Name:
Solmissus marshalli
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 150 meters
Common Name:
Nermertean worm
Scientific Name:
Nectonemertes sp.
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 200 meters
Common Name:
Sesquipedalian siphonophore
Scientific Name:
Praya dubia
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 250 meters
Common Name:
Northern lampfish
Scientific Name:
Stenobrachius leucopsarus
Habitat: Midwater

PHOTOGRAPHIC SURVEY CARDS

PHOTOGRAPHIC SURVEY
Depth: 300 meters
Common Name:
Lobed comb jelly
Scientific Name:
Bathocyroe fosteri
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 350 meters
Common Name:
Tomopterid
Scientific Name:
Tomopteris pacifica
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 400 meters
Common Name:
Pacific viperfish
Scientific Name:
Chauliodus macouni
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 300 meters
Common Name:
Blackdragon
Scientific Name:
Idiacanthus antrostomus
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 350 meters
Common Name:
Midwater jelly
Scientific Name:
Atolla vanhoeffeni
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 400 meters
Common Name:
Dragonfish
Scientific Name:
Tactostoma macropus
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 300 meters
Common Name:
Pallid eelpout
Scientific Name:
Lycodapus mandibularis
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 350 meters
Common Name:
Sword-tail squid
Scientific Name:
Chiroteuthis calyx
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 400 meters
Common Name:
Bloody belly
Scientific Name:
genus nov.; species nov.
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 300 meters
Common Name:
Midwater eelpout
Scientific Name:
Nectonemertes sp.
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 350 meters
Common Name:
Silky medusa
Scientific Name:
Colobonema sericeum
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 400 meters
Common Name:
Sperm whale
Scientific Name:
Physeter macrocephalus
Habitat: Midwater

PHOTOGRAPHIC SURVEY CARDS

PHOTOGRAPHIC SURVEY
Depth: 450 meters
Common Name:
Northern elephant seal
Scientific Name:
Mirounga angustinostris
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 500 meters
Common Name:
Vampire squid
Scientific Name:
Vampyroteuthis infernalis
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 550 meters
Common Name:
Sea gooseberry
Scientific Name:
Pleurobrachia bachei
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 450 meters
Common Name:
Gulper eel
Scientific Name:
Saccopharynx lavenbergi
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 500 meters
Common Name:
Halyard siphonophore
Scientific Name:
Apolemia uvaria
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 550 meters
Common Name:
Opah
Scientific Name:
Lampris guttatus
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 450 meters
Common Name:
Filetail catshark
Scientific Name:
Parmaturus xaniurus
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 500 meters
Common Name:
Owlfish
Scientific Name:
Bathylagus milleri
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 550 meters
Common Name:
Black-eyed squid
Scientific Name:
Gonatus onyx
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 450 meters
Common Name:
Comb jelly
Scientific Name:
Beroe forskalii
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 500 meters
Common Name:
Rocketship siphonophore
Scientific Name:
Lensia sp.
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Depth: 550 meters
Common Name:
Slender snipe eel
Scientific Name:
Nemichthys scolopaceus
Habitat: Midwater

PHOTOGRAPHIC SURVEY CARDS

PHOTOGRAPHIC SURVEY
Depth: 600 meters
Common Name:
Blackdevil anglerfish
Scientific Name:
Melanocetus johnsonii
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Substrate: variable
Common Name:
Spot prawn
Scientific Name:
Pandalus platyceros
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Substrate: Variable
Common Name:
Brittlestar on sea pens
Scientific Name:
Asteronyx loveni
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Depth: 600 meters
Common Name:
Shining tubeshoulder
Scientific Name:
Sagamichthys abei
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Substrate: Walls and rocks
Common Name:
Glass sponge
Scientific Name:
Acanthascus platei
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Substrate: Seep site
Common Name:
Cold seep clam
Scientific Name:
Calyptogena kilmeri
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Depth: 600 meters
Common Name:
Dollar hatchetfish
Scientific Name:
Sternoptyx sp.
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Substrate: Rocks on bottom and wall
Common Name:
Mushroom soft coral
Scientific Name:
Anthomastus ritteri
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Substrate: Rocks on bottom and wall
Common Name:
Basketstar
Scientific Name:
Gorgonocephalus eucnemis
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Depth: 600 meters
Common Name:
California headlightfish
Scientific Name:
Diaphus theta
Habitat: Midwater

PHOTOGRAPHIC SURVEY
Substrate: Variable
Common Name:
Brown cat shark
Scientific Name:
Apristurus brunneus
Habitat: Benthic

PHOTOGRAPHIC SURVEY
Substrate: Variable
Common Name:
Spotted ratfish
Scientific Name:
Hydrolagus colliei
Habitat: Benthic

PHOTOGRAPHIC SURVEY CARDS / WILD CARDS

PHOTOGRAPHIC SURVEY

Substrate: Rocks on bottom and wall

Common Name:
Predatory tunicate

Scientific Name:
Megalodicopia hians

Habitat: Benthic

PHOTOGRAPHIC SURVEY

Substrate: Carbonate shelfs

Common Name:
Brachiopod

Scientific Name:
Laqueus californianus

Habitat: Benthic

WILD CARD

Water alarm occurs. Make a careful ascent to the surface and terminate dive.

WILD CARD

Rough weather causes cancelation of your dive.

WILD CARD

A strong current causes you to miss two of your water samples.

WILD CARD

All systems fail. Settle on the bottom and wait (up to 80 hours) to be rescued.

WILD CARD

You encounter a giant squid and receive permission to change your dive plan. You may now observe and photograph it.

WILD CARD

Dive supervisor gives you permission to extend your dive time one hour. Collect two additional samples.

WILD CARD

Ideal weather allows you to make an additional dive. Select another dive mission.

WILD CARD

Clear water and calm conditions result in an ideal dive. Dive supervisor gives you permission to extend dive time two hours. Collect four additional samples.

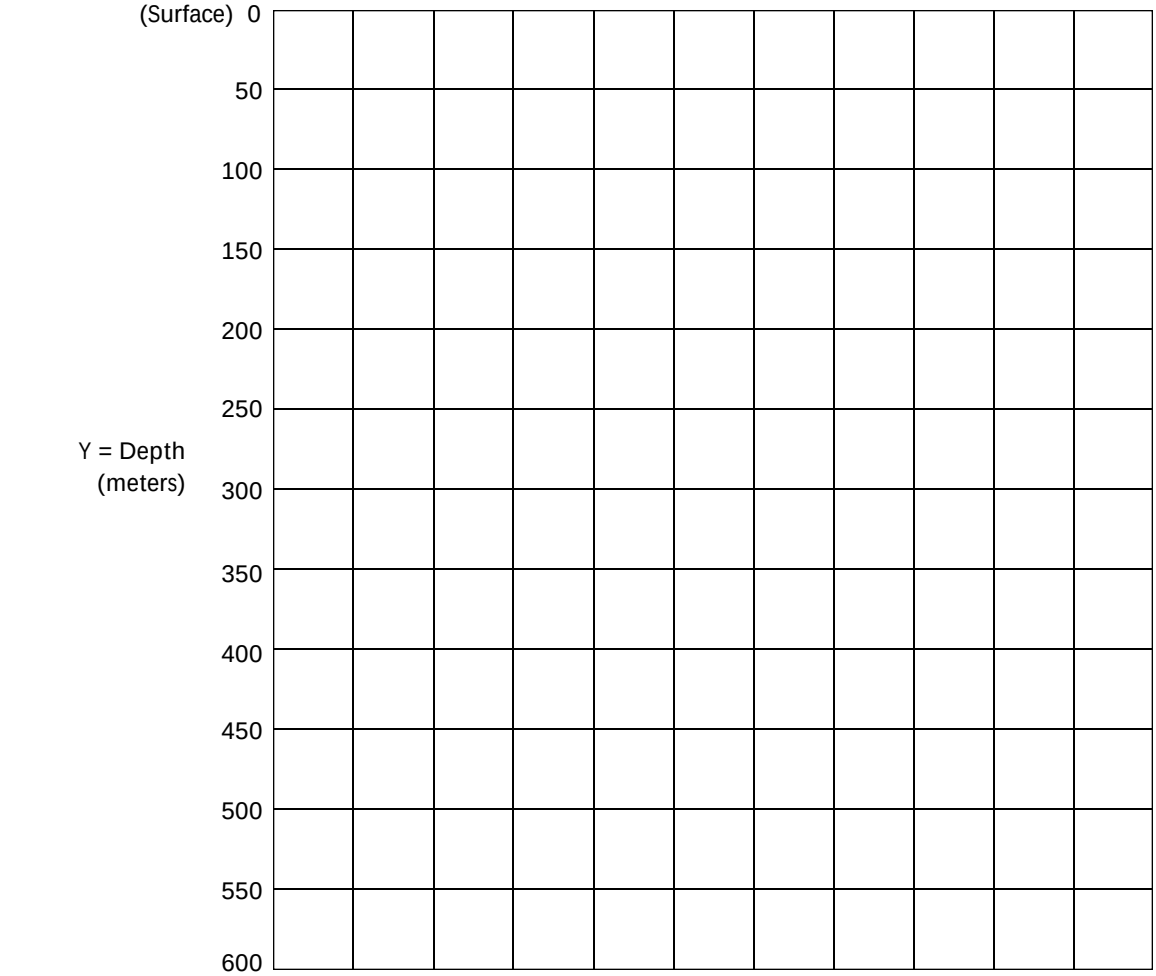
DIVE PLAN AND PRE-DIVE LOGISTICS SHEET

Dive Plan _____

Pre-Dive Logistics _____

GRAPH GRID

VARIABILITY OF PHYSICAL FACTORS IN VERTICAL TRANSECT



X = Pressure (atm)	0	10	20	30	40	50	60	70	80	90	100	110
X = Temperature (C)	4	5	6	7	8	9	10	11	12	13	14	15
X = Salinity (o/oo)	32.0		32.5		33.0		33.5		34.0		34.5	
X = Dissolved O_2 (mL/liter)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0

Sustainable Seas Expeditions

MONTEREY BAY NATIONAL MARINE SANCTUARY CHART

121° 30'

122°

36° 30'

ACTIVITY

Planning Your SSE Mission

Guiding questions

If you were selected as a DeepWorker pilot, what would your mission be? How would your study meet the goals of ***Sustainable Seas Expeditions*** and contribute to our understanding of the sea?

Discussion

The main goal of ***Sustainable Seas Expeditions*** is to explore, conduct research in, and promote conservation of the nation's 12 marine sanctuaries. Scientists conduct investigations for a wide variety of reasons. They may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.

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Ctenophore

By developing their own projects, students will gain an understanding of what is involved in conducting a scientific investigation at sea. Students select a sanctuary, then design a research project that includes a hypothesis, background information, materials needed, and methods of conducting the investigation. Teachers may select the top three student projects to be submitted to ***Sustainable Seas Expeditions***. Exemplary projects will be posted on the ***Expeditions*** web site; a select few may be considered for future ***Expeditions*** investigations.

Materials

- ❑ Student Sheet 14: Goals of **Sustainable Seas Expeditions**, one for each student or group
- ❑ Student Sheet 15: Project Description sheet (blank), one for each student or group
- ❑ Maps or GIS
- ❑ Access to the Internet (optional)

Procedure

1 Using the Exploring—For Answers Background Information sheet as a guide, begin a discussion on exploration of the seas. Explain that the ocean covers nearly three-fourths of the Earth's surface (about 71 percent), yet only about one percent of the seas have been explored. To visually demonstrate this, fold

a piece of 8 1/2 × 11-inch paper into fourths, explaining it represents planet Earth of which three-fourths is ocean. Drop a quarter on the "ocean" portion of the paper to illustrate the amount of ocean that has been explored.

2 Continue the discussion, engaging your students in a conversation about why we explore and why it is important to learn more. Lead them into further discussion about what they'd like to learn more about. Ask them if they were selected as a DeepWorker pilot, what would they want to study? How would their study contribute to our understanding of the sea? Explain that they will work in small groups or alone to develop a scientific investigation using the capabilities of DeepWorker. Using the teacher's version of the Project Description sheet as a model, ask students what kinds of information they would need to include in planning their investigations.

3 As students develop their investigation ideas, they will need to decide on their research topic, identify a study site, and select methods to collect data. Many ***Sustainable Seas Expeditions*** projects are site characterizations: surveying organisms and physical factors of a site. Others employ transects as ways to document species presence and abundance (for example, the vertical transect activity in these materials). Review the ***Sustainable Seas Expeditions*** projects with your students and discuss the kinds of methods that might be used in these investigations. Students may also refer to the ***Sustainable Seas Expeditions*** web site to see what scientists are finding during their expeditions or contact a sanctuary they are interested in to learn more about the issues they are facing.

4 Students' proposals for ***Sustainable Seas Expeditions*** projects must stay within the capabilities of DeepWorker and meet the goals of this program. Give students copies of the Meet DeepWorker Background Information sheet and the Goals of **Sustainable Seas Expeditions** handout to use as guidelines when developing their investigations.

5 While students are developing their investigations, engage them in discussions about the materials and methods they propose to use. The guiding questions on the Project Description sheet suggest topics for these discussions.

6 Give students the blank Project Description handout and have them begin to outline their investigations. Remind them to review the goals of ***Sustainable Seas Expeditions*** and describe how their investigations meet these goals.

7 Have students clearly define their research project, formulate a testable hypothesis, and describe the materials and methods that will be used. Ask them to clearly demonstrate how their investigation is connected to the scientific concepts guiding their hypotheses. How will their investigation contribute to our understanding of the seas?

8 While students are researching background information about their area of study, encourage them to access a variety of sources, sort them for relevancy, and identify complexities and discrepancies resulting from the synthesis of many sources. Make sure students reference the sources used.

9 Once students have a rough draft of their investigation, have them review it with a classmate.

10 Have students revise their plans, then prepare a final presentation to explain their proposals. Have them include graphs, maps, charts, and models as needed. Students can use the Project Description as a rubric to score each others' presentations.

11 If interested, have students (or yourself) select the top three student projects which best follow the guidelines. These projects may be submitted for consideration as projects for the ***Sustainable Seas Expeditions*** web site or possible future ***Expeditions***. Send them to:

Sustainable Seas Expeditions
Attention: Student Projects
735 State Street, Suite 305
Santa Barbara, California 93101

Fagatele Bay

Filling in the Project Description For Teachers

PROJECT TITLE:

HYPOTHESIS: Are their hypotheses testable?

INTRODUCTION: After visiting the web site of their selected sanctuary or talking to the research coordinator, have students give an overall description of their scientific investigations including: What research has been done? What do we already know? What scientific concepts are being investigated? (for example, predator and prey relationships, change over time, competition)

If students are studying organisms, ask them to discuss relationships among the organisms and their physical surroundings. What physical conditions does the organism favor? Does the organism's predators and prey favor the same conditions? What kinds of patterns can be seen among organisms, physical conditions, and their geographical location?

How does this contribute to our understanding of the seas?

How does the project meet the goals of ***Sustainable Seas Expeditions***?

LOCATION: In which sanctuary is the study site located? What is the latitude and longitude?

MATERIALS: What tools do they need to collect data? (Cameras, sampling tools, instruments to take temperature, and other measurements)

Have students make a complete list of all supplies that will be needed. How will the tools be deployed? (For example, how do you take a water sample?) If the tools don't exist, have students propose a design for what they could use.

METHODS: What kinds of sampling methods will they use in their investigation (photos, video, specimen collection, transect counts, and so on)? What are the pros and cons of different methods?

Will they take samples? How many? Where and when will they take them?

Does the investigation require samples be taken during a certain time of day or night? During a particular season?

How will they get the samples back to the surface?

How will the samples be analyzed?

What sources of error are inherent in the experimental design?

How long will the dives be? How many dives are required?

Are they recording their data with respect to where it is spatially? (For example, if doing a vertical transect, at what depth are they collecting data; or if doing a horizontal transect, where along the transect are they collecting data.)

REFERENCES: Have students include a variety of sources including scientific papers, journals, the Internet, and books.

Which references are most relevant to their investigations?

Did they find any discrepancies as a result of consulting multiple resources? Discuss the importance of primary literature as an accurate source of information.

This proposal was submitted by the students of Mike Guardino's marine research class at Carmel High School, California.

PROJECT TITLE: Comparison of Organisms Inside and Outside the Boundaries of a No-take Zone in Monterey Bay National Marine Sanctuary

HYPOTHESIS: More species exist in a no-take zone compared to an area where fishing and other harvesting practices are permitted.

INTRODUCTION: A number of marine ecological reserves have been designated along the California coast including Pt. Lobos Reserve in NOAA's Monterey Bay National Marine Sanctuary. This reserve, designated a "no-take" zone, does not allow commercial and recreational harvesting of natural resources. This higher degree of protection gives scientists an opportunity to better understand the dynamics of a natural system that is free from consumptive exploitation. It can also be used as a natural laboratory to further the research, conservation, exploration, and educational goals of the marine sanctuary. Baseline data collected in a no-take zone can be used to help monitor the health of the marine sanctuary and make informed decisions about its management. Furthermore, the abundant, mature, reproductive stock in a no-take zone can help nearby populations of organisms recover from the pressures of overfishing (Yoklavich, 1997). Therefore, an entire national marine sanctuary surrounding a no-take zone can benefit from the specially-protected areas within it.

The Pt. Lobos Reserve was first established to protect terrestrial habitats along the shore. In 1960, 750 submerged acres were added to prevent further damage to, and allow for the recovery of, its unique marine community. After many years of heavy fishing pressure, including the commercial harvest of abalone, the Reserve now features the species abundance and diversity that is characteristic of a pristine kelp forest community (Pt. Lobos web site, 1999).

In addition to Pt. Lobos Reserve, other marine reserves have been established or are being considered in the nation's marine sanctuaries. These include areas in the Channel Islands National Marine Sanctuary and Florida Keys National Marine Sanctuary. A second reserve in Monterey Bay National Marine Sanctuary, Big Creek Ecological Reserve, was established in 1994.

It is hoped that the data gathered in this study will help demonstrate the importance of designating no-take zones within our national marine sanctuaries. It may take time to realize the benefits of these zones, but it will certainly be worth the wait as we witness their establishment and recovery.

LOCATION: Two sites will be surveyed, both within the Monterey Bay National Marine Sanctuary (36° N 122° W).

- The Pinnacles (near Bluefish Cove) in Pt. Lobos Reserve
- A similar area outside Pt. Lobos Reserve

MATERIALS: DeepWorker 2000, RV MacArthur, video camera with lasers, compass, bathymetric charts, precise and accurate tracking instrumentation

METHODS: Conduct a video survey of the bottom topography and organisms both inside the Pt. Lobos reserve and outside of it. Perform a site characterization of the two areas that includes:

- a survey of the invertebrate species present; and
- a survey of fish species present along with how many of each species are seen.

The results will be compared with existing bathymetric charts of Carmel Submarine Canyon to give an accurate description of the region's bottom topography and benthos.

A video camera fitted with lasers will be used to document the size of the organisms being photographed.

Depth of survey: Maximum of 300 meters
Number of dives: Two (one inside and one outside of Pt. Lobos Reserve)
Length of dives: 4-6 hours each

REFERENCES:

GIS Data of the Monterey Bay. Version 1. CD-ROM. Moss Landing: Monterey Bay Aquarium Research Institute, 1998.

Gotshall, D.W. (1989). *Pacific Coast Inshore Fishes*. Monterey: Sea Challengers.

Humann, P. (1996). *Coastal Fish Identification: California to Alaska*. Jacksonville: New World Publications.

Love, R.M. (1991). *Probably More Than You Want to Know About the Fishes of the Pacific Coast.* Santa Barbara: Really Big Press.

Yoklavich, M.M. and R.M. Starr, 1997. "Mapping Benthic Habitats and Ocean Currents in the Vicinity of Central California's Big Creek Ecological Reserve." *NOAA Technical Memorandum NMFS.*

Yoklavich, M.M., Z.J. Lobe, M. Nishimota, B. Daly, 1996. "Nearshore Assemblages of Larval Rockfishes and Their Physical Environment off Central California During an Extended El Niño Event 1991–1993." *Fishery Bulletin* 94:766–782.

GOALS OF **SUSTAINABLE SEAS EXPEDITIONS**

- Document systematically the different types of algae, plants, and animals that live in the 12 national marine sanctuaries and provide a baseline for determining the health and condition of these organisms;
- Increase the nation's ability to conserve the natural and cultural resources of the oceans. The emphasis, as the name of the program indicates, is on sustainability of ocean resources; and
- Establish the utility of new submersibles, such as DeepWorker 2000, for enhancing ocean exploration and conservation.

KIP EVANS

Clown fish

PROJECT DESCRIPTION SHEET

PROJECT TITLE:

HYPOTHESIS:

INTRODUCTION:

LOCATION:

MATERIALS:

METHODS:

REFERENCES:

Blue shark

INVESTIGATION 4

Designing a Submersible

In this Investigation, students design submersibles that are neutrally buoyant and can travel through water The first activity, "What is Neutral Buoyancy?," introduces the concept of neutral buoyancy, a key feature of DeepWorker 2000 and your students' designs. The second activity provides an opportunity to understand some of the chemistry behind DeepWorker's air purification system.

BACKGROUND INFORMATION

Meet Deepworker

ACTIVITIES

What is Neutral Buoyancy?
Purifying the Air for DeepWorker Pilots
Design a Submersible

LEARNING OBJECTIVES

Students will:

- Define neutral buoyancy in their own words;
- Describe the chemistry behind purifying air for DeepWorker pilots;
- Describe some of the limitations scientists face when exploring the sea;
- Design a neutrally buoyant submersible capable of traveling through water.

STANDARDS

Science Education Standards

Develop abilities in technological design

Develop understandings about science and technology

ACTIVITY

What Is Neutral Buoyancy?

Guiding Question

What is neutral buoyancy and how does it affect a submersible's design?

Discussion

Density is a basic property of matter that measures the amount of mass of an object per unit volume (D = M/V). The density of freshwater is 1g/cm^3; the density of seawater is greater and varies considerably depending upon salinity and temperature. (For seawater with a salinity of 34.5 parts per thousand and a temperature of 15° C, the density is 1.025 g/cm^3). In the ocean, solids are generally more dense than seawater. They tend to sink while gases are less dense and tend to rise. Water has an unusual property: its solid phase (ice) is less dense than most other solids, enabling it to float in liquid water. Buoyancy is the tendency of a fluid (gas or liquid) to exert an upward force on an object that is submerged in it. An object that is positively buoyant will float, one that is negatively buoyant will sink, while a substance that is neutrally buoyant displaces a quantity of matter of equal density. An object placed in seawater is more buoyant than the same object placed in freshwater. This is because the dissolved salts in seawater cause the water to be more dense.

The volume of freshwater displaced by an object can be used to determine the mass required to make it neutrally buoyant. Remember that:

1 mL H_2O @ 4° C=1cm^3=1 gram.

Materials

- ❑ Lead shot
- ❑ 13 x 100 mm test tube
- ❑ #00 rubber stopper
- ❑ Milligram balance
- ❑ 100 milliliter (mL) graduated cylinder
- ❑ Water
- ❑ Indelible marker

Procedure

This activity may be used as a lab or demonstration.

1 Carefully measure freshwater into a 100 mL graduated cylinder so the bottom of the meniscus is precisely on the 80.0 mL line when viewed at eye level.

2 Mass a clean, dry 13 × 100 mL test tube and #00 rubber stopper on a milligram balance.

3 Add enough lead shot to the test tube (about half full) to make it negatively buoyant. Seal it with a tightly-fitting rubber stopper. Make a mark on the outside of the glass to record how far the stopper is inserted into the test tube.

4 Gently slide the test tube, stopper end down, into the graduated cylinder by tilting the glassware to one side.

5 Read the new volume in the graduated cylinder and determine the amount of water that has been displaced by the sealed test tube. Be sure no air bubbles have been trapped before taking this measurement. (Ask students why this is important: the trapped air displaces water, giving an inaccurate measurement.) Subtract the initial water volume (80.0 mL) from the (greater) final volume and convert to mass in grams.

6 Pour out the water and remove the weighted test tube from the graduated cylinder. Empty the test tube and replace the rubber stopper to the same mark on the glass. Refill the graduated cylinder to the 80.0 mL line and drop the empty tube in with the stopper end down. What volume does this positively buoyant object displace?

7 Remove the test tube again and add just enough lead shot to equal the mass of the displaced water. Refill the graduated cylinder with water to the 80.0 mL line and slide the neutrally buoyant test tube back in. Does the tube now rest in the water column rather than sink or float? Make any adjustments necessary to achieve neutral buoyancy.

Data and Calculations:

Mass of test tube and stopper = ____g

Final volume (____mL) - initial volume (80.0 mL) = H_2O volume displaced (_____mL)

Mass of displaced water (1 mL = 1g) = ____g

Conclusion

Compare what would happen if the same activity were done using seawater at 4° C. How would the shot weight need to be adjusted in seawater? Guide the discussion to consider how neutral buoyancy relates to submersibles, how students might address this in their designs, and how this feature benefits research.

ACTIVITY

Purifying the Air for DeepWorker Pilots

Guiding Question

How is the air in DeepWorker continually purified for pilots?

Discussion

The DeepWorker 2000 submersible uses "re-breather" technology to chemically remove carbon dioxide generated from aerobic respiration and a pair of high pressure cylinders to replenish the oxygen gas metabolized by aerobic respiration. This lab allows students to calculate the volume of carbon dioxide gas that can be removed from DeepWorker's cabin by the absorbent chemical "Soda-Lime." Soda-Lime, which is a mixture of caustic soda and lime [NaOH and $Ca(OH)_2$], is a chemical scrubber used to remove carbon dioxide from the air that has been expired by the pilot. SodaSorb® (the brand of soda-lime used by DeepWorker) is manufactured by the W.R. Grace Company in the United States. SodaSorb® consists of 70–80 percent $Ca(OH)_2$, 16–20 percent H_2O, 1–2 percent NaOH, and 0–1 percent KOH.

The mechanism for this exothermic reaction is:

$H_2O(l) + CO_2(g) \longrightarrow H_2CO_3(aq)$

$2NaOH(s) + H_2CO_3(aq) \longrightarrow Na_2CO_3(s) + 2H_2O(l)$

$Ca(OH)_2(s) + H_2CO_3(aq) \longrightarrow CaCO_3(s) + 2H_2O(l)$

There is a net production of three H_2O molecules for every molecule of CO_2 absorbed. Some chemical absorbents employ an indicator that changes color when the reactant is exhausted. The ethyl violet indicator in SodaSorb® changes from white to purple when the chemical can absorb no additional CO_2.

When a person breathes, 0.82L of CO_2 is exhaled for every liter of oxygen inhaled. An oxygen generation system should either produce a larger volume of O_2 than the volume of CO_2 consumed or make-up for the difference with a supplemental oxygen supply. A gas "regulator" is used to deliver oxygen to the DeepWorker's cabin at the proper rate. Pressure gauges monitor the supply of $O_2(g)$ in DeepWorker's twin cylinders.

The temperature of the absorbent influences the effectiveness of the reaction. SodaSorb® works much better in the relatively warm cabin of DeepWorker.

Materials

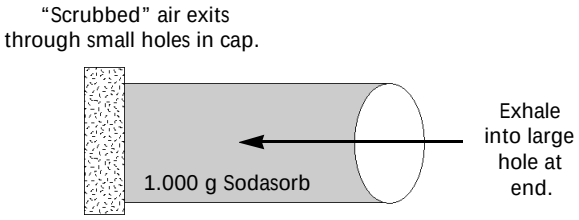
- ❑ Safety equipment (rubber gloves and eye protection)
- ❑ SodaSorb® (To order by phone, call 1-800-GET-SODA.)
- ❑ Timer
- ❑ Milligram balance

- ❑ Spirometer
- ❑ Gas collecting device (see illustration below)
- ❑ Calculator

Procedure

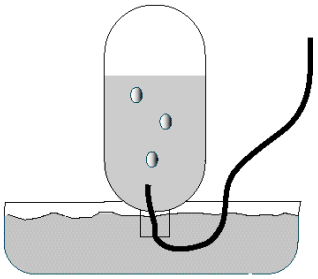
This activity may be used as a lab or demonstration.

1 Mass out 1.000 gram of SodaSorb® on a milligram balance and place it in a gas collecting device. Be careful to avoid packing the solid too tightly and be certain not to breathe the dust.



DEVICE USED TO COLLECT EXPIRED BREATH THAT CONTAINS CHEMICAL ABSORBENT.

2 Determine the tidal volume of gas that you produce in one minute by exhaling into a spirometer. An adequate homemade spirometer can be constructed with an overturned bottle of water, a dish pan, and a length of rubber hose.



HOMEMADE SPIROMETER

3 Begin exhaling at a normal rate into the gas collecting device and use a timer to determine how long you can continue before the ethyl violet indicator in the SodaSorb® turns purple. Assume that the chemical is exhausted at the first sign of a color change.

4 Determine the volume of gas that you exhaled by multiplying the time in minutes by the volume produced per minute.

5 Given that the average person at rest has 3.6 percent CO_2 (g) by volume in their expired breath, calculate the volume of CO_2 (g) that was absorbed by the SodaSorb®.

Data and Calculations

Volume of expired breath per minute:
_____ liters

Time elapsed before indicator changes:
_____ minutes

Volume of CO_2 absorbed per gram of SodaSorb®: _____

ACTIVITY

Designing a Submersible

Guiding Question

How does a submersible's design address the limitations inherent to exploring the sea?

Discussion

The ***Sustainable Seas Expeditions*** will use a small submersible to explore, conduct research in, and promote conservation of the nation's 12 marine sanctuaries. This one-person vehicle must be simple enough to operate so pilots may complete their mission, yet sophisticated enough to safely reach depths of up to 600 meters (2,000 feet). By researching, constructing, and testing a scale model prototype of a submersible, students will discover some of the design characteristics that make this vehicle so important to ocean exploration.

Materials

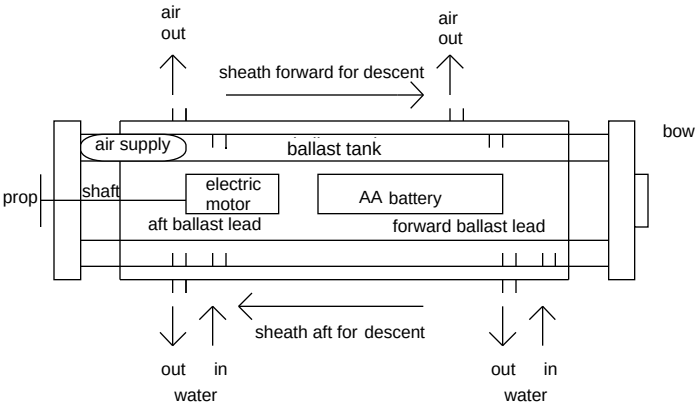
- ❑ A small aquarium (25 cm deep, 25 cm wide, 50 cm long), child's pool, or other container filled with clear, fresh water at ambient room temperature for testing submersibles
- ❑ Student Sheet 16: Submersible Specifications , one for each group
- ❑ ***Sustainable Seas Expeditions*** poster
- ❑ Copy of Meet DeepWorker Background Information for each group
- ❑ Materials for submersibles such as PVC pipe, batteries, and propellers to be determined by student teams

Procedure

1 Tell students that their goal is to work with a classmate to design, build, and test a submersible prototype that is neutrally buoyant and can travel through water. A small aquarium or other container, filled with clear, fresh water at ambient room temperature, will be available to test and demonstrate their submersibles.

2 Explain to students that their submersibles must meet certain specifications. Give them the Submersible Specifications and copies of the Meet DeepWorker Backgr ound Information sheet.

3 Set a date for students to demonstrate and explain their submersibles with each other, including what worked, what didn't work, and how they redesigned their vehicle accordingly.



Sample Student Design: Pressure hull of PVC pipe with sealed end caps inside ballast hull. The submarine descends when soft ballast tanks are flooded with water and ascends when ballast is blown (air replaces water). Hard ballast of lead shot is located inside pressure hull. When outer plastic trim sheath moves forward, air escapes from top vents. When sheath moves aft, water escapes from bottom vents as ballast air supply ruptures.

SUBMERSIBLE SPECIFICA TIONS

Your submersible prototype must meet the following specifications:

- It must displace at least .250kg of fresh water when fully submerged and can be no longer than 20cm from bow to stern with a beam (width) or height no greater than 20cm.
- It must be neutrally buoyant.
- It cannot be directly touched after it is deployed into the "ocean." Remote controls or tether lines may be used to operate controls on the submersible. A transducer may be deployed into the "ocean."
- The submersible must be built by you "from scratch;" for example, a commercial submarine retrofitted for this activity is not allowed.
- You and your partner will provide all materials for your submersible. It is not necessary to spend a lot of money to build a successful prototype.
- Your device must be safe.

Keep a Log

Keep a log of your activities. As part of the project, write a detailed description of your research and development, including what worked, what didn't work, and how you revised your design accordingly. Include a schematic, an explanation of all systems (ballast, steering, propulsion, remote control), and a bibliography. Use at least five references total from a variety of sources: journal articles, books, and web sites on the Internet. Include references to these sources as part of your written work.

Supplies and Where to Get Them

Rudders, hydroplanes, thrusters, and propellers should be considered in your design as part of the propulsion system. Batteries, electric motors, elastic bands, teacher-approved chemical reactions, compressed gas (air or carbon dioxide only), and lead shot for ballast are possible methods you may use to power your submersible and achieve neutral buoyancy. Care should be taken to ensure that thruster propellers are not a hazard. PVC pipe and plastic containers are possible materials for the frame of your submersible. All of the materials listed here are available in local hobby and hardware stores. Some materials you may already have at home.

For More Information

Web sites http://www.32ndparallel.com/custom.htm
http://www.rcboats.com/

Appendix 1: Expeditions Schedule

1999

n	APRIL 16–APRIL 25	Gulf of the Farallones National Marine Sanctuary
n	APRIL 27–MAY 6	Cordell Bank National Marine Sanctuary
n	MAY 9–MAY 22	Monterey Bay National Marine Sanctuary
n	MAY 25–JUNE 4	Channel Islands National Marine Sanctuary
n	JUNE 18–JUNE 29	Olympic Coast National Marine Sanctuary
n	JULY 8–JULY 13	Stellwagen Bank National Marine Sanctuary
n	JULY 26–AUGUST 6	Gray's Reef National Marine Sanctuary
n	AUGUST 16–AUGUST 28	Florida Keys National Marine Sanctuary
n	SEPTEMBER 1–SEPTEMBER 13	Flower Garden Banks National Marine Sanctuary

Appendix 2: About the Ocean

The Sea's Water

Coverage

- The seven oceans cover 71% (360 million square kilometers) of the Earth's surface and contain 97% of the Earth's supply of water.
- Earth is actually covered by only one layer of water. Even though the ocean is broken up into seven ocean parts, all of them are connected, one flowing into another.
- There are 1,365,336,000,000,000,000,000 liters (361,200,000,000,000,000,000 gallons) of sea water in the ocean. If all that water were piled on top of the United States, the land would be submerged under 140 kilometers (88.2 miles) of water.

Temperatue

- Almost all of the deep ocean is only a little warmer than freezing, 3.8° C (39° F).

Currents

- The Kuroshio Current, off the shores of Japan, is the fastest-moving ocean current on Earth. It can travel between 40 and 120 kilometers (25 and 75 miles) a day, 2-5 kilometers (1–3 miles) per hour, and extends some 1,000 meters (3,300 feet deep). The Gulf Stream moves nearly as fast.

Saltiness

- If the ocean's total salt content were dried, the salt would cover all of the continents to a depth of about 1.5 meters (5 feet).

Depth

- At the deepest point in the ocean, the pressure is more than 1,260 kilograms per square centimeter (8 tons per square inch). That's equivalent to one person trying to hold 50 jumbo jets.
- The average depth of the ocean is 4 kilometers (2.5 miles).
- The area of the Pacific Ocean exceeds that of all the land.
- The deepest spot in the ocean is in the Mariana Trench (W Pacific SW of Guam) at 11.7 kilometers (36,198 feet). It is so deep that if Mount Everest were to be placed here, its peak would still be one kilometer below the surface of the ocean.

Exploration

- The oceans are still relatively unexplored, to the extent that more is known about the surface of Venus than the bottom of the deepest seas.
- In 1976 one of the world's largest sharks, the megamouth, was seen for the first time; while the last five years has seen the discovery of a new species of beaked whale off the South American coast.

Life in the Sea

- There may be as many as 18 million diatoms in a cubic meter of sea water.
- In the world's oceans are:
  - — about 57 species of sea grasses
  - — less than 1,000 species of cephalopods (squids, octopi, and pearly nautiluses)

  - more than 1,400 species of sea anemones
  - about 1,500 species of brown algae
  - more than 6,000 species of echinoderms—sea stars, sea urchins, sea cucumbers, and sea lilies
  - about 13,000 species of fishes
  - about 50,000 species of molluscs
- Two thirds of the phyla, the major grouping below the kingdom level, are exclusively or dominantly marine.
- It is widely believed that the cheetah is the fastest creature on Earth, but the sailfish (a relative of the tuna and a highly prized sports fish) has been clocked at 110 kilometers (68 miles) per hour!

Fisheries

- Global fish consumption exceeds that of cattle, sheep, poultry or eggs, and is the biggest source of wild or domestic protein in the world.
- 86% of fish landings in 1989 were marine.
- 15 of the world's 17 largest fisheries are overfished or in trouble.

Health of the Sea

- Less than 30% of the coral reefs in Japan, Philippines, and Costa Rica are in good or excellent condition.
- The Great Auk, Steller's Sea Cow, Panamanian Fire Coral, San Diego Mud Snail, and Eelgrass Limpet are now extinct.

People and the Sea

- Oceans, although we may not realize it, are of great importance for all life (including people) on Earth. They provide food, resources, transportation, and recreational activities, and for these reasons should be treated with respect and care.
- While forests have been called the "lungs of the world," the oceans and seas also absorb huge quantities of carbon dioxide, thereby helping to regulate the Earth's climate. Changes in the winds and sea currents in the Pacific Ocean, for example, can be responsible for droughts and flooding across the southern hemisphere and possibly even further afield.
- Sewage, pulpmill wastes, fertilizers, soaps, detergents, radioactive wastes, synthetic fibers, plastics, oils, tars, greases, and insecticides are all pollutants man has placed in our Earth's oceans. We can help lessen the waste by recycling and buying less harmful, more environmentally-safe products.

Sources: National Oceanographic Data Center, Ocean Voice International, BBC Online

Teacher Resources

Channel Islands National Marine Sanctuary

113 Harbor Way
Santa Barbara, CA 93109
805-966-7107 (phone)
805-568-1582 (fax)
Web address: http://www.cinms.nos.noaa.gov

Brochures and Flyers

Channel Islands National Marine Sanctuary general brochure

Diving in the Channel Islands National Marine Sanctuary brochure—provides dive maps complete with information on anchorage, good diving spots, shipwrecks, and sea lion rookeries. Includes tips on how to protect the sanctuary to ensure its continued beauty for future generations.

Things to Do brochure—suggests activities for visitors and provides contact information on nearby harbors. Includes information on pinnipeds, whales, dolphins, and sharks and a map that illustrates pinniped hauling out and breeding areas.

Shipwrecks of the Channel Islands brochure—provides an historical perspective about shipwrecks within the sanctuary. Includes a map of shipwreck sites, information on public transportation to the islands, what to do if divers discover a shipwreck, and safety tips for boaters.

Newsletters and Newspapers

Alolkoy—this free quarterly newsletter offers highlights into current research projects and educational programs. Includes calendar of events, a constituent commentary page, and a kid's page created by students.

Annual Reports—gives an overview of sanctuary programs and activities that fulfill management plan guidelines.

Living Journal—available on the CINMS web site. Provides perspective on local and national projects and events related to the sanctuary. (http://www.cinms.nos.noaa. gov/public.stm)

Directory

1995 Marine and Coastal Educational Resources Directory for the South Central California Coast—a comprehensive guide to organizations providing information and resources on marine and coastal education.

Books

Window to the Channel—describes the varied resources that make this sanctuary a national treasure.

Posters and Charts

Channel Islands Aerial View poster—aerial photograph showing the four northern Channel Islands from the perspective of Anacapa Island looking west.

Sharks of the Channel poster

Educational Material

Los Marineros Education Program curriculum—multidisciplinary curriculum for grade 5.

Volunteer Opportunities

Sanctuary Naturalist Corp.—volunteers receive training on marine life found within the sanctuary and serve as naturalists aboard local whale watching vessels.

Sanctuary Marine Watch—volunteers receive training on sanctuary resources and provide interpretation for the boating and diving community.

Channel Islands National Marine Sanctuary intern—assist with research and educational outreach to support the sanctuary goals and objectives.

Recommended Local Web Links

Audubon Society- South Coast Chapter—http://www.audubon.org/chapter/ca/socal

Cabrillo High School Aquarium—http://www.cabrillo-aquarium.org

California Department of Fish and Game—http://www.delta.dfg.ca.gov/index.html

Channel Islands National Park—http://www.nps.gov/chis

Island Packers—http://www.islandpackers.com

Los Marineros—http://members.aol.con/rmt1838/fieldtrips.html

Passage Productions—http://www.passagepro.com

Santa Barbara Museum of Natural History—http://www.sbnature.org

Santa Barbara Maritime Museum—http://www.sbmm.org

University of California, Santa Barbara Biodiversity Forum—http://real.geog.ucsb.edu/bioforum

Cordell Bank National Marine Sanctuary

Fort Mason Building #201
San Francisco, CA 94123
415-561-6622 (phone)
415-561-6616 (fax)
Web address: http://www.nos.noaa.gov/ocrm/nmsp/nmscordellbank.html

Brochures and Flyers

Cordell Bank National Marine Sanctuary fact sheet

Newsletter

Hydrosphere—bi-annual newsletter about the Gulf of Farallones and Cordell Bank National Marine Sanctuaries. Includes articles about current research in the sanctuaries, educational offerings, volunteer programs, natural and cultural history, and field adventures.

Directories

Marine and Coastal Educational Resources Directory—lists marine and coastal educational organizations and agencies in the San Francisco and Monterey Bay areas. ($3.95)

Books

Ecology of an Underwater Island—summarizes the ecology of Cordell Bank including physical factors and community interaction.

Ocean Birds of the Nearshore Pacific—a guide for the field-going naturalist that includes whales, dolphins and porpoises, sea otters, seals and sea lions, sea turtles, and other marine creatures. ($19.95)

West Coast Whale Watching—this comprehensive guide offers the ultimate in watching whales and other marine mammals from Alaska to Mexico. ($14.95)

Blue Whales—includes beautiful photos and information. ($14.95)

Posters and Discovery Cards

Harvestable Bounty of the Sea poster—past and present fishing boats used in the Gulf of Farallones and Cordell Bank National Marine Sanctuaries. ($9.95)

Discovery Card Sets—12 card sets with color photos, amazing facts, illustrations, and challenging animal quizzes. Available are: marine mammals, gray whales, dolphins, humpbacks, and killer whales. ($3.99)

Resource Library

Marine Education Resource Library for Teachers—contains a wealth of materials for the classroom including curriculum guides, children's books, reference books, and videos.

Visitor Center

Gulf of Farallones National Marine Sanctuary Visitor Center—portrays Gulf of the Farallones and Cordell Bank sanctuaries. Interact with animals at a touch tank, glimpse under the sea through an aquarium, see a real white shark jaw, touch the fur of sea otters and seals, discover microscopic animals underneath the microscope, and imagine giant whales filtering tiny shrimp-like krill through baleen.

For more information or to order materials, contact the Farallones Marine Sanctuary Association at 415-561-6625, P.O.Box 29386, San Francisco, CA 94129.

Fagatele Bay National Marine Sanctuary

P.O. Box 4318
Pago Pago, American Samoa 96799
684-633-7354 (phone)
684-633-7355 (fax)
Web address: http://www.nos.noaa.gov/nmsp/FBNMS

Brochures and Flyers

Fagatele Bay National Marine Sanctuary general brochure (available in English and Samoan)
Our Fragile Coral Reef brochure (available in English and Samoan)
Research and Monitoring brochure
Watching Samoa's Humpback Whales brochure

Books

Pacific Coral Reef Coloring Book
Fa'atautaiga Traditional Fishing Methods
Laumai Sami/Sea Turtles
Tide Pamphlet

Posters and Postcards

Tenth Anniversary poster—features part of a coral reef painting used for an interpretive sign now posted in the National Park of Samoa Visitor's Center.

Postcards—offer views from a painting by Margaret Barnaby of coral reefs.

Educational Opportunities

M***arine Science Summer Camp***
EnviroDiscoveries
Village Outreach and Le Tausagi

Recommended Local Web Links

American Samoa Coastal Zone Management—http://wave.nos.noaa.gov/ocrm/czm/czmamericansamoa.html

National Park of American Samoa— http://ice.ucdavis.edu/US_National_Park_Service/National_Park_of_American_Samoa

Florida Keys National Marine Sanctuary

P.O. Box 500368
Marathon, FL 33050
305-743-2437 (phone)
305-743-2357 (fax)
Web address: http://www.fknms.nos.noaa.gov

Brochures and Flyers

Florida Keys National Marine Sanctuary general brochure
Lower Florida Keys Region general brochure
Please Care, Be Aware brochure
Do Not Touch Corals! Brochure (available in English, Spanish, and German)
Monroe County Lobster Information
Seagrass fact sheet
Yellow Buoy Information
Summary of What You Need to Know to Help Protect Sanctuary Resources brochure
Florida Keys National Marine Sanctuary, Past—Present—Future
Keeping Your Bottom Off the Bottom brochure
Teall's Guide, Key Largo to Conch Key
Teall's Guide, Marathon to Key West

Books

Florida Bay Dude! Educators' Guide to the South Florida Ecosystem

Newsletter

Sounding Line newsletter

School Programs and Public Events

Coral Reef Classroom—educational program for middle and high school classes.

Community Connection—two Key Largo eighth graders spend a day with sanctuary staff each month in spring, learning about resource protection, safe boating, and performing small job-related tasks.

Coral Shores High School Mentor Program and the ***Marathon High School Mentor Program***

Teacher Grants (for Monroe County schools)

Envirothons

Monroe County Environmental Education Advisory Council (MCEEAC) member

Ocean Celebration (sponsored by Dolphin Research Center)

Team OCEAN—trained volunteers station sanctuary vessels at heavily visited reef sites during peak recreational boating seasons. Volunteers educate and inform the public about the sanctuary, proper use of its resources, and basic safety precautions.

Rental Boater Education Program—rental boat businesses use TV/VCR units, video, stickers, and checklists to educate people renting boats in the Florida Keys.

Business Community Program—a comprehensive, Keys-wide database of over 400 waterfront and visitor-related businesses such as dive shops, hotels, and marine supply stores.

Directory

Florida Keys Environmental Education Resource Directory (1997 edition)

Posters

How Do You Keep From Losing Your Keys?
Florida's Coral Reef Ecosystem
Reef Fishes of the Florida Keys National Marine Sanctuary (Available from REEF at 305-451-0312, $5.00)

Videos

Protecting Paradise-Florida Keys Safe Boating Tips (available in English and Spanish)
Boat Groundings—Much More Than an Inconvenience
Waterways—over 100 half-hour television episodes ($10.00—selected titles available)
Introduction to Florida Keys National Marine Sanctuary (7-minute video—$10.00)

Presentations

Staff provide presentations to groups and organizations on a variety of topics related to the sanctuary and the Florida Keys coral reef system.

Volunteer Opportunities

Contact The Nature Conservancy at 305-289-9060 for a current list of volunteer opportunities.

Recommended Local Web Link

Florida Bay Dude!—http://www.firn.edu/flbaydude/resources/menu.html

Flower Garden Banks National Marine Sanctuary

216 West 26th Street, Suite 104
Bryan, TX 77803
409-779-2705 (phone)
409-779-2334 (fax)
Web address: http://www.nos.noaa.gov/ocrm/nmsp/nmsflowergardenbanks.html

Brochures and Flyers

Flower Garden Banks National Marine Sanctuary general brochure
Flower Garden Banks National Marine Sanctuary Mooring Buoy Coordinates brochure
Availability of Information on the Flower Garden Banks National Marine Sanctuary
List of Commercial Charter Vessel Operators in the Flower Garden Banks National Marine Sanctuary
Volunteer opportunities of the Flower Garden Banks National Marine Sanctuary
Flower Gardens Kids Page—Coral: Plant, Animal, or Mineral?
Flower Gardens Kids Page—Manta Rays!
Sea Turtles of the Atlantic and Gulf Coasts of the United States—description of each species.
Experiment—Observing the Effect of Salt on the Density of Water
Activity—Coral Feeding Simulation
The Flower Gardens: A Chronology of Research

Books

Mass Spawning by Reef Corals in the Gulf of Mexico and Caribbean Sea: A Report on Project Reef Spawn '94
Annual Research Summaries

Videos

Flower Garden Banks National Marine Sanctuary (11.5 minutes)
Our Favorite home video un-narrated video
Common Fish of the Flower Gardens and Stetson Bank ($5.00)
Reef Romance ($5.00)
Gardens Under the Sea—48-minute award-winning documentary. ($19.95)

Gray's Reef National Marine Sanctuary

10 Ocean Science Circle
Savannah, GA 31411
912-598-2345 (phone)
912-598-2367 (fax)
Web address: http://www.graysreef.nos.noaa.gov

Brochure

Gray's Reef National Marine Sanctuary general brochure

Educational Handbooks and Books

The Northern Right Whale from Whaling to Watching—educational module including handbook, video, and poster.
Tales of Whales, Turtles, Sharks, and Snails—elementary level educational handbook.

Posters

Rivers to Reefs
Invertebrates of the Reef

Gulf of the Farallones National Marine Sanctuary

Fort Mason Building #201
San Francisco, CA 94123
415-561-6622 (phone)
415-561-6616 (fax)
Web address: http://www.nos.noaa.gov/nmsp/gfnms/welcome.html

Brochures and Flyers

Gulf of Farallones National Marine Sanctuary general brochure—includes full-color map.

Newsletter

Hydrosphere—bi-annual newsletter about the Gulf of Farallones and Cordell Bank sanctuaries. Includes articles about current research in the sanctuaries, educational offerings, volunteer programs, natural and cultural history, and field adventures.

Directory

Marine and Coastal Educational Resources Directory—lists marine and coastal educational organizations and agencies in the San Francisco and Monterey Bay areas. ($3.95)

Posters and Discovery Cards

Marine Mammals of the Gulf of Farallones poster ($9.95)
Los Pajaros de Los Esteros poster—"Birds of the Estuaries" ($9.95)
Gulf of the Farallones National Marine Sanctuary Mural poster—a mural of the underwater open ocean habitat around the Farallon Islands.
Discovery Card Sets—12 card sets with color photos, amazing facts, illustrations, and challenging animal quizzes. Available are: marine mammals, gray whales, dolphins, humpbacks, and killer whales. ($3.99)

Resources and Education Packets

Marine Education Resource Library for Teachers—contains a wealth of materials for the classroom including curriculum guides, children's books, reference books, and videos.
Rocky Intertidal Teachers and Educators Packet—elementary and secondary level. Includes slide show with script, fact sheets, glossary, field trip ideas, classroom activities, full-color map brochure, "Things to Do to Save the Ocean" list. ($5.00)
Project Ocean—for grades K–6.

Books

Log Book of the Farallones —chronicles journeys in the Gulf of Farallones from 1971 to 1972 and later visits to Southeast Farallon Island. ($20.00)
Beached Marine Birds and Mammals of the North American West Coast—discusses how to identify most species of marine birds, mammals, sea turtles, sharks, and rays along the west coast. ($29.95)
West Coast Whale Watching—comprehensive guide offers tips for watching whales and other marine mammals from Alaska to Mexico. ($14.95)
Beachcomber's Guide to California Marine Life—a guide to exploring common marine fauna and flora from San Francisco to San Diego. ($17.95)
Great White Sharks—an academic book on the evolution, anatomy, physiology, behavior, ecology, distribution, and population biology of white sharks. ($79.95)
Blue Whales—includes beautiful photos and information. ($14.95)

Visitor Centers

Gulf of Farallones National Marine Sanctuary Visitor Center— portrays Gulf of the Farallones and Cordell Bank sanctuaries. Interact with animals at a touch tank, glimpse under the sea through an aquarium, see a real white shark jaw, touch the fur of sea otters and seals, discover microscopic animals underneath the microscope, and imagine giant whales filtering tiny shrimp-like krill through baleen.
Pacifica Visitor Center—highlights recreational activities in the sanctuary; includes an adult, male sea lion skeleton and sand box for kids.

Volunteer Opportunities

SEALS, A Harbor Seal Interpretation and Monitoring Program—trains volunteers to monitor harbor seal behavior and educate the public about responsible behavior around wildlife.
Beach Watch—acknowledged for its outstanding achievements, trains citizens-scientists to survey and document the resources of the sanctuaries.
Visitor Center—trains volunteers to educate the public about the sanctuary and its resources.
Internship Program

Recommended Local Web Link

Farallones Marine Sanctuary Association—http://www.farallones.org

For more information or to order materials, contact the Farallones Marine Sanctuary Association at 415-561-6625, P.O.Box 29386, San Francisco, CA 94129.

Hawaiian Islands Humpback Whale National Marine Sanctuary

726 South Kihei Road
Kihei, HI 96753
808-879-2818 (phone)
808-874-3815 (fax)
Web address: http://www.t-link.net/~whale

Brochures, Stickers and Flyers

Hawaiian Islands Humpback Whale National Marine Sanctuary general brochure
Ko'ie'ie Fishpond
Volunteer Announcement
Humpback Whale Approach Regulations
Watching Humpback Whales—includes biology, history, reproduction. (available in English and Japanese)
Pehea 'Oe E Hiki Ke Ho'omalu I Ka Moana (What you can do to protect the ocean (available in English and Hawaiian)
Hawaiian Islands Humpback Whale National Marine Sanctuary sticker
Issue paper on Fishing—one-pager addressing the issue of fishing in the Hawaii sanctuary.
Issue paper on User Fees—one-pager on the user fee issue.
Top Ten Questions Regarding the Hawaii Sanctuary
What Has the Hawaii Sanctuary Done for Hawaii
Sea Turtle Coloring book—includes conservation techniques. (available in English and Hawaiian)
Coral Reef coloring book—tri-lingual coloring book on the importance and conservation of the coral reef. This book was created in celebration of the United Nation's 1997 Year of the Coral Reef.
Ocean User's Guidebook—describes federal regulations pertaining to marine mammals and turtles.
Kohola/Kolea Children's Story coloring book—based on a story from the Marshall Islands concerning the plover and the humpback whale. (available in English and Hawaiian)
Pacific Coral Reef coloring book—(available in English, Hawaiian, and Samoan)
Species Cards—features the humpback whale, sea turtle, dolphin, and monk seal.
Native Plant Checklist flyer

Posters and Maps

Hawaiian Islands Humpback Whale National Marine Sanctuary poster
The Kohola (Humpback Whale) poster
Humpback Whale Activity poster—includes a whale migration maze, fluke matching game, and crossword puzzle.
Map of Maui Environmental Programs—describes environmental and educational programs.
Coral Reef Card—features common Hawaii coral reef species.

Volunteer Opportunities and Public Events

Hawaiian Islands Humpback Whale National Marine Sanctuary volunteer
Humpback Whale Workshop
Whale Fest
Whales Alive
Whale Discovery Day
Whale Regatta
Earth Day
Ocean Planet Exhibit: Bishop Museum
Career Day on the Water
Great Whale County
Federal Regulations and Enforcement Workshops for Ocean's User Workshop

Recommended Local Web Links

Hawaiian Monk Seal Recovery Efforts—http://kingfish.ssp.nmfs.gov/tmcintyr/pinniped/hawaiian.html
Hawaii Whale Research Foundation—http://www.hwrf.org
Kohola (Whale) in Hawaii—http://hookele.com/storyteller/kohola.html
Whales Alive Maui—http://www.nko.mhpcc.edu/whales_alive
Whale Watching Web site—http://www.physics.helsinki.fi/whale

Monitor National Marine Sanctuary

c/o The Mariners' Museum
100 Museum Drive
Newport News, VA 23606
757-599-3122 (phone)
757-5917310 (fax)
Web address: http://www.nos.noaa.gov/nmsp/monitor ***or*** http://www.cnu.ed/~monitor

Brochures and Other Printed Material

Monitor National Marine Sanctuary general brochure
Comprehensive bibliography—lists primary and secondary sources including news articles, papers, articles, and monographs.
The Monitor Collection and the permanent "Clash of Armor" Exhibit at The Mariners Museum brochure
The Ten Most-Often Asked Questions about the Monitor National Marine Sanctuary
Plans of the Monitor—blueprints of scale drawings of the ship and turret

Newsletter

Cheesebox newsletter—periodic activity report contains current information on ***Monitor***-related activities including on-site research, exhibits, management issues, and historical notes.

Books and Reports

Expedition to the Monitor National Marine Sanctuary: Data Analysis and Final Report
The Crewmen of the USS Monitor: A Biographical Directory
Preliminary Report: Stereo Photography and Artifact Retrieval 16 July–2 August 1977 Monitor Marine Sanctuary
Research and Education Combine to Bring the Monitor's Story Ashore
The Monitor National Marine Sanctuary: Preserving the Past for the Future
The Monitor—Lost and Found
A Look at the Monitor National Marine Sanctuary: Past, Present, and Future
Ironclad Captains: The Commanding Officers of the USS Monitor
Monitor Builder: A Historical Study of the Principal Firms and Individuals Involved in the Construction of the USS Monitor
Preliminary Report: Archaeological and Engineering Expedition Monitor Marine Sanctuary August 1–26, 1979

Educational Material and Presentations

Monitor National Marine Sanctuary curriculum—for grade 7; will be expanded to include middle and high schools. Includes a 15-minute video on the ***Monitor*** and sanctuary.
Outreach Kit—contains a wealth of information about the ***Monitor*** and sanctuary. Includes brochures, posters, publications, reproductions of artifacts recovered from the wreck, a reproduction of an officer's uniform, photographs of the ***Monitor*** and wreck, and reproductions of items that would have been used by the ***Monitor's*** crew.
On-Line Curriculum—includes information on the ***Monitor's*** builder John Ericsson, the construction on the ***Monitor***, the battle with the CSS Virginia, and the loss of the ***Monitor*** off Cape Hatteras.
Public Presentations

Poster and Models

Monitor National Marine Sanctuary poster
Monitor National Marine Sanctuary model—easy-to-assemble color model designed for third grade and above; includes information about the ***Monitor*** and sanctuary.

Videos, Exhibits, and Special Events

History of the Monitor and the ***Monitor National Marine Sanctuary*** (15-minute video)
"Monitor Days"—special events held at The Mariners' Museum including costumed interpreters and period music.
Down to the Monitor—contains an excellent historical overview and footage of archaeologists working at the wreck. (20-minute video)
Back to the Monitor—highlights sanctuary research and education; includes an historical overview of the ship and color footage of the ***Monitor*** and marine life inhabiting it. (Video)
Traveling Exhibit—details the sinking of the ***Monitor*** and discovery of the wreck in 1973.
Slides and Photographs

Monterey Bay National Marine Sanctuary

299 Foam Street, Suite A
Monterey, CA 93940
831-647-4201 (phone)
831-647-4250 (fax)
Web address: http://www.mbnms.nos.noaa.gov

Brochures and Flyers

Monterey Bay National Marine Sanctuary general brochure
Kayaking in the Monterey Bay National Marine Sanctuary brochure
Diving in the Monterey Bay National Marine Sanctuary brochure
Boating in the Monterey Bay National Marine Sanctuary brochure
Motorized Personal Watercraft in the Monterey Bay National Marine Sanctuary brochure
Together We Can—sanctuary flyer and coloring page (available in English and Spanish)

Citizen's Guide to Clean Water and the Monterey Bay National Marine Sanctuary brochure
Monterey Bay Begins on Your Street—brochure on urban run-off (available in English and Spanish)
Monterey is Closer Than You Think brochure

Newsletters

News from the Monterey Bay National Marine Sanctuary newsletter (3 issues/year)
Monterey Bay National Marine Sanctuary—Your Guide to its Natural History and Recreation newspaper

Directories

Marine and Coastal Educational Resources Directory—lists marine and coastal educational organizations and agencies in the San Francisco and Monterey Bay areas.
Monterey Bay National Marine Sanctuary Citizen's Stewardship Guide—lists opportunities for public involvement in the sanctuary.

Books

A Natural History of the Monterey Bay National Marine Sanctuary
Sanctuary Explorations

Posters and Charts

Monterey Bay National Marine Sanctuary—nautical chart
Are you Feeding Our Wildlife?—water quality poster
Monterey Bay National Marine Sanctuary Anniversary annual poster (five total)
Storm Drains Lead Straight to the Ocean poster
Good Cleaning Practice—poster for Auto Repair Industry
Good Cleaning Practice—poster for Food and Restaurant Industry
Monterey Submarine Canyon poster

Videos

Monterey Bay National Marine Sanctuary—A National Treasure (20 minutes)
Visitor's Guide to the Monterey Bay National Marine Sanctuary (12 minutes)
Dive into Fishwatching
Watersheds to Seashores (25 minutes)

Slide Presentation

Monterey Bay National Marine Sanctuary general slide show with script (20–25 minutes)

Volunteer Opportunities

Monterey Bay National Marine Sanctuary internships
BeachCOMBER volunteers
Save Our Shore's Sanctuary Stewardship Program
Center For Marine Conservation's BayNet Program
Monterey Bay National Marine Sanctuary Citizen's Stewardship Team

Recommended Local Web Links

American Cetacean Society—Monterey Bay Chapter—http://www.starrsites.com/acsmb
California Resources Agency—http://ceres.ca.gov
Coastside Live—http://www.coastside.net/COASTSIDE_Live
Internet Monterey Bay—http://www.bayotter.com
Local Oil Recycle Centers—http://www.ciwmb.ca.gov/wpe/usedoil/hotvb.asp
Local Marine Science/Education/Conservation Organizations—http://bonita.mbnms.nos.noaa.gov/intro/local_institutions.html
Monterey Net—http://www.montereynet.com
Sea Studios—http://www.seastudios.com
Santa Cruz Harbor—http://www.santacruzharbor.org

Olympic Coast National Marine Sanctuary

138 West First Street
Port Angeles, WA 98362
360-457-6622 (phone)
360-457-8496 (fax)
Web address:
http://www.nos.noaa.gov/ocrm/nmsp/nmsolympiccoast.html

Brochures and Flyers

Olympic Coast National Marine Sanctuary general brochure
The Intertidal Zone—fact sheet
History of the Olympic Coast National Marine Sanctuary—fact sheet
Marine Mammals—fact sheet
The Shipwreck, Austria—fact sheet
Sanctuary Advisory Committee Annual Report

Volunteer Opportunities

Olympic Coast National Marine Sanctuary intern program
Olympic Coast National Marine Sanctuary volunteer program

Stellwagen Bank National Marine Sanctuary

174 Edward Foster Rd.
Scituate, MA 02066
781-545-8026 (phone)
781-545-8036 (fax)
Web address: http://vineyard.er.usgs.gov

Newsletters and Newspapers

Stellwagen Soundings—newsletter

Posters and Charts

Stellwagen poster—shows underwater topography.

Curriculum Guides

From Whaling to Watching—for grades 4–8; includes 20-minute video and 40-page book detailing the history, biology, and conservation programs for the endangered northern right whale.
Spirit of the Auk—middle school curriculum focuses on human interactions with marine species (particularly whaling and fishing), sustainable use of resources, abundance, exploitation, extinction, food webs, and other issues. Includes video (***Bounty of the Banks***), audiotape by master storyteller Jay O'Callahan, and curriculum book.
The Food Bank CD-ROM—focuses on marine food webs at Stellwagen Bank. Includes hundreds of underwater photographs, dozens of video clips, and games (including an energy pyramid program).

National Marine Sanctuary Program

1035 East-West Highway
Silver Spring, MD 20910
Phone 301-713-3125
Fax 301-713-0404
Web address: http://www.sanctuaries.noaa.gov

Brochures and Flyers

National Marine Sanctuaries—Tour of the Sanctuaries general brochure.
National Marine Sanctuaries Accomplishments Report, 1998—highlights some of the most significant accomplishments and partnerships at each sanctuary.
National Marine Sanctuaries Management Plan Revision—describes the process to revise sanctuary management plans.
NOAA's National Marine Sanctuaries National Map—shows location of each sanctuary.
NOAA Backgrounder: National Marine Sanctuaries—describes the National Marine Sanctuaries Program.
Guide to Diving America's National Marine Sanctuaries—a comprehensive dive guide to the 12 national marine sanctuaries (reprint from Rodale's Scuba Dive Magazine).

Program Documents

National Marine Sanctuaries Strategic Plan, January 1999—contains the program's vision, mission, goals, and fiscal year 1999 priorities.
National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.)—the authorizing legislation for the National Marine Sanctuaries System.
National Marine Sanctuaries Program Regulations (15 CFR Part 922)—regulations for the national program and individual sanctuaries.

Newsletters and Information

Sanctuary News—an electronic newsletter updated monthly (http:www.sanctuaries.noaa.gov).
NOAA News—a comprehensive electronic newsletter that covers news and activities from all of NOAA's programs (http://www.noaanews.noaa.gov/).
NOAA Report—a publication that covers topics about the national marine sanctuaries and other parts of NOAA such as the National Weather Service and the National Marine Fisheries Service (http://www.publicaffairs.noaa.gov/nr).

Additional Web Resources

Coral Reefs

Coral Forest—http://www.blacktop.com/coralforest
Coral Reef Alliance—http://www.coral.org
International Year of the Reef—http://ww.coral.org/IYOR
Reef Relief—http://www.reefkeeper.org

Fisheries

Building Sustainable Fisheries—http://www.noaa.gov/nmfs/sustain.html
National Marine Fisheries Service Stats and Economics—http://www.st.nmfs.gov/st1/recreational/index.html
National Marine Fisheries—http://www.nmfs.gov

Hydrothermal Volcanoes

Adventure Under the Oregon Coast—http://www.teleport.com/~samc/seas/deep1.html
NOAA Vents Program—http://www.pmel.noaa.gov/vents/geology/video.html
VENTS Program—http://www.pmel.noaa.gov/vents/home.html

Maps

Digital Images or electronic charts—http://www.maptech.com
Environmental Protection Agency's Maps on Demand—http://www.epa.gov/enviro/ html/mod/mod.html
NOAA Nautical Charts and Mapping—http://chartmaker.ncd.noaa.gov
Ordering page for NOAA nautical charts—http://chartmaker.ncd.noaa.gov/ocs/text/prices.htm#order

Marine Mammal Migration

Journey North—http://www.learner.org/jnorth
On the Trail of the Right Whale—www.rightwhale.noaa.gov
Sea Turtle Tracking Program—http://www.cccturtle.org/sat1.htm
Turtle Migration Data—http://www.nos.noaa.gov/nmsp/grnms
Whale Net—http://whale.wheelock.edu/archives/whalenet

Oceans, Coasts, and Tides

Adopt-a-Beach Program—http://www.glo.state.tx.us
Adopt-a-Buoy Program—http://www.ndbc.noaa.gov/educate/educate.shtml
Adopt-the-Coast Action Kit—http://nos.noaa.gov/ocrm/pcd/outreach.html
Making Tide Predictions—http://www.ceob.nos.noaa.gov/tideframe.html
National Data Buoy Center—http://www.ndbc.noaa.gov

Online Data

Activities Using Research Data—http://www.oar.noaa.gov
Environmental Services Data Direct—http://www.esdim.noaa.gov
National Geophysical Data Center—http://www.ngdc.noaa.gov/ngdc/ngdcsociety.html
NOAA SW Coastal Buoy Data—http://www.nws.fsu.edu
Project YOTO Drifters—http://www.drifters.doe.gov

Online Expeditions

JASON Project—http://www.jasonproject.org
Ocean Adventure—http://hyperion.advanced.org/18828
Reefs of the Gulf—http://gulftour.tamu.edu/home.html
Society for Underwater Exploration—http://www.underwaterdiscovery.org
University of Washington "REVEL Project"—http://www.ocean.washington.edu/outreach/revel

Organizations and Other Resources

Association of Zoos and Aquariums—http://www.aza.org
Australia's Great Barrier Reef Marine Park—http://gbrmpa.gov.au
Center for Marine Conservation—http://www.cmc-ocean.org
Classroom Connect—http://www.classroom.net
Creatures—http://discovery.com/stories/nature/creatures/creatures.html
Deep Sea Animals—http://www.virtual-canyon.org
Earthwatch—http://www.earthwatch.org
EPA Oceans—http://www.epa.gov/owow
Estuarine Research—http://www.nos.noaa.gov/ocrm/nerr/nerrs_education.html

Environmental Defense Fund—http://www.edf.org
Galapagos Quest—http://www.cnn.com/NATURE/9903/15/galapagosquest/index.html
GOALS (Global Online Adventure Learning Site)—http://www.goals.com
Great American Fish Count—http://www.fishcount.org
Hawksbill Turtles—http://www.topia.com/hawksbill
Live from Antarctica 2—http://quest.arc.nasa.gov/antarctica2
Marine Sanctuaries—http://www.sanctuaries.noaa.gov
Monterey Bay Aquarium Research Institute—http://www.mbari.org
National Geographic Society—http://www.nationalgeographic.com
National Science Teacher's Associations—http://www.nsta.org
New Millennium Observatory—http://newportpmel.noaa.gov/nemo_cruise98
NOAA's Classroom at Sea—http://classroomatsea.noaa.gov
NOAA Central Library Internet Locator—http://www.lib.noaa.gov/docs
NOAA Teacher at Sea Program—http://www.tas.noaa.gov
NOAA Corps Fleet—www.nc.noaa.gov/fleet.html-
Ocean Futures—http://www.ocean.futures.org
Ocean Sciences Teacher Education Resource—http://www.vims.edu/bridge
Save our Seas—http://planet-hawaii.com/sos
Sites Alive—http://www.sitealive.com
The Nature Conservancy—http://www.tnc.org
Year of the Ocean homepage—http://www.yoto98.noaa.gov

Satellite Imagery

Satellite imagery—http://terraserver.microsoft.com
SeaWiFS Project—http://seawifs.gsfc.nasa.gov
Topex Poseidon—http://www.jpl.nasa.gov

SCUBA Diving

Divers Alert Network (DAN)—http://www.dan.ycg.org
Scuba Central—http://www.scubacentral.com

Shipwrecks and Archaeology

Links to Technical Diving—http://www.scubacentral.com
Links to Underwater Archaeological Resources—http://fiat.gslis.utexas.edu:80
Maritime History Virtual Archives—http://pc-78-120.udac.se:8001/WWW/Nautica/Nautica.html
Maritime Studies Program, East Carolina University— http://ecuvax.cis.ecu.edu/academics/schdept/hist/maritime/maritime.htm
Nautical Archaeology Program, Texas A & M University—http://nautarch.tamu.edu
Submerged Cultural Resources, National Park Service—http://www.nps.gov/scru
Underwater Archaeology—http://adp.fsu.edu/uwarch.html

Submersibles

Alvin—http://www.marine.whoi.edu/ships/alvin/alvin.htm
Deep Ocean Exploration and Research—http://www.doer-inc.com
Designing a submersible—http://www.32ndparallel.com/custom.htm
Geology 105—http://geosun1.sjsu.edu/~dreed/105/menu.html
National Undersea Research Program—http://www.ucc.uconn.edu/~wwwnurc/nurp.html
Nuytco Research Ltd.—http://www.nuytco.com
ROV Tiburon—http://www.mbari.org/rd/tiburon/index.html
ROV Ventana—http://www.mbari.org/dmo/ventana/ventana.html
Submersibles—http://www.rcboats.com
Submersibles Bathyscaph Scale Models Alvin Trieste—http://www.globaloutlet.com/store/vm.html
UW Oceanography: Mid-Ocean Ridge Processes—http://bromide.ocean.washington.edu
Woods Hole Oceanographic Institute's ROVs—http://www.marine.whoi.edu/ships/rovs/rovs.htm
Woods Hole Oceanographic Institute's Future Directions—http://www.marine.whoi.edu/ships/future_directions.htm

Teacher Resources

Amazing Environmental Organization web directory—http://www.webdirectory.com
Earth and Sea Investigations—http://www.earthsea.org
Hotlinks page—http://members.aol.com/rmt1838/hotlinks.html
NOAA Sea Grant College Programs in the U.S.—http://www.mdsg.umd.edu/seagrantmediacenter
Resources for Teachers—http://www.csun.edu/~vceed009
Sea Grant Teacher Resources—http://www.mdsg.umd.edu/NSGO/WhatisSeaGrant.html#EDUCATION
The Difference Between Weather and Climate—http://www.ogp.noaa.gov/OGPFront/Edoutrch.html
Weather Education—http://www.nws.noaa.gov/er/btv/html/wxeduc.html

Weather

El Niño and Climate Prediction—http://www.pmel.noaa.gov/toga-tao/el-nino
El Niño Homepage—http://www.ogp.noaa.gov/enso
In Tech 2000 Forum—http://miamisci.org/hurricane
National Hurricane Center—http://www.hurricanehunters.com/welcome.htm
NOAA Ship on El Niño Watch—http://rho.pmel.noaa.gov/atlasrt/kaimi.html
NOAA Weather Radio—http://www.nws.noaa.gov/nwr/nwrbro.htm
Weather Education—http://www.nws.noaa.gov/om/educ/educ2.htm
Weather Education—http://www.nws.noaa.gov/om/edures.htm
Weather Education Information in the Regions—http://nws.noaa.gov/regions.html

Additional Books and Articles

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Barracato, Jay. 1998. ***Teach with Databases: Toxics Release Inventory.*** Grades 9–12. Arlington, Va: NSTA.

Bascom, Willard. 1928. ***The Crest of the Wave. Adventures in Oceanography.*** New York: Harper & Row.

Beebe, William. 1934. ***Half Mile Down.*** New York: Harcourt, Brace and Co.

Broad, William J. 1997 ***The Universe Below: Discovering the Secrets of the Deep Sea.*** New York: Simon and Schuster.

Carson, Rachel. 1951 ***The Sea Around Us.*** New York: Oxford Press.

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Cousteau, Jacques. 1953. ***The Silent World.*** New York: Harper & Brothers.

Crowder, Jane, and Cain, Joe. 1997. ***Water Matters, Volume 2.*** Grades 3–8, 32 pp. Arlington, Va: NSTA.

Cuyvers, Luc. 1993. ***Sea Power: A Global Journey.*** Annapolis: Naval Institute Press.

Daily, Gretchen C., and Paul R. Ehrlich. 1992. "Population, Sustainability, and Earth's Carrying Capacity." ***Bioscience*** 42 (10): 761–771.

Doran, Rodney; Chan, Fred; and Tamir, Pinchas. 1998. ***Science Educator's Guide to Assessment.*** Curriculum. Grades 7–12, 220 pp. Arlington, Va: NSTA.

Earle, Sylvia A. 1995. ***Sea Change: A Message of the Oceans***. New York: Random House, Inc.

Earle, Sylvia A., and Al Giddings. 1980. "***Exploring the Deep Frontier: The Adventure of Man in the Sea.***" National Geographic Society.

Earle, Sylvia A. 1999. ***Hello Fish.*** Washington, D.C.: National Geographic Society.

Earle, Sylvia A. 1999. ***Dive***. Washington, D.C.: National Geographic Society.

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_____. 1990. "Ocean Everest—An Idea Whose Time Has Come." ***Marine Technology Society Journal*** 24 (2): 9–12.

_____. 1989. "Sharks, Squids, and Horseshoe Crabs: The Significance of Marine Biodiversity." ***Bioscience*** 41 (7): 506–509.

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Eckert, Scott. 1992. "Bound for Deep Water." ***Natural History*** March: 28–35.

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Hass, Hans. 1951. ***Diving to Adventure.*** Garden City, New York: Doubleday & Co., Inc.

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McKinnon, Michael, and Peter Vine. 1991. ***Tides of War.*** London: Boxtree Ltd.

Nash, Ogden. 1937. "A Beginner's Guide to the Oceans" in ***Good Intentions***. Boston: Little Brown and Company.

National Geographic Society. Nov. 1990. ***Should We Set Aside Ocean Wilderness?***

National Geographic Society. July 1992. ***Sub Story.*** World Magazine, 8–11.

National Geographic Society. March 1993. ***Monterey Bay Waters Gain Protected Status.***

National Geographic Society. Sept. 1993. ***The Problem's Deep.*** World Magazine, 14–23.

National Geographic Society. April 1994. ***Diving for Treasures in a Living Sea.***

National Geographic Society. May/June 1994. ***Dive! Dive!*** Traveler Magazine.

National Geographic Society. Dec. 1996. ***Now THIS is a Fish Story.***

National Geographic Society. April 1997. ***Can He Fly a Sub to the Deep?***

National Geographic Society. Sept. 1997. ***Down We Go into the Deep Blue Under.***

National Geographic Society. Feb. 1998. ***To the Ocean Floor.*** Millenium Moments.

National Geographic Society. April 1998. ***When I Was a Kid: Jacques Cousteau.*** World Magazine.

National Geographic Society. Nov. 1998. ***New Support for Sustainable Seas.*** Behind the Scenes.

National Geographic Society. Feb. 1999. ***Coral Eden.***

National Geographic Society. 1978. ***The Ocean Realm.*** Washington, D.C.: National Geographic.

Our Living Oceans: "The First Annual Report on the Status of U.S. Living Marine Resources." Washington, D.C.: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

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National Science Teachers Association. 1992. ***Earth: The Water Planet*** Curriculum. Grades 6–10, 204 pp.

National Science Teachers Association. 1993. ***Earth at Hand*** Curriculum. Grades 5–10, 176pp.

National Science Teachers Association. 1997. ***Decisions-Based on Science*** Curriculum. Grades 9–12, 144 pp.

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Sustainable Seas Expeditions

Teacher Resource Book

EVALUATION FORM

Thank you for taking the time to complete this Evaluation Form. Your comments will help us improve the educational materials that we develop in the future.

1. Circle the grade level(s) you teach:

   6 7 8 9 10 11 12

2. I teach (circle all that apply):

   Geography Life Science Physical Science Earth Science Social Science

   Other: _____

3. Rate the Teacher Resource Book in terms of quality .

High quality				***Low quality***
1	2	3	4	5

4. Rate the Teacher Resource Book in terms of usefulness.

Very useful				***Not useful***
1	2	3	4	5

5. The materials and activities are written at a level appropriate for a high school audience.

Strongly agree	***Agree***	***Not sure***	***Disagree***	***Strongly disagree***
1	2	3	4	5

6. These materials address my needs to teach to the local, state, and national standards in science and geography .

   Agree ***Disagree***

7. The Investigations I used in my classroom were (circle all that apply):

   Investigation 1: What are National Marine Sanctuaries?

   Investigation 2: A Closer Look at One Sanctuary

   Investigation 3: Planning an Expedition

   Investigation 4: Designing a Submersible

8. The amount of time my students spent on **Sustainable Seas Expeditions** was:

0–1 hours | 1–2 hours | 3–5 hours | 6–8 hours | 8–10 hours | More than 10 hours

9. Was there an **Expeditions** Student Summit in your area? Yes No

If yes, did your students attend? Yes No

Did your students share their projects with others? Yes No

If yes, how valuable was this experience to their learning?

Very valuable				***Not very valuable***
1	2	3	4	5

10. I am interested in participating in **Sustainable Seas Expeditions** again next year .

Strongly agree	***Agree***	***Not sure***	***Disagree***	***Strongly disagree***
1	2	3	4	5

11. Circle the parts of the **Sustainable Seas Expeditions** Teacher Resource Book that you feel need improvement:

Background Information | Investigations | Teacher Resources

12. Suggestions for improvement:

13. Did you notice student learning as a result of using these materials? Please explain your observations and conclusions.

14. Are there any activities, background information, or resources for teachers and students that you recommend adding to or deleting from these materials?

Please send your completed Evaluation Form to:

Sustainable Seas Expeditions

Attention: Teacher Resource Book

735 State Street, Suite 305

Santa Barbara, CA 93101

NSTA National Science Teachers Association

NATIONAL MARINE SANCTUARIES

NOAA

Learning IN MOTION

NATIONAL GEOGRAPHIC SOCIETY

Privacy and Security Notice

Sustainable Seas Expeditions Web Site
Silver Spring, Maryland

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Collection of Technical Information

All Web servers need to collect technical information in order to share their contents with visitors. The technical information (see example below) identifies what part of the Web site a visiting computer wishes to reach, and where to send the requested information once it is found. For site management, this technical information is also used for statistical analysis. Summary statistics are used for such purposes as assessing what information is of most and least interest, identifying usage trends over time, determining technical design specifications, and identifying system performance or problem areas. These aggregate statistical summaries are posted on the National Ocean Service Web site, and are available to the public.

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Web Cookies

This Web site does not use Web "cookies."

Site Security

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Questions or Comments

If you have any questions or comments about the information presented here, please forward them to SSEwebmaster@noaa.gov.

Example of information collected by this Web site

Web servers keep a record of their activity in a log file. Every time a visiting computer requests a file from the Web server, a log entry is recorded. A typical log file entry for the Sustainable Seas Expedition Web site looks like this:

> **10/04/00 13:19:18 OK 200**
> **somemachine.somenetwork.com**
> **Mozilla/4.75 (Macintosh; U; PPC)**
> **http://othermachine.othernetwork.com/neatsites.html**
> **"sustainableseas.noaa.gov ":index.html 16208**

What this entry means:

> **10/04/00 13:19:18** -- Date and time of the request (24-hour clock).
>
> **OK 200** -- Status code of the request. "OK" and a status code of "200" are equivalent; they mean the requested file

was successfully found and delivered to the requesting (visitor's) computer.

somemachine.somenetwork.com -- Internet address (or IP address, in the form of 123.123.123.123) of the requesting computer. The last part of the address, .com, indicates the requesting computer is on a commercial network. Other commonly seen addresses end in .mil (US military), .net (a different category of commercial network), .org (non-profit organization), .gov (US government agencies, state and Federal), etc. Depending on how the requesting computer is connected to the Internet, this may not identify a specific computer.

Mozilla/4.75 (Macintosh; U; PPC) -- Type of browser used by the requesting computer.

http://othermachine.othernetwork.com/neatsites.html -- The Internet address of the last site visited by the requesting computer, useful in discovering how visitors found this Web site.

"sustainableseas.noaa.gov" -- The Internet address of this Web site. As it is possible to operate several Web sites on a single computer, the Web server uses this information to determine which Web site should handle the request.

:index.html -- The name of the file requested by the visiting computer.

16208 -- Size of the requested file, in bytes.

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top

August 2, 1999

Gale Mead, Expedition Log Editor

This morning saw the pre-dawn arrival on board of Sylvia Earle, and various other personnel, ready for a 6:30 a.m. departure back out to the reef. The heat has, overnight, calmed from utterly oppressive to merely sultry, but this afternoon promises more crushing, humid, 100-plus temperatures.

The project team is making a plan for the remainder of the mission's dives to be completed in the morning and at night, to avoid having to work on deck in the worst heat of the day. But for today, we will have to tolerate a dive during peak heat hours, to accommodate the schedule of a boatload of media representatives on board to report on SSE's progress.

A YSI 6600 Water Quality Sonde was mounted to DeepWorker to record a variety of environmental parameters. (Sonde provided by YSI)

After much discussion, the project team decides to save Sylvia's dive for this evening, and to have me and National Geographic photographer Kip Evans do a two-sub dive this afternoon. Kip will pursue his usual mission of capturing images of critters, habitat, and the second sub. My tasks include checking out both the fish and the sub itself.

The predives start at around 11:00 a.m. even though we don't plan to dive until 2:00 p.m. The heat is a formidable force, and we are moving a little more slowly than we otherwise would. As I proceed through predive checks on sub #3, I discover that the port lateral thruster has leaked out almost all of the oil that is supposed to fill its chamber. Scott, Larry, and Phil are right on it, and quickly replace it with a spare thruster that's in good working order.

Kip climbs into his sub, and fields questions from reporters right up until they close the hatch. As soon as Kip's sub is off the deck, mine is transferred into position for launch and I gather my last minute necessities: towels to soak up sweat, two frozen bottles of water and some water-soaked towels that have also spent some time in the deep freeze, and a paper cup of crushed ice. Heat and dehydration are a real concern, especially when you're the only person available to treat or prevent your own heat stroke.

The reporters approach the sub, and the first asks, Do you carry a good luck charm? A little abashed, I hold up the little striped cat who has accompanied me now on the past several missions, a gift to me from a very dear 9-year old friend. Like the Geobear in the Olympic Coast, Stripes allows Tess to travel vicariously, and I'm hoping Kip can capture a photo of Stripes peering hungrily at the fish while at depth.

Click on the above image to view a graph of YSI 6600 Water Quality Sonde data.

Hatch closed, sub launched, and I maneuver over to the RHIB. The plan is for me to follow Kip's buoy line down so I can find him on the bottom, but I can't get too close, because I have to be careful not to get our two buoy lines entangled. Visibility is much worse than we'd expected, and I have trouble seeing his line underwater. We decide to have Kip surface, and the two of us descend together.

photo

Gale Mead exuberant after a successful dive.

We play follow-the-leader all the way to the reef, Kip receiving compass headings from topside, me following behind across sandy bottom scattered with occasional small rocks covered with corals and sponges. Eventually, we find the reef, and pause so that Kip can swoop around and over me to film my sub. The heat inside the sub is hardly better at 65 feet than it was topside, and I am grateful for all the ice I brought with me.

We spend an hour cruising the reef, with barracuda, angel fish, and a host of smaller fish in evidence. A group of about 20 spade fish in a vertical plane formation cruise between the two subs, do a lap around my sub, then back and forth in front of Kip's cameras.

Sub #3 worked well, and the efforts made by Nuytco to trim the sub were effective. I had no trouble maneuvering, and was level in the water. All systems performed as advertised, except the manipulator arm.

I powered it up and watched the gauge for the hydraulic fluid as it charged up to 1000. But a few small movements of the arm were all I could manage before the gauge dropped back to zero. I powered it down and back up again as instructed, but to no avail. I didn't have a need for it anyway, but it'll be something for the guys to work on when the sub returns topside.

Back on deck, we learn that the RV Jane Yarn is experiencing technical problems, and the berthing spaces that ship was to have provided will therefore be unavailable. Cathy Sakas will stay on board the FERREL for the next two nights so she can get her next night dive in, while Reed Bohne, Dave Lott, and I return to shore. I quickly gather my things so I can depart with them on the media's shuttle for the two-hour ride back to Savannah.

Tonight, Sylvia was scheduled to complete an exploratory night dive, but our luck with calm weather just ran out, as the FERREL was caught in a mighty thunderstorm that precluded any dive operations. We'll try again tomorrow night, weather permitting.

National Geographic photographer Kip Evans awaits his turn to launch.

Rough weather has plagued many of the expedition projects especially on the west coast. The Gray's Reef expedition is not immune and the ships ride out a tremendous storm that clocks a peak gust of 80mph.

William Bartram, our fellow colonial explorer wrote in 1776.

"There are few objects out at sea to attract the notice of the traveller, but what are sublime, awful and majestic: the seas themselves, in a tempest, exhibit a tremendous scene, where the winds assert their power, and, in furious conflict, seem to set the ocean on fire. On the other hand, nothing can be more sublime than the view of the encircling horizon, after the turbulent winds have taken their flight, and the lately agitated busom of the deep has again become calm and pacific: the gentle moon rising in dignity in the east, attended by millions of glittering orbs; the luminous appearance of the seas at night, when all the waters seem transmuted into liquid silver; the prodigious bands of porpoises foreboding tempest, that appear to cover the ocean; the mighty whale who cleaves the seas in his course; ... or as we approach the coast , the capes and promonitories first strike our sight, emerging from the watery expanse, and, like mighty giants, elevating their crests towards the skies; the water suddenly alive with its scaly inhabitants; squardons of sea-fowl sweeping through the air , impregnated with the breath of fragrent aromatic trees and flowers; the amplitude and magnificance of these scenes are great indeed, and may present to the imagination, an idea of the first appearance of the earth to man at the creation".

(top) RETURN

August 3-4, 1999

Gale Mead, Expedition Log Editor

Tom Potts, Research Coordinator
Gray's Reef National Marine Sanctuary

Will we or won't we? Can we or can't we? It's 1:25 on Wednesday, and sanctuary research coordinator Tom Potts sits patiently in the pilot's seat of the DeepWorker awaiting the verdict. Final checks on the sub were completed at 1:10, and since then, we've been watching the seas, feeling the pitch and roll of the FERREL, and trying to gauge the conditions for launch and recovery.

The crushingly hot temperatures have abated, but along with that change in the weather has come the loss of those perfect, glassy calm seas. Winds are 17 knots out of the northeast, and we have a very sloppy 3-5 foot swell. Tuesday, the FERREL steamed 60 miles offshore to the deep reef, but conditions were too rough even to launch the ROV, never mind the sub. Tom finally decides to get out of the sub and await the decision in the relative comfort of the crew's mess.

I spend some time chatting with the FERREL's Commanding Officer, Cdr. Paul Moen. Paul is not a large man, but he projects confidence, competence, and poise, and it's easy to see why he is so well-liked by his crew. When not commanding his ship, he writes, sings, and plays folk songs about the sea, and he promises to share a recording of his music with us soon.

Cdr. Moen told me the challenges of working with SSE have been significant, but well worth the extra effort the job has required. He is clearly very proud of his crew and his ship, as they have been able to prove to naysayers that the FERREL is fully capable of handling the launch and recovery of the subs, as well as the other challenges of meeting SSE's special needs.

Finally, at about 1800, conditions look calm enough for a launch. Everyone moves quickly to get Tom back in the sub, pull a vacuum, and get the sub over the side. Seas and wind make for a bumpy deployment, but the FERREL's deck department, led by Chief Bosun Cornell Hill, are an efficient team, and are pros at handling the sub. The launch goes flawlessly, and as the sun sets, Tom submerges onto the reef.

The rest of us converge on the oceanographic lab to see how the new tracking system, installed late last night, is working. And hallelujah! It's working flawlessly! Through-water communications are working well, the 3-chip camera will be great for taking night footage of the reef, and the sub's systems are all in perfect working order. The team from Nuytco can take a great deal of satisfaction in seeing things go so smoothly.

The plan is for Tom to have an extra-long dive, to make the most efficient use of this opportunity to get the sub onto the reef. He change, from fish that are active during the day to those that only come out at night. We suspect he's in for a spectacular show.

Here's Tom's dive report:

"Visibility at the surface was not much more than five feet, and didn't improve much in the few minutes it took to hit bottom at 62 feet. The bottom was coarse sand, and it was necessary to get a compass heading from topside so I could find the reef ledge. By adjusting my course to run perpendicular to the sand ripples, while following reef-associated fishes, such as black sea bass, spadefish, and sheepshead, it took only a few minutes to find the heart of the reef.

"The ledge was a well-developed, live bottom outcropping. All exposed hard bottom was colonized by invertebrates and covered with algae. The fish composition was typical for south Atlantic bight outcrops. Warm water temperatures make the habitat suitable for tropcials like spotfin butterflyfish, blue angelfish, and cocoa damselfish. The absence of large grouper was a bit surprising, given the abundance of ideal habitat such as large undercuts.

"I begin to run 100 meter transects, and completed one before I determined that visibility was insufficient to allow me to estimate a course that would keep me on the reef. I then switched to three-minute timed transects, which allowed me to cover a large portion of the reef in about 20 minutes. After six transects, available light was waning, and unsuitable for continuing with this portion of the dive.

"Taking advantage of the opportunity to sit on the bottom and observe, I was privileged to watch the amazing day-night fish composition change-over. Tomatates gathered in schools to head off the reef to sandy bottom to feed. Spottail pinfish and blue angelfish limited their activity and hunkered down under cover. Scup took on a blotched, mottled pattern that resembled the markings of black sea bass.

"As sun set and ambient light faded to black, the sub's bright HID lights attracted swarms of tiny free-swimming invertebrates and fish. This created a feeding frenzy for black sea bass, flounder, and even a few mackerel and barracuda."

It's now 10:30 p.m., and the sub only just now arrived back on deck. It's been a very long work day for the ship's crew, the scientists, and especially the team from Nuytco. Before we can call it a day, we'll still need to wash down the sub, complete the post-dive work, and put the sub's batteries on charge for tomorrow. Tom will

have to review and makes copies of all the video from his dive, making notes of what he saw and did. In the morning, we'll make a 6:00 a.m. check of the weather to decide how we're going to plan the day's dive activities, but we probably won't try to dive until later in the morning. In spite of the challenges of the weather, it's been another successful day at sea.

William Bartram (1776) notes

"Behold the watery nations, in numerous bands roving to and fro, admidst each other, here they all seem at peace; though incredible to relate, but a few yards off, near the verge of the green mantled shore there is eternal war, or rather slaughter! Near the banks the waters become turgid,... which afford a kind of nursery for young fry, and its slimy bed a prolific nidus for generating and rearing of infinite tribes and swarms of amphibious insects, which are the food of the young fish, who in turn become a prey to the older. Yet when those different tribes of fish are in the transparent channel, their very nature seems absolutely changed, for here is neither desire to destroy or persecute, but all seems peace and friendship; do they agree on a truce, a suspension of hostilities? or by some secret divine influence, is desire taken away? or they are otherwise rendered incapable of pursuing each other to destruction?"

DeepWorker recovery after Tom Potts dive at Gray's Reef.

(top) RETURN

SUSTAINABLE SEAS EXPEDITIONS
MISSION LOG

GRAY'S REEF

SITE INDEX

August 5, 1999

Gale Mead, Expedition Log Editor

Tom Potts, Research Coordinator
Gray's Reef National Marine Sanctuary

Gale writes:

Another great day of successful dives. Early this morning, the FERREL steamed out to the deep reef site we'd wanted to dive Tuesday. Weather is overcast and steamy, but winds and seas are calm enough to allow us to dive.

The FERREL has a small crew of only four officers and about 10 crew. Everyone has to pitch in to make launch and recovery of the sub successful, with officers, Nuytco technicians, and scientists handling taglines alongside deck crew members, taking turns at swimmer duty, and operating the winch. Having a cohesive team spirit with a common goal makes it possible for us all to work effectively together. Laddie Akins is soon in the water for a three-hour visit to the deep reef 200 feet below. Visibility is spectacular, 50 feet or more in beautiful blue water.

Here's Laddie's dive report:

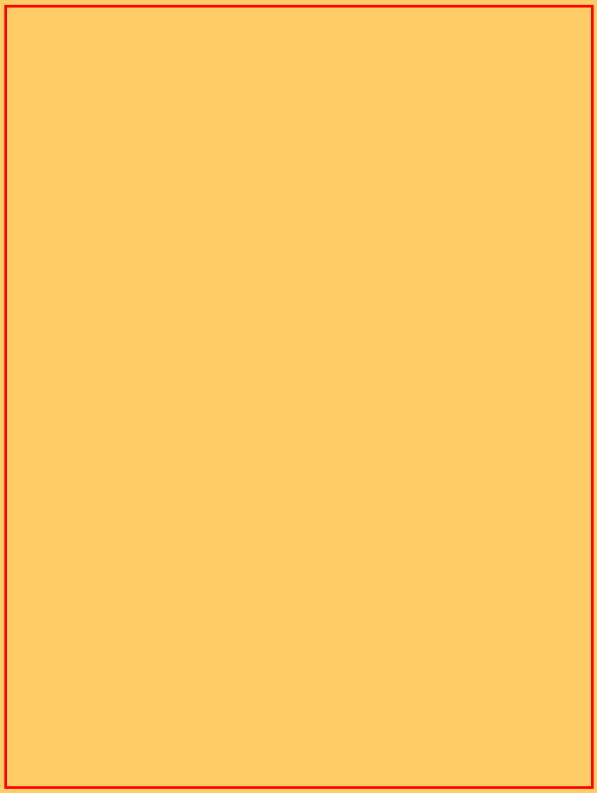
0700 hours - Pre-dives start for my first deep dive and the weather is looking good! A look over the side of the FERREL shows a deep, deep blue - the kind reserved for royalty and Montana Skies. Pre-dives run smoothly and I'm ready to launch by 08:30.

The focus of my dive on this site is going to revolve around three main objectives. First, the FERREL has placed three markers about 400meters apart on what we believe to be the contour of the site. They consist of 45 pound concrete weights with small floats attached by a four foot line. With direction from topside tracking, I'm hoping to locate these markers for

Laddie Akins preparing to be deployed in the DeepWorker while Phil Otalora supervises.

future reference as study site locations. Tracking has been sporadic and this location is unknown, so I'm hoping for the best, but expecting the needle in the haystack. It's a big ocean!

Second on my list of objectives is to locate the high profile system we've seen on the depth finder and to conduct fish surveys in the area. With this site nearly 80 miles offshore, I expect it to be heavily influenced by the Gulfstream current - that steady river of ocean that curls clockwise through the Gulf of Mexico, shoots the gap between Cuba and the Florida Keys then moves northward along the east coast to about Northern North Carolina. The conditions of an area bathed by this current usually warm, clear and at least somewhat tropical. My plan is to find out how tropical. This offshore reef system may well be a feeder reef for the shallow Grays reef sites we've visited earlier in the week. It will be interesting to see the similarity and differences between them.



Alex Score prepares the buoy markers to be deployed in the Sapelo Scarp Reef for permanent transect stations.

The third objective is simply exploration. Finding out what is here. There have been some ROV images from this site and some side scan sonar images, but to really get a true picture of the area, a first hand look is hard to beat. I've got three hour long digital video tapes and a roll of 35mm still camera film to burn and I plan on using every bit of it.

0930 hours - I'm lifted and eased into the water behind the FERREL. The water is a sapphire blue. Its hard to gauge visibility without a good reference, but I'm guessing at least 60 feet and possibly up to 100. I'm a short distance away from our target site, so I get a short tow from the chase boat. As I peer through the DeepWorker's dome, I see a four foot Silky Shark swimming slowly towards me from the edge of visibility. It moves in a slow determined path to about 30 feet, then does an abrupt 180 and heads deep again. I guess I didn't look quite fishy enough for a closer approach.

0945 - Time to dive! I flood my soft ballast tank and begin a slow drop to the bottom. Every 50 feet of descent I radio topside to let them know where I am. I go through a slight thermocline at about 60 feet and continue down. At 100 feet a couple of Almaco Jacks come over to greet me and keep me company. 160 feet and I can see bottom! I slow the descent and touch down at just over 180 feet. I've landed in a barren sand bottom, and spend a few minutes waiting for topside to confirm my location using their tracking system.

After my position is confirmed, I move in according to topside's direction. I'm heading for our research station marker number 1. 40 minutes of sand later, I begin to see the outline of a hardbottom ledge up ahead. In the sand just in front of the ledge are 8 beautiful angelfish waiting to greet me. I drop to the sand and radio topside that I've found the first hardbottom of the deep reef system. The position is marked and I continue on a course for marker #1.

I'm moving over nice rocky outcroppings now, but still no sign of the marker. Topside gives me another heading change and I alter my course 30 degrees to starboard. 30 seconds later I see a 15 square-cut ledge. I look to the right and there sits marker #1! Beautifully placed right at the edge of two high profile ledges. The amberjacks are everywhere, angelfish and groupers too. I move in to get good photo and video footage of the marker. 20 seconds of concentrated maneuvering and I glance up to get a reference on the ledge. I almost fall out of the sub!! I've spent 17 years of diving and many, many thousands of hours in the water and never dreamed I would see what swam before me. Not one but three Mola Molas (Ocean Sunfish), were coming right toward me. For those of you who aren't familiar with the Mola Mola, it looks like a giant swimming front-half of a fish. It lacks any real tail region as if it lost its back end somewhere along the way. These three were nearly 6 feet in length and at least as tall, using their well developed dorsal and anal fins to swim in a flapping motion. I have never seen a mola alive in the open ocean and was amazed at how well adapted they were. Despite their odd appearance, they were outswimming my sub with ease. I worked hard to get a few images, then had to fall off back to the ledge. I just couldn't keep up. Well, of course, the adrenaline was flowing now. I had to concentrate on getting back into the swing of locating marker number 2.

1100 - I've been trying to work my way upcurrent to get to number 2 and am having a difficult time of it. The current is quite strong and as I move full ahead, I also have to move full down to keep from being pulled towards the surface by the drag on my surface buoy line. I decide to try running a few transects. Still the same trouble. I decide to concentrate on exploring the backsides (downcurrent sides) of the ledges instead. I find more fish treasures. Wrasse Bass, Tatler Bass, Rock Beauty Angelfish, Yellowtail Reeffish, Queen Triggerfish, Bank Butterfly and what looks to be a Greenbanded Wrasse. Time flies. My voltage has been dropping steadily from the hard work of the thrusters and I know Tom Potts is hoping for a dive in the afternoon. I radio topside and they agree it would be best to head up with some battery power left for Tom. (I really have to go to the bathroom as well! This is not like scuba diving for those of you that know what I mean!)

Time to head for the surface. On the way up I think about this deep reef system. No hard corals, lots of sponge cover, rocky outcroppings - some very large, and lots of fish. One of my questions was to look at what species would be frequenting this site. It certainly has the large temperate water species like the Amber and Almaco Jacks and Scamp, but it also had quite a few species that would be considered much more tropical. French Angels, some of the butterflyfish, Queen Triggerfish, Purple Reeffish don't frequent the colder waters of the South Atlantic. The large number of Jacks was also a pleasant surprise. During week one at the shallower Gray's Reef site I didn't see even one. They may be subject to heavy fishing pressure in close. The Scamp may be subject to the same circumstances there. What I didn't see was also

surprising. Not one Slippery Dick Wrasse that dominates the shallow sites. No Black Sea Bass. No Bank Sea Bass and no Round Scad that accompanied me by the thousands on y shallow night dive. Certainly much different in the deep.

Markers are now placed and video, still and sonar documentation collected on the deep reef system. There was also quite a lot of fish data collected. Future studies on the seasonal changes and temporal (time) changes will be very useful in understanding the benefits of this system to the rest of the shallow water sites. It certainly appears to be a haven for commercially harvested species including both groupers and jacks. It also appears to be a home to a warmer water assemblage than the shallow sites currently under management. I hope it continues to prosper and look forward to visiting the area in future missions to see how it fares.

Gale continues:

During Laddie's dive, Tom Potts served as data recorder, running through-water communications from the chase boat and documenting life support readings. The ship's Operations Officer, Stacy Maenner was the swimmer, and Tom Zemianek assumed his usual role as cox'n, driving the chase boat for the duration of the dive.

Tom provided the following commentary on the view from the chase boat:

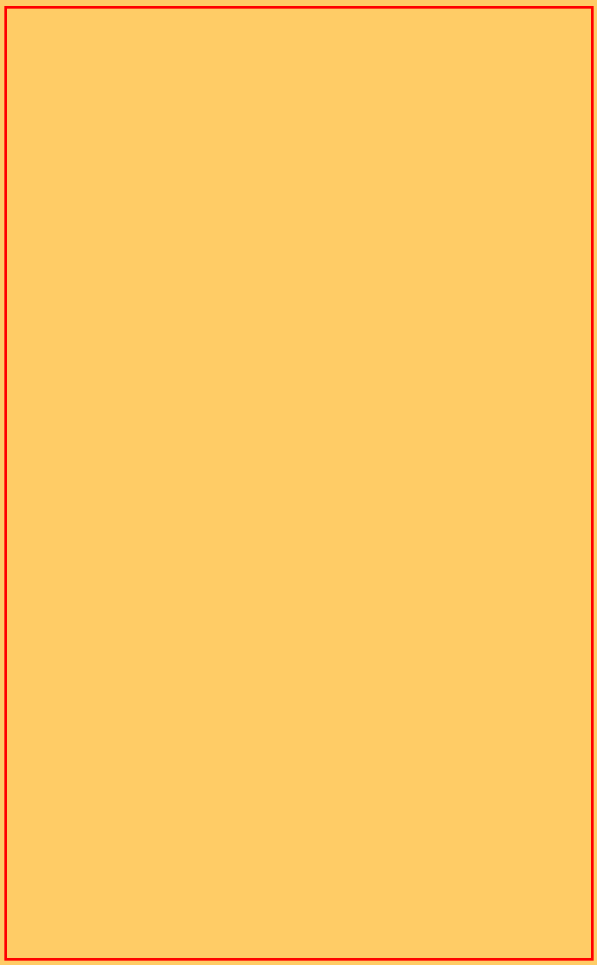
"While supporting Lad Akins dive this morning, Stacy, Tom and I experienced a bit of Mother Nature's extremes. As Lad was conducting sub operations on the bottom, our surface team, milling about in the rigid inflatable, witnessed a pod of ten or so spotted dolphins playing at the surface. Over the course of a half-hour, we were treated to spectacular leaps and loud fluke slaps often within a few boat-lengths from the RIB. Calm seas and the ability to pick up their echolocation on the hydrophone only enhanced the experience.

Tom Potts records life support data and monitored through-water communications from the chase boat with NOAA Ship Ferrel's Tom Zemianeck.

"After the show, though, a line of clouds filtered over the top of us. Soon, cool winds and a nice downpour chilled us to the bone. Even though I longed for my foul-weather jacket and maintaining the submersible log posed a bit of a challenge, I reminded myself that there were numerous people that would have gladly traded position with me given the opportunity."

The turnaround time after Laddie got back on deck was minimal, and many of us were startled to hear the announcement at 13:00 that the sub would launch again at 13:25. This time, Navigation Officer Paulene Roberts, a petite, athletic woman from Alaska, with an engaging smile and an upbeat attitude, ran the chase boat, while Alex

Score ran comms and her husband, the FERREL's Executive Officer David Score, served as swimmer. In the heat of the day, I think many of us envied David just a little bit, as the water looked oh, so inviting. On the other hand, he did report seeing a shark while he was in the water (not sure what species) so there are at least some potential tradeoffs.



Chief Boatswain, Cornell Hill, gives orders during the deployment of the DeepWorker in the Sapleo Scarp reef.

Here's Tom's dive report:

"It took us only one hour to turn the sub around from Lad's post-dive to my pre-dive. By 1320, all final checks were completed and I was ready for launch. The ship moved into position and made an easy, steady deployment. Paul Moen, the FERREL's C.O., did a tremendous job, dropping the sub almost right on top of the reef.

"I finally touched down in a sand plain in 206 feet of water. Although visibility was well over 40-50 feet, the outcrop was just beyond visible range. But like a bugle call to signal my arrival in their neighborhood, 100-150 almaco jacks and amberjacks filed off the reef to escort me to my destination. When I arrived, I was awestruck.

"The outcrop was like no other I've seen inshore off Georgia and North Carolina. It appeared similar to the habitat commonly found in deep water (>1000 feet) off Cape Hatteras. Large boulder outcrops, often with vertical relief exceeding 12 feet, were scattered randomly over the bottom. The sand was scoured in places creating large craters ringed by livebottom. When the boulders did join into a contiguous entity, they formed mountain-like structures that formed an apex. Once I transited over the top, I sat in a large sand plain in 185 feet of water. Here, I was able to get a "birds-eye" view of the region before the current swept me over the edge once again.

"I began running a series of timed transects and was treated to a completely different fish community compared to Gray's Reef. Scamp and a few other currently unidentified grouper species appeared to be the keystone predators. What was more spectacular, however, was the large number of tropical fish species I encountered. Purple reeffish, banded butterflyfish, reef butterflyfish, rock beauties, yellowtail reeffish, queen triggerfish, unidentified hamlet, and others were abundant. Even more amazing was the fact that these were large adults indicating that these areas are probably constantly bathed in relatively warm water allowing for year-round resident

(and maybe self-sustaining) communities.

"I was able to complete eight random transects and conduct a 20-minute qualitative survey before low battery power forced me to terminate the dive. This was quite unfortunate since I consider this to be one of the most incredible dives I've ever made. However, the FERREL took numerous position fixes that should allow us to revisit the site in the future."

After Tom was back on deck, the scientists scrambled to copy their videotapes, and complete the other documentation required after each dive, while Nuytco staff worked furiously to repair the manipulator on sub #3 and took care of maintenance on sub #7. The plan is to make our last dive of the mission at 06:00 tomorrow morning, which means we start pre-diving the sub at 04:30. Even so, there is so much work to do that almost no one is able to get to bed early. It brings to mind one of Sylvia Earle's favorite remarks, when asked when she finds time to sleep with everything she does: "I'll have plenty of time to sleep a hundred years from now!"

William Bartram adds in 1776

"Thus secure and tranquil, and meditating on the marvellous scenes of primitive nature, as yet unmodified by the hand of man, I gently descended the peaceful stream, on whose polished surface were depicted the mutible shadows from its pensile banks; whilst myriads of finny inhabitants sported in its pellucid waters."

(top) **RETURN**

August 6, 1999

Alex Score, Educator
Gray's Reef National Marine Sanctuary

I decided to have the last Gray's Reef dive in the middle shelf of the Georgia Bight. Larry Shumaker, an experienced mariner and submersible pilot, had observed a depth change in the middle shelf area two days ago while traveling back to Savannah over night due to bad weather. The depth sounder showed a relief of about 30 feet. WOW! We all wondered what a 30-40 foot drop would look like, with a sudden transition going from 70 down to 110 feet. We all were excited about investigating this area, thinking it might be the transition zone from Gray's Reef, an inner shore reef, to the outer shelf reef, Sapelo scarp.

The day started very early, almost as if the previous day never ended. We were all up at 4:30 am preparing to pre-dive the DeepWorker for a 6:00 am dive. We all started a little slow. After a few days of working 16 hours and getting less than 5 hours of sleep you do end up getting up slower and slower every day.

After a successful pre-dive, I was in the water by 6:00 and started descending into this area with some fears and excitement in hopes of discovering a really interesting reef area. Moments after leaving the surface I was joined by a group of 10 spotted dolphins swimming gracefully around the sub's dome. I was breathless for a minute, just long enough for them to swim away. I kept hoping throughout the remainder of my dive for them to come back for one more visit but was thrilled to have had even that brief close encounter.

I hit bottom shortly thereafter, at a depth of about 110 feet. The bottom was a hard bottom covered with a thin sand veneer. I cruised around from 100 to 85 feet hoping to find some areas of live bottom. The bottom was mostly sand and unfortunately I found no areas of significant relief. I cruised around over and across the drop feature twice and covered an area of approximately 5 square miles.

Taking steady headings with the DeepWorker and covering large distances can become very tiring. I slowed down every once in awhile when I would come across one small rock or small sponge rising up from the sand. Any structure found in this sandy desert was like a small oasis.

In one area a group of small scrawled cowfish were hovering around a vase sponge

protecting this small habitat. Every once on a while they would scatter away to feed on the bottom sand and other small wrasses would enter the sponge to try to steal the cowfishes home. In no time the cowfishes would return and run the wrasse away.

I watched this behavior for awhile observing how structure in the sandy ocean becomes home for so many individuals. Only about 5% of the Georgia Bight is composed of hard bottom area, which supports life with sponges, tunicates, soft corals, and fish -- the type and diversity of life found on Gray's Reef.

DeepWorker surfacing and preparing for recovery procedures.

DeepWorker being recovered from the stern of the NOAA Ship Ferrel.

After spending approximately 4 hours in a barren sandy area, I had an even greater appreciation for how very important it is to protect that small fraction of the Georgia Coast that has a hard-bottom substrate. These slender slices of live bottom support the Georgia Coast with great diversity in bottom dwelling invertebrates and fish species. These areas are not only beautiful, but possessed of great historical and ecological value.

This was the last dive of Gray's Reef SSE mission this year. I know that Laddie Akins and Tom Potts share my eagerness to return to these areas so we can continue exploring and learning more about these habitats. It's been a great experience and we have been able to gather very good data that goes far to advance beyond what was previously known about this important area.

Alex Score is getting ready to open the hatch after a 4 hour dive in the middle shelf area of the Georgia Coast.

Until next time around,

Alex Score

(top) RETURN

August 9, 1999

Reed Bohne, Manager
Gray's Reef National Marine Sanctuary

"Far off like floating seeds the ships
diverge on urgent voluntary errands
and this full view
indeed may enter
And move in memory as now these clouds do
that pass the harbor mirror
And all the summer through the water saunter"

W.H. Auden from "Seascape"

The expedition ends yet begins again in the Florida Keys. The NOAA ship FERREL saunters south with its magical craft aboard. To each of the pilots here, privileged to be transported in comfort and quiet to the world of the reef, the experience has been transforming. Many have declared it to be the most incredible natural history moment of their lives. The science is important and critical to the mission but beyond the data that returns, our pilots emerge awestruck.

NOAA Ship FERREL departing Gray's Reef

As naturalist John Muir once wrote: "Here is calm so deep, grasses cease waving...wonderful how completely everything in wild nature fits into us, as if truly part and parent of us. The rivers float not past but through us, thrilling, tingling, vibrating every fiber and cell of the substance of our bodies, making them glide and sing." Thoreau also said "...you cannot perceive beauty, but with a serene mind."

Serenity is the unexpected gift of the Sustainable Seas Expedition. It is probably the last word most of us would use to describe the briarpatch of logistics, weather, equipment and personalities that must mesh to bring one person safely to the

FERREL Commanding Officer Paul Moen and officers Pauline Rogers and Stacy Maenner plotting a course for Florida

seafloor and back in the DeepWorker submersible. But in the end I believe most pilots would agree that they will not forget those moments when they could disconnect from the chattering surface, shade there eyes from the instruments, sit in solitude at the reef and absorb the world swimming around them.

I am reminded of Cathy Sakas' beautiful description of a journey to the reef at night on July 30. She arrived at the reef at twilight. Our familiar friends of the reef swam about her then night began to descend. She wrote "Then as if a bell had sounded everything seemed to ghost away. Nothing was stirring. It was like a shift change had occurred without any visible evidence of scurrying bodies. They just simply weren't there anymore. I sat longer."

Cathy then describes the sudden arrival of fish swarming over the sub, a hammerhead shark introducing itself and octopus chasing sea bass. She effuses "I was ecstatic, what a sight to behold...I was transfixed. How could one person be so lucky. I was and am humbly grateful."

Anne Morrow Lindberg once wrote " The sea does not reward those who are too anxious, too greedy or too impatient. To dig for treasures shows not only impatience and greed, but lack of faith. Patience, patience, patience is what the sea teaches. Patience and faith. One should lie empty, open, choiceless as a beach - waiting for a gift from the sea."

We have all received such a gift with Sustainable Seas; whether one of the fortunate few to pilot the DeepWorker or in serving as one of the many hands that made this expedition so successful. We now begin the essential task of organizing the results of the expedition, reviewing and analyzing the data and deciding how best to employ the DeepWorker's considerable talents for the next expedition.

Dr. Sylvia Earle, Expedition Leader for Sustainable Seas and Explorer in Residence for the National Geographic Society reminds us often that the greatest threat to the oceans is not understanding the effects of our actions and caring enough to sustain and protect the marine world which she calls our "life support system". In her new book "Wild Ocean, America's Parks Under the Sea" she writes "If a machine existed that could transport us back in time, it might also take us forward to see the consequences of choices we are now making. Modern computers enable us, in a way, to do just that - to help visualize and calculate the consequences of our actions in the next millennium and beyond. What would it mean to us and to the ocean not to have bluefin tuna, anymore, or to exist without whales, having let them slide into extinction? What might be the consequences of consuming the last cod or allowing 350 million years of horseshoe crab lineage to end abruptly in our time, on our watch? No doubt about it, Earth is now and always has been an ongoing 'work in

progress'. The vital issue for us is whether or not we can also manage ourselves that our future will continue far as a vibrant part of the action."

And so the Sustainable Seas Expedition ends at Gray's Reef. We are grateful and exhausted. We marvel at the stamina of those assigned to the whole expedition to all the sanctuaries. We have run them and ourselves hard and it has been a great success. We know the Florida Keys has an incredible story to tell and adventures planned and we look forward to watching the expedition unfold. Again as always we let William Bartram have the last word and hope his 18th century perspective continues to guide us in the 21st century. He wrote: "Having, in this journey, met with extraordinary success, not only in the enjoyment of an uninterrupted state of good health, and escaping ill accidents, incident to such excursions, through uninhabited wildernesses, and an Indian frontier, but also in making a very extensive collection of natural productions. On recollection of so many and great favors and blessings, I now, with a high sense of gratitude, presume to offer up my sincere thanks to the Almighty, the Creator and Preserver."

(top) **RETURN**

Summary of Investigations

Overview

The primary objective for the first year of the Sustainable Seas Expeditions was to characterize the reef and offshore sites for invertebrate and fish populations, paleo-archeological fossils, and loggerhead sea turtles habitat use. Data collected will be used to develop educational and outreach materials for the sanctuary and add to long-term monitoring programs. Additionally, Gray's Reef National Marine Sanctuary and the National Ocean Service used this unique opportunity to increase public awareness and appreciation for our nation's marine sanctuaries and the work of the National Ocean Service. This was accomplished through outreach and media.

DeepWorker surfaces after three hours of observations at Gray's Reef.

Fish Assemblage Characterization of the Georgia Bight

Tom Potts from the National Undersea Research Center and Laddie Akins from Reef Environmental and Education Foundation (REEF) conducted fish surveys at Gray's Reef near shore reefs and Sapelo Scarp outer shelf reefs. A total of seven submersible dives were completed, five at Gray's Reef and two at the Sapelo Scarp reefs.

Over 15 hours of qualitative video was taken to document fish, invertebrates, and substrate. Fifteen quantitative/qualitative video transects were completed to document fish communities at the two sites. Detailed analyses of the videotapes have yet to be completed.

Conducting video transect protocol tests were not attempted due to time and equipment limitations. However, pilots were able to get a better idea of the numerous challenges associated with using this new system. For instance, pilots gained considerable experience in operating the DeepWorker submersible in such a manner as to offset bottom currents. By correctly orienting the submersible into the current and applying appropriate forward and sideways thrust, pilots were able to conduct relatively fluid, timed video transects. Still to be resolved, though, are questions

Tom Potts and Tom Zemianeck record DeepWorker's life support readings and monitor through-water communications from the chase boat.

pertaining to camera position in relation to the sub and camera angle in relation to the substrate, field-of-view quantification, laser placement and adjustment, and incorporation of ancillary audio capabilities to augment video footage.

Day-night Activity Characterization of Gray's Reef Vertebrates and Invertebrates

Cathy Sakas, Gray's Reef National Marine Sanctuary marine educator, observed the changes in activity of Gray's Reef live bottom reefs from the diurnal to crepuscular and on through the nocturnal periods. One successful submersible dive was completed starting before dusk at 19:30 and ending after 23:30. Over three hours of video was collected at the sand bottom, low relief live bottom, and high relief ledge area. Since the submersible was not equipped with a low light sensitive camera, video documentation and observations where performed with the submersible lights on and were not indicative of the natural behavior of the fish and invertebrate fauna during the night period. To better document the changes between day and night activities a low light level camera and film need to be used. The submersible light attracted a large amount of larval fish, a hammerhead shark, and black sea bass. Submersible night dives with high intensity light might be a useful tool in collecting large samples of larval fish and will be considered for future projects. Bioluminescence of ctenophores and unidentified sessile invertebrates were observed during periods when all lights were turned off inside and outside the submersible.

Cathy Sakas in the DeepWorker documents the day-night activities at Gray's Reef.

Comparative Characterization of Live Bottom Fauna in the Gray's Reef National Marine Sanctuary

Live bottom reefs are the primary habitat on the continental shelf on the Southeastern U.S., which support dense assemblages of sponges, corals, and other invertebrates. These dense invertebrate assemblages in temperate regions form complex benthic communities that provide habitat for a great diversity of associated species, many of which provide direct food resources for commercial and recreational fish species. The composition and structure of macro-benthic communities influence the spatial heterogeneity of resource and refuge patches for many of these economically important fish species. A thorough understanding of benthic fauna assemblages and diversity of hard bottom reef communities is essential in determining the capacity in which reefs function as habitat for economically important

Gray's Reef is known for its great diversity in sponges.

fisheries. Although no dives were solely dedicated to this project during this years investigations, video documentation from other dives will be analyzed for invertebrate species composition. Submersible cameras were critical for the success of this project since good close video transcects are imperative for accurate identification of species. Unfortunately, during the Sapelo Scarp dives one of the cameras malfunctioned and did not have good color or resolution for the analysis of invertebrate fauna. Other video footage taken at Gray's Reef will be analyzed and used in conjunction to photo-quadrats and video transects currently used in Gray's Reef invertebrate fauna monitoring program.

Paleoenvironments and Archaeology at Gray's Reef

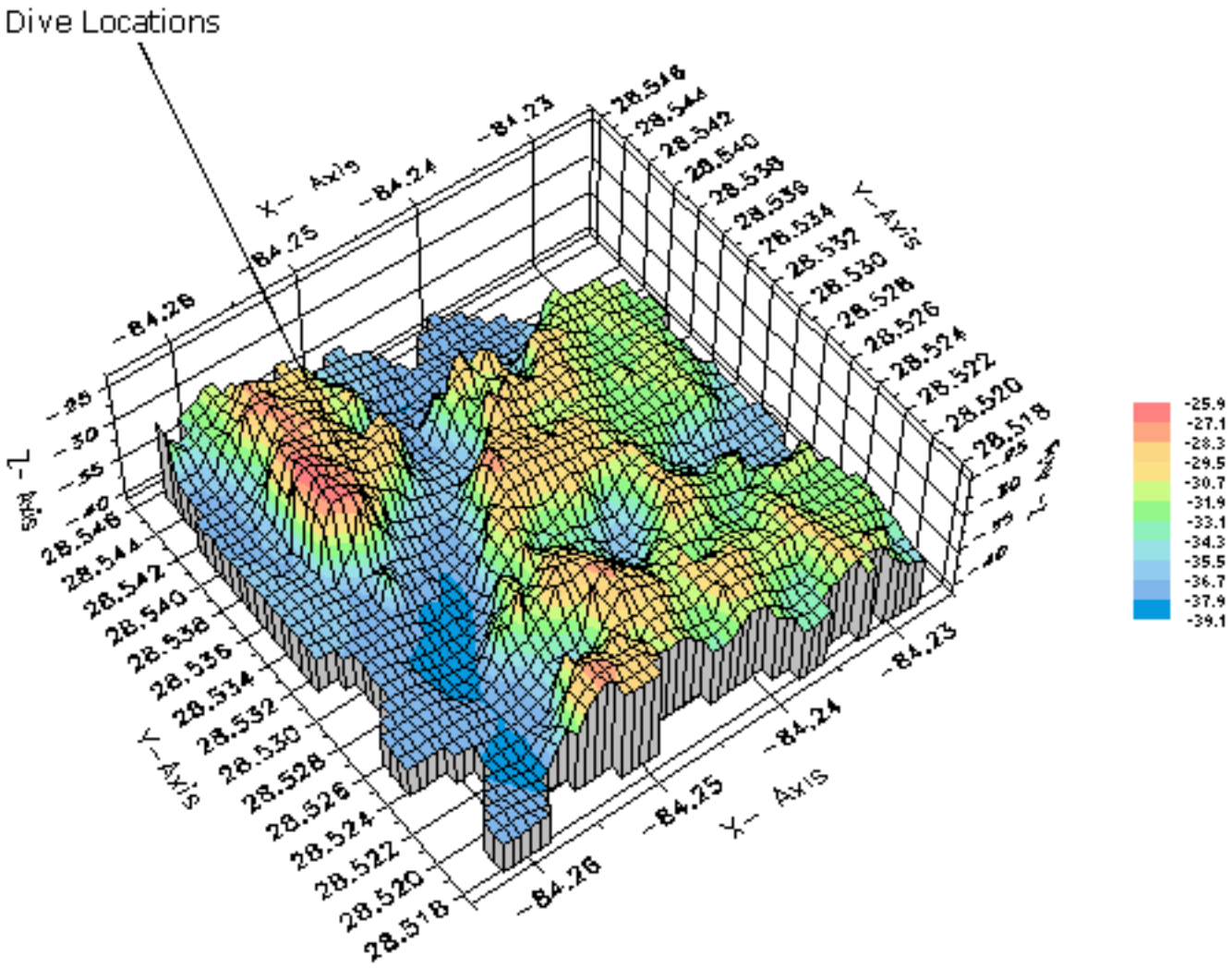
Alex Score in the DeepWorker takes visual counts of invertebrates at Gray's Reef.

This project is a continuation of research at Gray's Reef that has (1) discovered scientifically significant fossilized remains of nearly 12 extinct mammals from the last glacial period- the Pleistocene; (2) obtained core and shallow excavation samples of previously unexplored buried land surfaces that have been shown to contain plant remains of a paleoecology associated with the extinct animals; and (3) begun construction of paleoenvironmental/ paleoclimatological model for the late Pleistocene based on these data obtained from our undersea research. A total of three dives with approximately four hours of observations were completed covering over six miles of sand-bottom habitat at Gray's Reef. A systematic transect search method was employed running North/South transect for 15 minute intervals. One fossil was observed during the search that seemed to have been from a large mammal, probably the leg bone of a bison. Unfortunately, the manipulator arm in the submersible was not functioning so the fossil sample could not be collected for further testing. The submersibles proved to be a good searching tool for large areas and will be used again for this project.

Sea Turtle Population Survey

No submersible dives were made for this project but turtles were observed on two of the submersible dives. Turtles were observed swimming and feeding in the high relief live bottom habitat and sleeping in the sand flats area. More dedicated dives with systematic searches will be required for this project.

(top) RETURN


Dive Locations
X-- Axis
-84.26
-84.25
-84.24
-84.23
Y-- Axis
28.546
28.544
28.542
28.540
28.538
28.536
28.534
28.532
28.530
28.528
28.526
28.524
28.522
28.520
28.518
-25.9
-27.1
-28.3
-29.5
-30.7
-31.9
-33.1
-34.3
-35.5
-36.7
-37.9
-39.1

August 15-16, 1999

Sylvia Earle, Project Director
Sustainable Seas Expeditions

Walter C. Jaap, Scientist
Florida Marine Research Institute

Gale Mead, Expedition Log Editor

August 15 marked the beginning of the SSE mission into the Florida Keys National Marine Sanctuary. A tremendous amount of planning has gone into this mission, working out the logistics for the many people from a variety of organizations who will be involved; the plans are ambitious to say the least! Sanctuary and SSE personnel have been working extra hard in preparation for this portion of the expedition.

In addition to the 8 people housed on the FERREL, we have many more sleeping aboard two of the sanctuary's boats, the DANTE FASCELL, and the RACHEL CARSON, and at the campsite on board Loggerhead Key. Many of these additional scientists, education/outreach people, and sanctuary staff will be transferring to the FERREL every day, returning to their respective boats and campsites each evening. This makes for a great deal of logistical maneuvering!

Terry Garcia, Assistant Secretary of NOAA, communicates with the ship as he steps through his DeepWorker pilot training.

Sally Yozell, Deputy Assistant Secretary of NOAA, is exuberant after completing her DeepWorker pilot training.

The FERREL left Key West at 9 am on the 15th, and made its way offshore for submersible training checkout dives. We'd invited key people from the U.S. Department of Commerce (the federal agency that runs NOAA) and National Geographic to complete sub pilot training, so they could see with their own eyes what wonderful critters and systems we're working to study and protect. Terry Garcia and Sally Yozell have long been involved and interested in marine issues and marine sanctuaries, and have been great supporters of the Sustainable Seas project. Rick Allen, President of National Geographic Ventures, and Mark Shelly, Producer of the National Geographic series "The Shape of Life," also had the opportunity to pilot the submersible.

Rick Allen, president of National Geographic Ventures, receives instruction on piloting the DeepWorker.

Mark Shelly, National Geographic producer, being lowered into sanctuary waters.

The consensus from all of them was "WOW!" All were suitably awed by the experience of seeing the reef and its inhabitants first hand while piloting the little hot rod submersible.

During the night, the FERREL moved 80 miles beyond Key West to the Dry Tortugas, where the first week of dives will take place. National Geographic's Explorer in Residence and SSE's director and driving force, Sylvia Earle, had the first dive of the day. She took the sub to a depth of 78 feet on De Maria's Hump, a reef near an area known locally as "Sherwood Forest" for its magnificent, diverse, and dense coral formations, and for the cone-shaped corals that are unique to this area.

Here's what Sylvia had to say about her dive:

Today's dive on Tortugas Bank is special for a number of reasons. It is my first official submersible dive for the Florida Keys leg of the Sustainable Seas Expeditions; it has been 47 years since my first visit to the Florida Keys; 34 years since I was aboard the research vessel Anton Bruun and discovered a new deep water plant that I later named Padina profunda growing close to where I now planned to dive.

And, a member of the present expedition is Dr. K.M.S. Aziz, a distinguished microbiologist from Bangladesh, and a fellow student of Dr. Harold J. Humm's. Yesterday, while sitting on the bow of the R/V FERREL, we called Dr. Humm at his residence in Bern, North Carolina, and reminded him of how, when we were at Duke University in the 1960s, he had encouraged both of us to study marine plants in Florida, the Caribbean and elsewhere in the world's oceans, and both of us are still at it.

Much has changed in the waters surrounding the Florida Keys since the first time I was here, years ago. The waves that washed along Miami Beach, Key Largo, and elsewhere in the Upper Keys appeared then as the sea does now at Tortugas Bank - like liquid sapphire. But no more. The Sustainable Seas Expeditions are aimed at gaining an understanding of why so much has changed so fast, and also, at trying to determine what can be done to heal the harm brought on by what many millions of us have put into the sea, and by the many millions of wild creatures we have removed.

After an hour and a half of preparation, I was sealed in, lowered into the water from the stern crane, moved a hundred yards or so from the ship and descended to the bottom through clear, blue, warm water. Water temperature is 29 degrees centigrade - 86 degrees Fahrenheit - warm enough to bathe in comfortably, but inside the sub, too hot for comfort! A small fan stirs the air and the cooling vest I'm wearing feels wonderful, but it is decidedly toasty nonetheless. The vest was the brainchild of Richard Nordstrum, President of Cis-Lunar, supplier of the communications system used on the DeepWorker subs. After observing the wilted pilots emerging from training exercising in Key West a few weeks ago, he dreamed up this ingenious design for "keeping cool under pressure" - freezer-packs of cooling fluid worn in a vest with special pockets.

Clumps of the golden brown seaweeds,*Sargassum natans and Sargassum fluitans*,are floating on the surface as I descend, one with a long strip of entangled plastic ribbon. I wanted to reach up and grab it, but on the sub I was diving the manipulator arm has been modified to serve as a pan and tilt unit of sorts, to raise, lower and swing the National Geographic's three chip digital camera that we're using as the primary system for photo documentation. I hope the ribbon isn't mistaken by a naive young turtle or fish for something edible. Such debris has taken a terrible toll in recent years when creatures engulf what appears to be a tasty morsel, and then find their stomachs blocked with indigestible plastic.

The terrain where I landed has small patches of hard coral, sponges, plumes of soft coral, and a scattering of small fish. While it is difficult to tell for sure what individual species are from inside the sub, I've provided a **list of the species** I was able to identify.

Few of the corals I observed appear to be troubled by the phenomenon known as coral bleaching - a sure sign of stress - and I could see little evidence of the diseases that have become common elsewhere in the Florida Keys - black band, white band and coral afflictions. One small Monastrea seemed to be losing a battle with black band disease. The "black" substance characteristic of this condition appears to be a kind of bluegreen algae, Phormidium, one notorious for taking on various forms.

I had no luck finding turtle grass or other sea grasses during the 3.5 hour period of observation. It is a little deep for seagrasses, and I may have missed seeing the smallest, a notable deep-water species of Halophila, though I made a special effort to look for it. Nor could I find any sign of Padina profunda, the fan-like brown alga that I had discovered here years ago.

There were lots of fish, but few large predators. I did observe three barracuda, 3 to 4 feet long, each with 3 or 4 accompanying small bar jacks, one small red grouper, about 16 inches long, and another small grouper, a tiger, I think - M*yctoperca tigris*- about 16 inches long.

About an hour into the dive, I was startled by sudden flashes around DeepWorker. It looked as though someone had tossed a sackful of silver coins into the sea, as a school of 50 or 60 small bar jacks cascaded from above and surrounded the little sub. Bright black eyes peered in at me from all angles, and some fish circled around several times, apparently curious about the terrestrial primate cruising around in their backyard.

I crossed great expanses of what appeared at first glance to be just sand, but I quickly focused on the true nature of the place--well-populated sand-cities, metropolis after metropolis marked with millions of small holes and mounds of burrowing creatures. Occasionally, I passed over carefully arranged piles of broken coral and shells, the well-constructed homes of sand tilefish, *Malacanthus plumieri*,who hovered nearby like pale blue-silver phantoms. Dozens of three-inch long yellow-headed jawfish,*Opistognathus aurifrons*,seemed to be politely arguing over territorial claims, while others simply fluttered vertically over their burrows, their dark eyes evident even from where I sat, warm and dry, in my first-class viewing perch inside the sub.

Except for the school of young bar jacks, I saw no other jacks, and just one curious yellowtail, no other snappers. Some night dives are planned for later in the week. I look forward to seeing what happens!

After Sylvia was back on deck, everyone worked quickly to turn the sub around and get it ready for Walt Japp to dive. Walt has been studying the reefs and fishes of the Tortugas for decades, and is able to offer a unique perspective on the history of research in this special place. He has provided a detailed and fascinating overview of the area's **colorful history**.

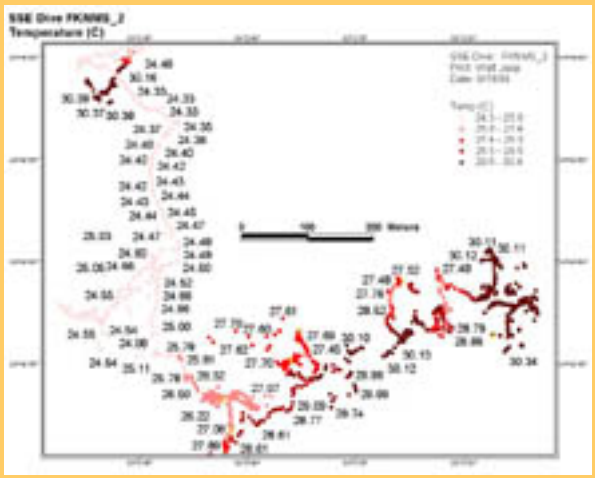
Here's Walt's dive report:

In the afternoon, it was my turn. I had training in California and Key West where we dove the sub to about 30 feet in the harbors. This was a great learning experience, but we could see very little because the visibility was like looking through a milk shake. We prepared the boat with great anticipation. I got in, turned on the oxygen, radios, and other life support equipment, and tested the video gear. In no time, it was time to close the hatch. The crane lowered me into the water and the swimmer disconnected the lines. I was free to descend and explore.

The sub descended through the blue and, there it was, the sea floor at 167 feet. It was not the reef. To avoid a ship we moved away from the reef for launching. After some directions from Larry Shumaker, the dive supervisor, I headed off by compass to find the reef. It was a great feeling after about ten minutes to see a few odd corals and sponges. Soon the number of corals increased and the depth was about 110 feet. The reef was right in front of me and it looked just about as I remembered it from several scuba dives. Scuba dives at this site had always been frustrating because they were never long enough and the concern for safety always limited the dives to a quick look see.

With DeepWorker, time was not an issue, I was diving in a pressurized hull, so all the safety concerns that are associated with scuba diving are not applicable. I could view the reef, fish, lobster, and coral formations from all angles. The entire reef could be traversed with ease. Left heel down, the sub rose, right toe down and right and DeepWorker responded with precise upward and right motion like a light airplane.

My goal in this first dive was to video tape and photograph Sherwood Forest Reef determine the size of the reef, and get an idea of how many different kinds of corals were on the reef. We are also interested in the identifying problems on the reef, such as anchor damage. As the dive continued, I found using the video camera and the still camera was very easy. I captured several grouper and many coral formations with the video. The entire, dive was being recorded with special navigation software. Environmental data was collected with water quality sampling device and logged into a computer file.



DeepWorker track at Sherwood Forest with temperature readings collected by YSI datasond.

The dive was excellent. Back on the FERREL, we viewed the video and were quite pleased with the overall quality (color and distinct focus). Spending 2.5 hours underwater between 90 and 167 feet was very satisfying. If I had done this with scuba, I would have had a major price to pay in terms of decompression stops. We are entering a new millennium with a new tool that has great capabilities to expand our knowledge of planet ocean. The team that built and supervises DeepWorker--Sustainable Seas should be proud of their accomplishment. Three Cheers!!! I am looking forward to tomorrow's DeepWorker dive.

Once Walt was back on deck, the FERREL made its way near Loggerhead Key, and anchored for the night. Meanwhile, the folks staying aboard the DANTE and the RACHEL spent a quiet and pleasant evening at **Fort Jefferson**, before anchoring off Garden Key for the night.

Fort Jefferson was constructed on Garden Key in the Dry Tortugas by the US government in the mid to late 1800s. The hexagonal brick building covers almost the entire key, with a large open garden area in the middle. Walking the endless chambers of the fort offers a sense of history that is quite moving. Fort Jefferson was used as a prison for deserters during the U.S. Civil war, and after the war was prison to the four individuals convicted of aiding John Wilkes Booth in the assassination of President Lincoln.

The army abandoned Fort Jefferson in 1874, and the fort was later made a wildlife refuge to protect nesting Terns, green sea turtles, and loggerhead turtles. Visitors to the park are able to tour the ruins of the fort, and scuba dive and snorkel in the nearby waters.

Tomorrow, we will be hosting more news media visitors, and conducting submersible operations with Walt and Sylvia again piloting.

(top) **RETURN**

Species List

Provided by Sylvia Earle during her dive on August 16, 1999

Among the corals observed were:

Corky sea finger, *Briatreum asbestinum*(with feathery polyps extended)

Porous sea rods, *Pseudoplexaura sp.*(upright, bush-like branches)

Sea plumes, *Pseudopterogorgia sp.?*(as their name suggests, tall feathery clusters)

Sea fans, *Gorgonia flabellum*(common; mostly healthy, but some ragged and not in good shape)

Great star coral, *Montastraea cavernosa*(large mounds, scattered; some were flattened and spreading, other rising to a coned peak - like great mounds of ice cream)

Scroll coral? *Agaricia?*(large, flat shelving corals)

Rose coral, *Manicina areolata*(occasional small rounded colonies)

Other rounded hard coral of uncertain identity.

Other obvious invertebrates include:

One spiny lobster, *Panulirus argus*

Christmas tree worms, *Spirobranchus giganteus*(occasional individuals sprouting from stony coral heads)

Loggerhead sponges, *Spheciospongia vesparium*(occasional individuals growing among coral heads and occasionally alone on sand-shell substrate)

Vase sponge, *Callyspongia?*(several small clusters)

Surprising by their absence were:

Crinoids - none

Sea urchins - none

Conchs - none

Among the plants that I could clearly see other than the floating Sargassum were:

Dictyota(small clumps in crevices)

Avrainvillea sp.(growing on open sand)

Halimeda sp.(small clumps, some amid coral, as well as a few clumps with lumps of rock on the open sandy areas)

Probably *H. tuna*, *H. goreauii,* and *H. incrassata*.

Large patches of what appear to be filamentous blue-green algae lightly attached on the surface of the white sand bottom. Large areas of the sea floor lightly covered with what appears to be a growth of microscopic plants.

There were lots of fish, but no large predators other than the following:

3 barracuda, S*phyraena barracuda*(3 -4 feet long, each with 3 or 4 accompanying small bar jacks)

1 small red grouper, *Epinephelus morio*(about 16 inches long)

1 small grouper, a tiger, I think - *Myctoperca tigris*(about 16 inches long)

Among the other kinds of fish encountered along the way were:

Smooth trunkfish, *Lactophrys triqueter*(two nosing around in a sandy depression, with several small yellow goatfish, *Mulloidichthys martinicus*)

Later, I encountered half a dozen spotted goatfish, *Pseudupeneus maculatus*(fluffing the sandy-shell bottom with their amazingly active chin barbels)

Other species were no doubt present, but the only kind I feel rather confident about is the glass goby, *Coryphopterus hyalinus*(although the translucent little fish I saw here and there on reef patches may have been the closely related masked goby, *C.*

personatus)

Creole wrasse - One group of about a hundred in their distinctive purple-blue phase, a black smudge on every nose; several solitary individuals marked with blue front, yellow aft section, cruised about the reefs.

Hogfish, *Lachnolaimus maximus*(three sighted during the three and a half hour dive, all were small, 12 inches or so)

Spanish hogfish, *Bodianus rufus*(one nicely colored purple and yellow individual with a keen interest in small submersibles)

Clown wrasse, *Halichoeres maculipinna*(several on a large patch of coral)

Yellowhead wrasse, *Halichoeres garnoti*(several on a large patch of coral)

Bluehead wrasse, Thalassoma bifasciatum (numerous juveniles on coral patches)

Parrotfish - I'm not sure of the species other than one stoplight parrotfish, *Sparisoma viride*,one princess parrotfish, *Scarus taeniopterus*,and two red band parrotfish, *Sparisoma aurofrenatum*.All were small - no giant blues or rainbows or midnight of the kind and size I would expect to find around such healthy-looking reefs. I wonder if fish traps have been doing them in - as well as the other large fish that should be here, but aren't.

Several schools of grazing tangs, blue tangs, *Acanthurus coeruleus*,worked in groups of 15 to 20 individuals, ranging from open sand where they nibbled at patches of bluegreen algae, to places on the coral heads that sprouted filamentous algae.

Also, a few surgeonfish, *Acanthurus bahianus*.

Spotfin butterflyfish, *Chaetodon ocellatus*(one pair)

French angelfish, *Pomocanthus paru*(just one, but a real beauty)

Queen angelfish, *Holocanthus ciliaris*(two, swimming together on a patch reef)

White grunts, *Haemulon plumieri*

A few juveniles Tomtates, *Haemulon aurolineatum*(several small individuals around coral heads, the black spot at the base of the tail obvious)

Cocoa damselfish, *Stegastes variabilis*(several on reef patches)

Bicolor damselfish, *Stegastes partitus*(several on reef patches)

Purple reeffish, *Chromis scotti*(several on reef patches)

Blue damselfish, *Chromis cyanea*(one small group - 6 or 8 individuals)

Jolthead porgy, *Calamus bajonado*(one who swam close to the camera and peered into the lens)

Butter hamlet, *Hypoplectrus unicolor*(several solitary individuals in coral crevices)

(top) **RETURN**

History of Research in the Dry Tortugas

Walter C. Jaap, Scientist
Florida Marine Research Institute

Dry Tortugas is a complex of shoals, reefs and low lying islands situated 60 to 70 miles west of Key West Florida. The Dry Tortugas name translated from Spanish: "Las Tortugas" meaning Turtles and "Dry" is from the fact, that in 1512 when Ponce de Leon made a visit he found no drinking water; however, the sea was filled with sea turtles.

To this day it has remained a remote area that has an abundance of unique wildlife. Prior to the landing by Ponce de Leon, the Tortugas never supported permanent settlements. Native Indians would have come to Tortugas to harvest birds, eggs, and shellfish.

During the age of sail, there were numerous maritime casualties in and around Dry Tortugas, because of poor charts, hurricanes, and inadequate navigational skills. Of the 215 vessels known to have sunk around Dry Tortugas, 27 percent went down between 1840 and 1860.

In 1824 Commodore Porter, an American naval officer reconnoitered Dry Tortugas and in 1825, a lighthouse was built on Garden Key. Military expeditions visited Dry Tortugas from 1830 until 1845, this resulted in laying the first bricks of Ft. Jefferson in 1846. Construction continued through 1860s. The fort stands (but is deteriorating) today as the largest brick building in north America. The fort never fired a shot in anger. Up to 880 military prisoners were imprisoned in Ft. Jefferson in 1865. The most famous prisoner was Dr. Mudd, a physician who treated John Wilkes Booth. The military continued a presence at Dry Tortugas in the Spanish American, First World War, and Second World War. During the Spanish American War, two Battleships, Iowa and Texas ran aground on reefs in Dry Tortugas; the reefs were subsequently named Iowa and Texas Rocks.

During the early 1850s oceanographic expeditions began visiting Dry Tortugas. Louis Agassiz and Louis Pourtal's were the first scientists to set sight on the Dry Tortugas. These pioneers in oceanography led the way for a great number of scientists who have come to Dry Tortugas to study all facets of the area: water, physical

environment, geology, plants, and animals. A compiled list of research papers includes 424 scientific publications from Dry Tortugas.

Louis Agassiz had a son, Alexander. We presume that Louis influenced Alexander, because in 1881 he came to Dry Tortugas and made an excellent map of the marine system to include the bathymetry, the reefs, and islands. Alexander Agassiz's map was used by a researcher 100 years later to evaluate changes in Dry Tortugas reefs, seagrasses, and algae over a 100 year period. Gary Davis (the researcher) found that one reef type (elkhorn coral reefs) had declined significantly. Staghorn corals and octocoral dominated hard bottom had increased between 1881 and 1981. We are impressed that Alexander Agassiz successfully mapped Dry Tortugas system over 100 years ago.

The scientist that made Tortugas a major station for marine research was Alfred Goldsbourough Mayor. Mayor was a student of Alexander Agassiz. In 1892-93 the two made an expedition to the Bahamas and Cuba. Alexander sent Mayor to Tortugas on collecting expeditions. In 1902, The Carnegie Institution provided support to build a laboratory and support operations at Dry Tortugas. In July 1904, two prefabricated buildings were built on Loggerhead Key. This was the beginning of the Carnegie laboratory at Dry Tortugas. A 60 ft long research vessel, the Physilia went into service in 1905 and in 1910 a twin screw vessel the Anton Dohrn replaced the Physilia as the Tortugas principal large research vessel.

The Carnegie lab in the 1930s on Loggerhead Key in the Tortugas. (photo credit: John Wells)

At this time, the Carnegie lab was the best tropical marine research laboratory in the world. Mayor's philosophy on his work (he was a world authority on jelly fish) is personalized in a concise quote, "Love, not logic, drives the naturalist to his work." In 1920, Mayor, went to Samoa and examined the reefs directly using a diving hood. He became ill on his return to the United States and in spite of warnings to stay in Arizona, he returned to Dry Tortugas. Mayor died of tuberculosis in 1922 at the laboratory in Tortugas. His memorial stone is on Loggerhead Key reads:

ALFRED GOLDSBOROUGH MAYOR

Who studied the biology of many seas and here founded a laboratory for the Carnegie Institution directing it for 18 years with conspicuous success. Brilliant versatile courageous utterly forgetful of self he was the beloved leader of all who worked with him and who erect this to his memory.

Born MDCCCLYVIII Died MCMXXII

The first scientists to study at the Tortugas laboratory arrived in 1905. The typical pattern was to arrive in the spring and leave before the hurricane season (late summer). The laboratory and Physilia were constructed for $10,800. The annul budget at the laboratory was $15,000. Typically, there were 6 to 10 scientists using the laboratory between 1905 and 1920. All facets of science were focused on with an emphasis on tropical biology and ecology.

The research vessel Anton Dohrn was used at the Carnegie lab in the Tortugas in the early 1920s. (photo credit: John Wells)

The enchanting lure of Tortugas was very strong. Some researchers continued to return again and again. Vaughan worked on reefs and corals. He was a prolific researcher and spent many summers working at the Carnegie Laboratory. The record holder was W.H. Longley. Longley spent every summer except one here, from 1910 until 1936. One hundred and forty-six scientists worked at the Carnegie Laboratory. Much of their work is chronicled in 35 volumes of Papers Tortugas Laboratory published by the Carnegie Institution.

Major achievements that were recorded at Tortugas include the early use of diving helmets by scientists. Around 1914 Mayor and Longely employed diving helmets to examine reefs at Dry Tortugas. The diving clothing was overalls, tennis shoes, and a heavy diving helmet. A wax covered slate was used to take notes. Longley is credited with taking the first underwater color photographs of reefs at Dry Tortugas in 1917.

Following Mayor's death in 1922, laboratory use declined and the funding was severely restricted. Longley became director and the laboratory continued to be an active research facility. By the mid 1930s the facility had electricity. Longley died in 1937 and the lab slowly decayed, and eventually burned in 1964.

In 1975 and 1976, the National Park Service supported research expeditions to Dry Tortugas to study coral reefs. We lived in Fort Jefferson and worked for approximately a month studying the geology, corals, fish, physical oceanography, algae. Subsequently, in 1989 we began monitoring several reefs in the National Park (formerly a National Monument). The work has documented that these reefs have remained very stable until last year, when Hurricane Georges came right across Dry Tortugas. We were somewhat amazed that a remnant population of elkhorn coral survived the hurricane.

In 1999, the Florida Keys National Marine Sanctuary coral reef monitoring project established three sampling sites in Dry Tortugas, two in the park, and one in the sanctuary. The Sustainable Seas Expeditions DeepWorker submersible will be a great tool to look a deep reefs on an areas referred to as the Tortugas Banks and Reiley's Hump.

Significant research has been conducted on the bird populations found on Bush and Long Keys. The original creation of the Ft Jefferson National Monument by Teddy Roosevelt was to protect birds. Masses of terns (noddy and sooty) nest on Bush Key, a small island. The noise can be heard from some distance during the nesting season. The sooty terns only nesting place in the western Atlantic is on Bush Key. The populations are relatively steady, but things such as hurricanes can have a major influence on these animals. Turtle nesting is common on the smaller sand islands. In the days of sail, turtle was a staple of the seafarer diet and the relentless hunting devastated the sea turtle populations. They are currently totally protected and seem to be more abundant now than twenty years ago. The park service has supported marine archeological expeditions to Dry Tortugas. This work established that the Tortugas was a maritime crossroads and that much can be learned from the cargoes and design of the ships.

This year (1999) is 94 years since the Carnegie Laboratory was built at Dry Tortugas. The area is now a National Park and the Florida Keys National Marine Sanctuary surrounds it. The Park Service and the Sanctuary are actively engaged in a process that will provide more protection for the resources through designating portions of the sanctuary and park as protected areas. Within these areas, the marine plants and animals will be totally protected from harvest. The benefits should provide an increase in populations that are under intense harvest pressure: lobster, grouper, and snapper. In respect to Mayor, we suggest that we all have a passion and responsibility to make this a better planet to live on.

(top) **RETURN**

August 17, 1999

Ben Haskell, Science Coordinator
Florida Keys National Marine Sanctuary

Pamela Hallock Muller, Marine Biogeologist
University of South Florida

Walter C. Jaap, Scientist
Florida Marine Research Institute

This morning, the FERREL and the DANTE set out early to an area of Tortugas Bank called Black Coral Rocks, with plans to dive Walter in the morning and Sylvia in the afternoon. News media representatives were on board to talk to the scientists and obtain footage of the launch and recovery operations. Pam Muller is on board with us to direct studies of the biogeologic characteristics of this special place. She writes:

Tortugas Bank and Riley's Hump are topographic features on the Florida shelf west of the Dry Tortugas National Park. These features represent a unique combination of biological and geological resources. They are located at the crossroads of where reefs actively live and grow in the Dry Tortugas and Florida Keys Reef Tract to the east, and the open, reef-less expanse of the Florida continental shelf to the west. Another way of saying this is that the Tortugas Bank lies at what reef scientists call the coral reef "turn-on/turnoff point," meaning that on one side reefs grow and on the other side they don't. That very fact suggests that, if scientists can understand the Tortugas Bank, we can tell a good deal about why reefs live and grow at all.

By its very nature, a coral reef is a combined biological and geological feature. The biology, plus a suitable environment, creates the geology. That is, a suitable environment allows the corals and their associated plants and animals to live so abundantly that their skeletons and shells can accumulate to build a geological structure.

To build a reef, the corals require a warm, shallow, sunlit environment. Coral reefs are the "Goldilocks" of the sea: the water must not be too warm or too cold, it can't be too shallow or too deep, it must not be too salty or too fresh. The corals need nutrients and food to live and grow, but not too much or algae and sponges will out-compete the corals. In other words, for corals to live and grow, conditions must be

"just right." And geology must be one aspect of "just right." However, in the past 125,000 years, **the coastal geology of Florida** has changed dramatically as sea level has fluctuated by hundreds of feet.

Rising sea level created a problem for Florida's reefs. Corals grow fastest in water less than 30 feet deep, moderately fast in water less than 60 feet, and more slowly down to about 120 feet. Prior to 6,000 years ago, sea level rose faster than South Florida reefs could accumulate. A reef that started growing in shallow water, for example, when sea level was 200 feet lower than present, could not keep up and so eventually became submerged too deep for coral growth. Reef growth retreated or "back-stepped" up the shelf. As a result, the deep shelf off South Florida has a series of step-like benches that connect now-drowned or drowning reefs.

In the Florida Keys, you can dive a reef that formed at a lower stand of sea level. This is the modern deep reef, which extends from about 65 feet down to about 110 feet. In some places there is a less distinct reef face at about 45-60 feet. The most actively accreting modern reef extends from the surface down to about 25 feet.

However, reefs can only backstep when there is shallower water to backstep to. On a structure like the Tortugas Bank, whose top is about 50 feet below present sea level, there was no place to backstep to. Thus, the bad news is that the only modern reef on the Tortugas Bank is the deep reef. The good news is that it is one of the most beautiful deep reefs in the Florida Reef Tract.

Geologically, the Tortugas Bank and Riley's Hump are something of a mystery. When did they form? Are they related to other submerged features like the outlier reefs off some of the main reefs of the Florida Keys? Is their history similar to that of the Florida Middle Grounds, which are off West Central Florida? Did they mostly accumulate 125,000 years ago when sea level was highest? Or did they grow in shallower water when sea level was intermediate between interglacial maximum highs and glacial extreme lows? These are some of the questions that Dr. David Mallinson, and other marine geologists from the University of South Florida's Department of Marine Science in St. Petersburg are asking. They are addressing these questions using a variety of approaches from detailed remote surveys to direct observations by remotely operated vehicle, scuba diving, grab sampling, and coring. DeepWorker provides the possibility for direct observations and ultimately for sampling of small pieces of reef rubble.

Understanding the biological communities and growth potential of modern deep reefs is the focus of DeepWorker Pilot Walter Jaap and his colleague Jennifer Wheaton of the Florida Marine Research Institute, a part of the Florida Fish and Wildlife Conservation Commission. Besides the geologic and scientific significance of these communities, the deep reefs of the Tortugas region are also economically important as essential habitat and spawning areas for commercially and recreationally harvested fish such as grouper and snapper.

Today, the deep, relatively remote reefs such as the Tortugas Bank have far fewer visitors than popular shallow dive destinations like Looe Key Reef. That may change.

Already in the Cayman Islands and Hawaii, submarines carry thousands of tourists to visit deep reefs. How long will it be, 5 years, 10 years, before submarines carry tourists to Florida's deep reefs?

Moreover, these reefs have another potential importance, one in which geological knowledge can inform biological research. Shallow reefs worldwide are seriously threatened by a whole series of insults including nutrification and sedimentation from terrestrial activities, increasing intensities of biologically damaging ultraviolet radiation resulting from stratospheric ozone depletion, and increasing concentrations of atmospheric carbon dioxide resulting from the burning of fossil fuels. All of these stresses likely weaken corals and other reef organisms, making them more susceptible to pathogens, some of which may also be coming from land.

The geologic record shows that, when environmental degradation killed shallow reefs in the past, the deep reefs usually survived and provided refuges for organisms that eventually recolonized the shallow reefs. The beautiful deep reefs of Sherwood Forest on the Tortugas Bank are home to a diverse array of species that can thrive on shallow reefs. Thus, deep, relatively remote reefs may be crucial to future restoration of our declining shallow reefs.

The amazing color beneath the sea at Sherwood Forest (photo credit: FKNMS)

Walter Japp was the only scientist who completed a dive today, because of the combined effects of weather and technical problems. He submitted the following report on the trials, tribulations, and ultimately, the successes of the day:

The day was a day to remember. During the pre-dive briefing Lt. Dana Wilkes, the project's Director of Operations, had emphasized that safety and efficiency were key to success in getting the maximum productivity in a given day. I woke up at 6 am and ate an early breakfast. Dave Savage and I executed the pre-dive checks and all was fine. I was in the sub, on the crane hook, about six feet off the deck, when the water leak sensor in the port battery pod said, "I am reporting a water leak."

We put the boat down on the deck and Steve Drover and Jeff Heaton of Nuytco evaluated the problem. I remained in the sub and shut off the power, turned on the power, did various tests to see if they had corrected the problem. After a half an hour, the decision was made remove the batteries.

The problem was that during Tuesday evening we had a rainsquall pass over the FERREL. The battery pod protective cover blew off, and rain entered the pod. Rainwater was causing the water sensor to indicate a leak. We gave it a second shot and launched DeepWorker, but just about the time they were prepared to release the

crane-lifting sling, the sensor fired off again. I was frustrated that the thing continued to be a problem.

Up on deck again and the same drill. By this time were in another rainsquall and lightning strikes were going off and the wind was gusting. The morning dive was scrubbed and now the weather was giving us a challenge. The afternoon was standby to standby, and as soon as the weather clears we can give it go. The weather showed signs of clearing at about 4 pm and the dive was pushed to 5 pm.

Once again, into DeepWorker, check the communication, life support, and cameras. It looked good. We launched DeepWorker shortly after 5 pm and I descended to about 83 feet. I settled the boat on the bottom in a cleared area and awaited some scuba divers from the FERREL. Sylvia Earle, Kip Evans, and Dave Score arrived on scene and we had some fun video taping and photographing each other while documenting the reef. It was a very dim light and the sub's lights attracted schools of bar jacks, Creole fish, angelfish, and a grouper.

The divers departed and I was back to the task of defining the boundaries of Sherwood Forest. To do this, I ran a course of 315 degrees and followed it until the reef ended and I was on sand and a few rocky outcrops. Then I ran along the edge of the reef about 100 yards and began a course that was about 135 degrees. Each time I reached the edge of the reef, I notified the FERREL of the fact and they put the information into a navigation computer system. Sherwood Forest is a large piece of real estate and it took about ten minutes to pass from one side of the reef to the other.

Standard operating procedure is to check and report the life support parameters (oxygen, carbon dioxide, battery power, etc) every fifteen minutes. This is viewed by some to be intrusive to the work, but it is a good idea to know that all is well. About two hours into the dive, that old demon, the port side battery pod flood sensor, went crazy with sound and visual alarms. I was pretty sure that this was a false reading, but "you never know."

I notified the FERREL and they said, "stand by DeepWorker." After a few moments, Larry Shumaker said, "Walt, turn the power off, turn it back on, and see if the water alarm goes away." I followed the instructions, but no joy. The alarm was still firing away. They said come on up. What they did not tell me was that the rain was pouring down like cats and dogs (perhaps a frog choker is a better description), and, oh yes, the wind was gusting about 25 knots. I reached the surface with no problem, blew air into the ballast tank and was bobbing about in a moderate sea.

The chase boat was on scene and I could see Dave Score and Christy Hughes being pelted by the rain. The FERREL was near by and was maneuvering for the pickup. All was going according to plan. I piloted DeepWorker about 25 feet directly behind the FERREL and Dave Score hooked up the towline. He also attached the taglines to the starboard and port attaching points. But at this point, I began to drift past the FERREL along the starboard side, when I was supposed to remain dead astern of her.

The FERREL moved ahead slowly to keep DeepWorker off the stern. When that happened, the sub was caught up in the wash from the FERREL's propellers. I went down, around, and did the tipsy doodle. The starboard and port taglines were crossed, the towline was snagged on the video light pole, and eventually turned the light 180 degrees. I was treated to a roller coaster ride. Meanwhile, on deck, intrepid members of the FERREL's deck department, along with other ship's personnel, Nuytco crew, and other SSE personnel, were getting pelted, pummeled, and soaked by the sheets of rain, while trying to maintain control of the lines.

In a few seconds, DeepWorker popped back up to the surface and the swimmer, Dave Score, fixed the lines. After a bit of rolling about, we got the lift sling attached. The crane lifted the sub back onto the deck of the FERREL. I said a prayer and gave thanks for the crew's great effort under rather trying conditions. They rigged a tarp as a makeshift tent over DeepWorker ("rain drops keep falling on my head..."). After the tent was raised, I opened the hatch and said, "That was quite a ride! Can we do it again?"

The post dive maintenance and tests were postponed because of the rain. When the rain stopped, I went back on deck to work on the submarine and was ambushed by Nuytco's Jeff Heaton and Steve Drover. They had high tech water machineguns and blasted me from both sides. I can't get no respect! There's nothing like three grown men running around on the deck of a ship, already soaked from the rain, playing squirt gun commando!

The video from the dive was spectacular, with great color off National Geographic's three-chip camera. I captured some interesting views of a large black coral that was at the base of the reef. The navigation tape was a good record of the dive and we had not overlapped the transects covered in my earlier dive. We were very pleased, and are eagerly preparing for tomorrow's dive operations. The ocean calls.

Walt's dives took place on a special reef near Tortugas Bank known as "Sherwood Forest." Ben Haskell, Science Coordinator for the sanctuary, provided the following eloquent description of the reef:

Sherwood Forest. The name conjures up images of a dark, quiet forest covered in moss and mushrooms and shrouded in mystery. These are the images that came to the mind of scientists when they dove on a coral bank straddling the westernmost boundary of the Florida Keys National Marine Sanctuary. They dubbed it Sherwood Forest and the name has stuck. Fishermen have known about the area for years.

What's impressive about Sherwood Forest is not just the quantity of coral that one sees on the bottom but the bizarre mushroom shapes of the coral heads. This is an adaptation to the low light conditions the corals are growing in at the 60-90 foot depth range. This area contains the richest and healthiest coral reef left in the Florida Keys. The coral forms a veneer over the real bottom, which is actually about 3 to 5 feet below the coral. The veneer is riddled with holes and caves, which form an ideal habitat for fish to live in.

Despite this seemingly ideal fish habitat no one seems to be home; at least no one bigger than the minimum size limit. There are plenty of small tropical fish darting in and around the mushroom heads but large fish are conspicuously absent from Sherwood Forest as well as the surrounding area. Heavy fishing pressure over the years has culled out the large predatory fish like grouper and snapper, radically altering the population size structure which in turn reduces the number of eggs produced and ultimately the sustainability of the fishery. Removal of too many breeding adults can make it impossible for a population to recover. The absence of large predators also causes an imbalance in the coral reef ecosystem.

One of the purposes of establishing a no-take ecological reserve in the Tortugas is to restore a naturally functioning ecosystem where an encounter with a large, scary predator is not a rare occurrence but rather the norm. Some parts of the ocean need to be set aside as wilderness areas where wild things rule and humans are merely observers.

(top) **RETURN**

August 18, 1999

Gale Mead, Log Editor
Sustainable Seas Expeditions

Finally, at 9:40 pm, I have time to write. Sylvia is down in the sub right now, nearing the end of her night dive. National Geographic's photographer Kip Evans did a night scuba dive so he could get some footage of Sylvia piloting the sub, and he's only recently back on deck. The FERREL is rocking and rolling, owing in no small part to its 7 foot draft (very shallow for a boat of this size).

Once the sub is back on deck, the FERREL will motor closer in to Loggerhead Key and anchor for the night. Then those of us who are staying on the sanctuary's boats (the RACHEL CARSON and the DANTE FASCELL) and on Loggerhead Island, will be transferred back on the RHIB, probably around 1 am. Meanwhile, I'm working in the crew's mess with my laptop, where a couple members of the ship's crew are watching The Matrix.

Today was one of those days when I just LOVE my job, no two ways about it. I got up at 7:30 am, and got dressed in the Uniform of the Day: swim suit, surf trunks, and high top Converse All Stars. The DANTE motored over to the FERREL and picked up Sylvia and a few others, then the DANTE, RACHEL, and TORTUGA (a research boat operated by the State of Florida Fish and Wildlife Conservation Commission) cruised over to a reef called Loggerhead Forest for a scuba dive. It was a clear, sunny morning, and we felt good. Billy Causey and Dave Savage are two of the best possible tour guides for a scuba dive in sanctuary waters. They know these dive spots intimately, and their love for the place really shines. It was a beautiful dive, with good visibility, lots of grouper, six different species of hamlet, numerous other fish, and gorgeous corals, and sponges. At one point, Sylvia went nose to nose with a two-foot grouper, and he regarded her calmly, as if he recognized in her a friend and champion.

Sadly, the divers did see evidence of coral bleaching and disease, even in this remote location. Warmer water temperatures, which are likely associated with global climate change, are the suspected culprit for bleaching, in which the algae that live symbiotically with the coral itself die off. Sometimes coral can recover from bleaching, other times, it doesn't. Signs of various coral diseases are more ominous, as they suggest that even this far out, human-caused water quality problems are at work.

While Billy and Dave led Sylvia and others on their dive from the DANTE, Kip Evans and several others dove from the RACHEL shooting video and stills, and another group dove from the Tortuga, doing reef survey work. All three groups of divers met up underwater for brief visits during the dive.

When the divers surfaced, they found that weather conditions had done a 180. They had left in calm sunny weather, and returned to a major downpour, with black clouds, wind, choppy seas, and huge buckets of water sheeting down. No need to rinse your gear, just stand in the rain for a minute or two!

Then the three vessels motored over to a snorkeling site near Loggerhead Island, to see if we could find the 300 pound jewfish that live under the wreck of the Windjammer, a steel-hulled sailing ship that had run aground in about 15 feet of water. By the time we got there, the weather had died down, still overcast, but no longer doing its best monsoon impersonation.

Sylvia and Kip did a second scuba dive, while the rest of us snorkeled, but it was shallow enough that we could free dive down to look in the hidey holes and peer in at the awesome jewfish. It was a very cool site, with reasonably good visibility. Back on board, Kip and I had to hurry to get cleaned up and ready for our afternoon dive in the DeepWorkers.

We transferred back to the FERREL, where I jumped right into prediving sub 3, while Kip worked on sub #7, and the ship motored to our chosen dive site, a deeper reef called Riley's Hump. We'd decided that we'd go off the side of the "hump" into deeper water, because not much is known about the habitat and wildlife in that section, so we could do some exploring and capture some of what we would be unable to get by scuba alone.

Around 3 pm when they were finally ready, I helped with launch of sub 7 with Kip piloting. And the monsoon started again! So we were soaked to the skin while handling lines and maneuvering the sub into the water. And while I can't speak for anyone else who was working on deck at the time, I was really enjoying myself! There was a news crew from CNN on board, taping me and Kip all through pre-dive and launch, although I don't know if or when it'll air.

Launch Kip, help move my sub into position, run to the head, run back, jump in, and do final checks. Whee! Kip and I descended together to about 90 feet, onto a beeyoootiful coral reef. We tooled around in a generally southwest direction, because our goal was deeper water, to try to see and do stuff we couldn't using scuba. Off the reef and onto sandy bottom, which was the habitat we were on for the rest of the dive. Gradually deeper, to a maximum depth of 150 feet. Not beyond scuba depth, but deeper than I personally have ever gone, and for a heck of a lot longer than you could spend there without a major decompression debt.

We chased each other across the sand, taking turns leading, occasionally stopping so Kip could film my sub, or a lone sea cucumber, or an octopus living in a rusty metal ice bin, or a pair of binoculars someone had lost overboard. 2-1/2 hours on bottom,

then time to surface. It would have been nice to see more wildlife, but I was glad for the opportunity to dive deeper, and part of the fun was diving a spot where they didn't really know WHAT we'd find, because it was unexplored.

Back on deck, I postdove sub 3, while they were prediving sub 7 for Sylvia's dive. Sylvia is diving is on a different portion of Riley's Hump. She had to spend a large portion of her dive in shallower water, around 50 feet or so, so that the scuba divers could stay with her. Then she was able to move off into deeper water. She reported lots of squid, and two sleek and beautiful reef sharks, and will have more to report, I'm sure, when she's back on the surface.

3 a.m., Aug. 19: I've only just now arrived back on the DANTE, and am eager to get some shuteye. Sylvia stayed down in the sub a little longer than originally planned, and it was after 1 am before the ship arrived back at the anchorage site. The RHIB shuttled passengers back to the campsite on Loggerhead Key, then returned to pick up those of us headed for the DANTE and the RACHEL.

But just as the RHIB was about to tie up to the FERREL, the motor died, and Sanctuary Manager Dave Savage, who was driving the boat, found himself adrift, moving farther and father away from the FERREL! He was finally able to get it running sufficiently to get back to the FERREL, and we all boarded the RHIB thinking the problem was solved. Off into what was indeed a dark and stormy night, with some trepidation about the reliability of the RHIB's motor.

We got no more than 50 yards away from the ship when the motor quit again, and we had to row back to the ship. They eventually diagnosed a simple kink in the fuel line, and we all piled back onto the boat for the two-mile run. On the way over, we noticed that the skies had cleared, and although it was very windy and choppy, it was a beautiful night. You can see so many more stars out here, away from city lights, especially on a night like this, when there's not much moonlight. It's breathtaking and humbling.

Tomorrow's schedule involves another round of afternoon and night dives with the sub, but some of us late night travelers will still have a somewhat early morning. Laura Francis, SSE's Education Coordinator, will be scuba diving in the morning with photographer Kip Evans and some other members of the team, as a dress rehearsal for tomorrow's satellite uplink dive. Meanwhile, most of the rest of us will transfer back to the FERREL so we can be here during sub ops. Sleep deprivation has become par for the course for many of us working on this project, but it's well worth it. I wouldn't want to be anywhere else than right here, right now, being a part of this exciting adventure.

(top) **RETURN**

August 19, 1999

Gale Mead, Mission Log Editor

Don DeMaria, Commercial Fisherman

Erich Mueller, Scientist
Mote Marine Laboratory

For those of us who have been struggling with not enough sleep, the morning passed in a bit of a fog. It was a hot day, somewhere in the neighborhood of 97 degrees, with high humidity. On the FERREL, we steamed back to Riley's Hump, where Erich Mueller and Walt Japp were scheduled to dive this afternoon and evening. Erich, a scientist from Mote Marine Laboratories, has just joined the mission. He plans to investigate reef health and gather information on the habitat and its residents.

Riley's Hump, the reef we visited yesterday and will continue to explore today, is a unique and incredibly productive reef located approximately 14 miles southwest of Loggerhead Key. At first glance, Riley's Hump does not appear to be such an extraordinary place. There are no high-relief coral formations such as one finds in other areas of the Tortugas, such as Tortugas Bank. But take a closer look.

Don DeMaria explains:

"Riley's is the extreme western end of the Florida Keys reef system, which means it is up-current from the rest of the reef tract. Many of the large fish and lobster that the Florida Keys and south Florida are so famous for may well originate at Riley's. Many commercially and recreationally important fish species do aggregate to spawn on Riley's. Beyond their importance as species to be extracted from the system for their commercial value, these key species play an irreplaceable role in the overall functioning of a healthy reef system.

"The most well known spawning aggregation is that of the mutton snapper. When this aggregation was first fished intensely about 15 years ago, there were reports of commercial longline vessels from the Fort Myers area catching as much as 30,000 pounds of mutton snapper per vessel on a single fishing trip. Today, catch rates are much lower due to the intense fishing pressure Riley's has received. The mutton snapper aggregation still exists, but their numbers have been drastically diminished.

"If you look a little closer at Riley's Hump, you will see populations of species that exist nowhere else in the continental United States. Sargassum triggerfish are one example. Riley's has a considerable population of adult sargassum triggerfish on one small area, perhaps no larger than one acre. How these fish got there, and why they remain only in this one small area, is not yet known.

"Visibility underwater at Riley's often exceeds 100 feet. Since Riley's is so close to the edge of the continental shelf, and bathed by the Gulf Stream, large pelagic fish often venture over the area. It is one of the few places a diver can look up and occasionally see marlin, sailfish, or dolphin, and look down to see snapper, grouper, and angelfish.

"Riley's Hump is unique in terms of location, marine life, and reproductive potential. Consequently, this reef section more than any other deserves special protection."

Erich's dive went flawlessly, and he was able to capture some gorgeous images of the reef, some of which we hope to be able to upload here soon.

Here's Erich's dive report:

"My first mission dive! After a number of training dives in Monterey, California and Key West, Florida, it was exciting to be diving 'Rileys Hump,' some 12 miles southwest of the Dry Tortugas. Long known to fishermen as a productive area with coral formations and some fish species uncommon in other parts of the Keys, this special area has only recently begun to be appreciated by scientists. I was also looking forward to diving in an area with good visibility and things to see.

"The descent into the blue water was beautiful and very different from the training dives, diving in shallow, murky water. I reached the bottom around 95 feet deep and was no deeper than 105 feet for the duration of the 2-1/2 hour dive. Ocean triggerfish swam slowly in the middle of the water column above me. The bottom was mostly a low -relief coral habitat often described as 'hard bottom.'

"The cavernous star coral *(Montastraea cavernosa)*was the most common stony coral species. Flexible corals, the gorgonians, were also common, and bent slightly in the gentle current. At times, a school of gray snapper would visit in their curious way, but most of the fish I observed were small reef fish seeking shelter amongst the small coral heads.

"Near the end of the dive came the most memorable sight: a school of horse-eye jacks enveloped the sub and continued to swim around it in an almost endless whirl. Their curiosity apparently satisfied after 10 minutes or so, they swam off into the blue from which they had emerged."

While Erich was completing his dive, the DANTE took Laura Francis, Kip Evans, and the team from NASA to conduct a dress rehearsal for the satellite uplink dive scheduled for tomorrow. Their dive, on a small reef unpalatably dubbed "Temptation Rock" by spearfishermen who find it oh-so-tempting to shoot the fish there, went

well, although problems with through-water communications provoked some concern.

Walt Japp completed an early evening DeepWorker dive that started with such a breathtaking experience that the rest of the dive could hardly compete. As soon as he submerged, great schools of grunt circled around and around the sub. Then, a big, beautiful, 4-foot adult loggerhead turtle approached, circled the sub, and approached again, looking, at one point, as if he just might sample a bite of the sub's external equipment! He made a survey of the reef's south end, dropping off to a maximum depth of 170 feet.

Expedition crew aboard the RV Dante Fascell explore the Keys.

Once Walt was back on deck, we steamed back to Garden Key for the night. Tomorrow will be our last day of operations in the Tortugas, with Laddie Akins and Erich Mueller diving the sub, while another team conducts the satellite broadcast on board the DANTE. Then we return to Key West for an Open House event on board the FERREL scheduled for the 22nd. On the 23rd, we set out again, working our way up the Keys towards Key Largo.

(top) **RETURN**

August 20, 1999

Gale Mead, Log Editor

Erich Mueller, Scientist
Mote Marine Laboratory

Mary Tagliareni, Interim Education Coordinator
Florida Keys National Marine Sanctuary

Today, in addition to submersible operations, a team aboard the DANTE FASCELL conducted a live satellite broadcast from Temptation Rock. It was a perfect example of the kind of collaborative effort that has been so central to the SSE project, with staff from the National Geographic, NOAA headquarters, the sanctuary, and NASA all working together to pull off a technologically and logistically challenging feat.

The DANTE arrived on station at Temptation Rock several hours before the broadcast was scheduled to begin, to give the NASA team time to set up and test their equipment. The sanctuary's Mary Tagliarini and SSE's Education Coordinator Laura Francis orchestrated the topside interviews with Sylvia Earle, Walt Japp, and Billy Causey, while Kip Evans and Bill Goodwin dove the reef below with video camera and augamasks (for through-water communications) to transmit comments and images from underwater.

During the down time before the broadcast, several of us were able to jump in the water to snorkel around the reef. And to be honest, I don't know how I could have resisted! Clear, warm water, huge schools of fish, and the occasional smallish grouper were certainly compelling attractions! Billy Causey enthused about the grouper we saw, two or three in the 18" size range. Sylvia brought us back down to

Earth with the reminder that there should have been far more grouper there, much, much larger than the ones we saw. The effects of fishing pressure are quite evident here.

Sanctuary Biologist Bill Goodwin wearing an aga mask and underwater communication equipment prepares for the internet uplink. (photo credit: Mary Tagliareni/FKNMS

At one point, only Dr. K. M. S. Aziz, a distinguished microbiologist from Bangladesh, and I were in the water, and I was cruising near the edge of the reef, where the terrain switches abruptly to a white sand bottom. I could hardly believe my eyes when a beautiful and unusually marked young manta ray cruised into view below me! I free-dove down to get a closer look, then remembered my manners and surfaced, shouting for Aziz to join me. We followed the ray along the edge of the reef, across the sand, and over to the edge of the next reef. Occasionally, the ray would pause to feed, performing slow, elegant backwards somersaults, mouth open wide, to filter tiny edibles from the water. It was only when I realized how far from the boat I'd gotten that I reluctantly broke off and let the manta disappear in the distance.

The big moment has finally arrived - the live interactive internet uplink for the Florida Keys Sustainable Seas Expedition. I had been working with the folks at NASA and SSE for the past few months pulling all the pieces together. Our first visit to the site was on July 21 when Andrea McCurdy, Steve Baumgartner, and myself visited the Tortugas area. We had to have a plan for every type of weather that we might face on the day of the event- wind and sun, rain and no wind, rain and wind, or the perfect day of no wind or rain but calm and sunny. We also had to consider all of the different wind directions when choosing a location. Plan were written for each scenario but I was still nervous about the many uncontrollable factors one faces when doing an outside live event.

On August 18, we used SCUBA gear to evaluate Loggerhead Forest as a location for the dive team to conduct their part of the uplink. Loggerhead Forest was about 40' - 60' deep with healthy coral cover and abundant fish.

On August 19, we had "dress rehearsal" at Temptation Rock to work out kinks in the underwater communications, establish a strong signal with the satellite, and review the outline for the next day. We were not able to be at Loggerhead Forest as planned because of a squall moving through and the seas being too rough. Temptation Rock is a shallower site, 20' to 30' deep, and closer to Loggerhead Key receiving from the seas building too high as they do in open water.

Finally it is August 20. The sun shines bright this morning but the wind is blowing 15 mph. Temptation Rock is selected as the location and

Sanctuary Biologist Bill Goodwin and SSE Education Coordinator Laura Francis prepare to test the underwater communication system for the uplink. (photo credit: Mary Tagliareni/FKNMS)

the anchors are set on the R/V DANTE FASCELL by 9:00 AM. All types of equipment is set up: satellite dishes, cameras and tripods, dive equipment, underwater cameras, underwater communications box, and the set. Even though everyone should know their job because of the rehearsal the day before, Andrea McCurdy still holds meetings with all of the different groups to answer last minute questions and give final directions.

The topic of the uplink is "Preserving for the Future" with a focus on marine zoning. Our guests are Dr. Sylvia Earle, Project Director of the Sustainable Seas Expeditions and Explorer in Residence for the National Geographic Society; Billy Causey, Superintendent of the Florida Keys

National Marine Sanctuary; Walt Jaap, Florida Marine Research Institute and DeepWorker pilot; and Bill Goodwin, Sanctuary Biologist conducting the underwater tour of the reef with video camera work by Kip Evans of the National Geographic Society. I served as the host and Laura Francis monitored the web chat room.

There were about 50 registrants for the uplink ranging from individuals, family members, and school classrooms. At 1:00 PM EST we went live on the internet- after the first few minutes the butterflies were gone and I really started to enjoy being a participant in this event. As Laura monitored the chat room the questions came in, she had a difficult task in deciding which questions would be presented to our panel of experts.

Dr. Earle discussed the Sustainable Seas Expeditions and introduced the concept of marine zoning. Billy Causey explained the zoning plan at the Florida Keys National Marine Sanctuary and the undertaking of establishing a marine reserve in the Tortugas area. Walt Jaap shared some of the footage from his DeepWorker dives earlier in the week and assisted Billy in explaining how special the Totugas area and why it should be established as a ecological reserve. All three of the panelists answered questions from the chat room and helped make this a motivational, informational, and educational program.

Forty minutes into the program, Karen Dobson, NASA technician, switches to the underwater microphone and camera. The pictures are great but we have a very difficult time understanding Bill Goodwin. After a few more tries we decide

it will be better if Billy Causey narrates what the audience is seeing from the live underwater footage.

Mary Tagliareni, Dr. Sylvia Earle, Billy Causey, and Walt Jaap participated in the uplink answering questions, narrating underwater footage, and teaching the viewers about the Tortugas area.

Overall the program was a success- the problem with the underwater communications was the only disappointment but it had not been unexpected. Everyone involved including the panel of guests, line tenders, bubble watchers, camera operators, photographers, NASA technicians and videographers all did a fantastic job.

In the very near future I believe that this type of education effort will become more commonplace. Within this one hour, we were able to reach to a wide and diverse audience and have them actually participate and help direct the direction of the uplink. I'm excited about the future and who we will be able to reach with this type of media.

While we were busy with the uplink, Laddie Akins, who was also with us at Gray's Reef, was completing his first Fish Count transect dive with the DeepWorker in this sanctuary. Dive Supervisor Larry Shumaker completed a dive concurrently, checking out systems on sub #6. For this dive, we were back at Sherwood Forest, an area he's explored in the past using scuba gear.

During his 2-1/2 hour dive, Laddie was able to complete eight transects to survey fish populations. He stated that he was deeply concerned and disappointed at the lack of fish, and especially the almost total lack of grouper. During his entire dive, he saw only two small (subadult) scamp in an area that used to be heavily populated by grouper. He noted that during his dive two fishing boats were in the area, illustrating how very popular the location is for fishing activity. Unfortunately, all that fishing pressure has had its consequences. At present, none of the area surrounding the Dry Tortugas has been designated a "no-take zone," but our observations here this week have clearly demonstrated the need for better protection for the fish that live and breed here.

After Laddie's dive, it was Erich Mueller's turn. Here, he discusses his research and describes his dive:

"The first known coral disease, 'black band' disease, was initially described in the 1970s, and at the time was considered merely an interesting phenomenon. However, as more coral diseases were observed in the 1980s, it became apparent that some diseases were capable of killing large numbers of corals very rapidly and having substantial effects on reef communities.

Nuytco submersible specialist Steve Drover helps Erich Mueller prepare for his dive where he will investigate coral disease on the Tortugas Bank.

"Additional diseases continue to be described and some appear to be increasing in their impact, particularly in the western Atlantic region that includes the Caribbean, Florida and the Bahamas. It is possible that this apparent increase in coral disease incidence is due to greater awareness and observation effort. It is believed that coral diseases are more widespread and are having a much greater impact than in the past, but it is vital to gather more detailed information so we can better quantify changes over time.

"To quantitatively assess the incidence of coral diseases in the Florida Keys (including the Florida Keys National Marine Sanctuary, Tortugas National Park and Biscayne National Park), Mote Marine Laboratory joined an effort led by Dr. Deborah Santavy (U.S. EPA) to establish permanent monitoring sites in a program known as the Florida Keys Coral Disease Survey. In addition to looking at the change of coral disease incidence over time, the survey examines different areas of the Florida Keys that have varying influences on local water quality, some caused by human activity.

"The survey also includes several reef zones at different water depths. Using scuba, the depths that can be examined are limited. Thus, the DeepWorker submersibles employed by the Sustainable Seas Expedition provide a system that allows surveys to the depth limits of reef coral growth (about 220 feet). In this project, we are looking to develop survey approaches with the DeepWorker that are compatible with the shallow-water measurements made throughout the Florida Keys. Specifically, we would like to answer the question: 'Does the incidence of coral disease vary with depth?'

"This evening/night dive was to explore a site that has not been documented on the Tortugas Bank, recently named 'Dante's Inferno.'

"This remarkable formation consists of several dramatic pinnacles comprised of and covered by brilliantly colored corals. It was discovered and named by the crew of the sanctuary's research boat, the DANTE FASCELL.

"The sub was towed by the chase boat to the coordinates, and I descended to a hard bottom at about 65 feet. Topside provided guidance to the coordinates on the bottom through use of their tracking system, but no drop-offs or substantial relief was encountered, so I decided to head west to find the edge of the habitat.

"Visibility was not very good, appearing to be 10-15 feet from the sub, and got worse as dusk descended. Then, out of the darkness came a pinnacle of coral. Up and then over the coral, then dropping to 85 feet. I worked along the slope carefully as the reef came up abruptly from different directions. I was joined late in the dive by Sylvia Earle, Kip Evans, Laura Francis and Dave Score, scuba diving to film the sub in action.

"While the solitude of the sub allows one to focus on the task at hand, it was fun to have some company. I worked on close-up techniques with the video camera. With

the camera zoomed in so closely, I had to hold the sub as still as possible, as any small movement would result in major shifts in the camera's view. Panning and tilting was by very gentle thruster activation. Even my own movements inside the sub would make the sub rock, making for a rather queasy video to watch!"

Finally, it was time to call it a night so the ship could begin the long 8-hour trip back to Key West. Up I went through the blackness to the moonlit sea above. Tomorrow will be a day of rest for some members of the SSE team, sanctuary staff, and ship's crew, but most will be busily engaged in preparations for the open house event scheduled for Sunday, and for the next leg of the cruise, which begins Monday morning.

(top) **RETURN**

August 21, 1999

The Sustainable Seas Expeditions: A National Perspective on the First Year

Francesca Cava, Project Manager
Sustainable Seas Expeditions

A central theme of the Sustainable Seas Expeditions' (SSE) first year has been to act as a catalyst, bringing together institutions and people to better recognize the importance of the oceans and the special significance of our National Marine Sanctuaries. Many people have worked very hard to make the vision of SSE a reality, and a tremendous amount has been learned.

There have also been many firsts. It was the first time a national "Call for Collaboration" invited researchers and educators to join an expedition to explore the nation's system of marine sanctuaries. It was the first time that NOAA ships launched and recovered manned submersibles, and the first time that scientists, educators, writers, managers and teachers were trained as pilots of one-person subs. For the first time, an aggressive national public outreach effort, which included the media, books, videos and the Internet, was launched and maintained in a campaign to educate people about our oceans and their sanctuaries. And for the first time, the President of the United States called for the doubling of federal support for the National Marine Sanctuary Program.

During one of SSE's Technical Advisory Committee meetings, committee member John Ogden stated, "SSE has the potential to become the nation's ocean program." This statement certainly provided an ambitious vision for the program. Already, however, it is fair to say that never before has a public-private partnership led to such interagency support for a national focus on the value of marine sanctuaries. And that support is growing.

As the Expeditions continue, we will have more challenges ahead: Our technologies must still be refined to provide better ways to access the ocean, explore its secrets and collect valuable data; our discoveries and protocols should be extended to marine-protected areas around the world; and, no matter how many times we visit a single sanctuary, we have much, much more to learn. We invite you to join us as we meet these new challenges, seek new knowledge, and find new ways to protect and enjoy

our national marine sanctuaries.

(top) RETURN

August 22, 1999

Ivy Kelley
Florida Keys National Marine Sanctuary

Seven students from two Florida Keys high schools participated in a Mini-Student Summit on August 22, 1999. Nick Lowenborg, Tiffini Miller, and Kimberly Ganem, of Key West High School, were accompanied by their teacher, Dean Jones. The upper Keys were represented by Coral Shores High School students Amanda Self, Samantha LaRocco, Margie Lunsford, Jackie Kenny, and teacher David Makepeace.

The students and teachers helped plan the Florida Keys SSE Student Summit (tentatively scheduled for October) with Joanne Delaney and Ivy Kelley of the Florida Keys National Marine Sancutary and Laura Francis, Education Coordinator for the Sustainable Seas Expeditions. After a brief introductory session, the group toured the NOAA ship FERREL, where they learned about the many fascinating research missions the ship has supported, and witnessed first-hand the inner workings of the electronics lab.

Mini-Student Summit participants, teachers, and sanctuary staff appreciated a private audience with Her Deepness, Dr. Sylvia Earle, aboard the NOAA ship Ferrel.

Dave Savage and Mary Tagliareni, FKNMS DeepWorker pilots, toured the students through the DeepWorker and its systems. The students each had an opportunity to climb into the sub for a first-hand look and to get a feel for what it's like to be a DeepWorker pilot.

The Student Summit took place in the context of a larger open house event aboard the FERREL and in the adjacent Mallory Square in Key West. Over 800 people toured the ship and had the chance to learn more about SSE, and the sanctuary.

Lt. Commander Dave Savage explains the inner workings of the DeepWorker 2000 to Coral Shores High School student Jackie Kenny.

Samantha LaRocco (right) and Jackie Kenny record their on board experiences using computers in the Ferrel's electronic laboratory.

Most exciting to students, teachers, and FKNMS staff was the time they spent with Sylvia Earle, former NOAA Chief Scientist and current National Geographic Explorer-in-Residence. Dr. Earle spoke eloquently about her concerns for the future of our ocean planet and her hopes for the wisdom of upcoming generations. The students listened raptly as Dr. Earle detailed some of the history of ocean exploration, the changes she had seen and our still nascent study of the oceans. We know less about the oceans than we do the surface of the moon.

After lunch and an unexpected detour in a recalcitrant elevator, students met for an afternoon of discussion and brainstorming about the itinerary and hands-on activities for the Student Summit. Teachers and students both expressed their desire to see SSE become a part of their studies throughout the year, and not just a one-time event. To this end, various strategies were suggested and elaborated upon.

Students suggested a discussion of "hot topics" that would inspire debate and challenge thinking. Other ideas were to obtain video and data collected from each of the SSE sanctuaries for comparison/contrast studies; communicate with students from other sanctuaries; have projects "bring the ocean to the classroom"; have students collect and analyze their own data; and collect and to develop research projects for next year's SSE.

Teachers expressed their desire to see the students involved in a project that was "not just more schoolwork." Students agreed that any ideas must "be something we do because we really like it." An agenda was set, and staff

greatly appreciated students' input about realistic time limits on activities. More fine-tuning remains to be done about the main group activity, and a date and venue will be set by the end of August.

Lt.jg Pauline Robbins welcomed visitors aboard the NOAA ship Ferrel at the Mallory Square dock. (photo credit: FKNMS)

(top) RETURN

August 23, 1999
What role does exploration play in marine science?

Ben Haskell, Research Coordinator
Florida Keys National Marine Sanctuary

This inaugural year of the Sustainable Seas Expedition has focused on exploring the deeper water habitats of the national marine sanctuaries. While exploration will continue to be a major focus of SSE in coming years, scientific investigations will begin to play an increasingly important role in the accomplishments of SSE.

Is there a role for exploration in marine science? Absolutely! In fact, science can't happen without exploration, because exploration is simply the act of observing new places or phenomena and asking questions. Science follows from exploration by answering questions in a verifiable and systematic way.

Dr. Erich Mueller, SSE pilot in the Florida Keys National Marine Sanctuary, is able to explore deep water reefs more thoroughly with DeepWorker than he has been able to in the past, and thinks he sees fewer diseases in deepwater corals than he does in shallower water corals. This leads him to ask the question: Why? Dr. Mueller can now design an investigation using the DeepWorker to test the hypothesis (or question) that deepwater corals are healthier than their shallow counterparts.

Another example of using the DeepWorker for exploration and science is for the design and monitoring of the proposed Tortugas ecological reserve in the Florida Keys National Marine Sanctuary. This year the Sustainable Seas Expedition helped sanctuary managers answer the question: What types of habitat exists in the deeper water areas of the proposed reserve? In coming years, after the reserve is in place, the DeepWorker will be used to monitor fish populations inside and outside of the reserve in order to answer the question: what effect is the reserve having on fish populations?

The Sustainable Seas Expedition and its DeepWorker submersible have much to contribute to the exploration and science of national marine sanctuaries. Here in the Florida Keys National Marine Sanctuary we look forward to seeing and learning new things, asking many questions, and finding the answers to some of them.

(top) RETURN

August 24, 1999

John McDonough, Sustainable Seas Project Manager
NOAA Special Projects Office

Lcdr. Dave Savage, Upper Keys Manager,
Florida Keys National Marine Sanctuary (FKNMS)

Amanda Self, Samantha LaRocco, and Jackie Kenny
Coral Shores High School Students, Tavernier, FL

Gale Mead, Mission Log Editor
Sustainable Seas Expeditions

Gale begins:

What can I say, but WOW! What a morning! Dave Savage, FKNMS Manager, had made arrangements for National Geographic photographer Kip Evans to take a helicopter ride over the sanctuary and in particular overflying the FERREL during sub recovery operations, courtesy of the US Coast Guard. John McDonough and I were able to accompany Kip on the flight. John works for NOAA's Special Projects Office, and is one of SSE's greatest unsung heroes. His behind-the-scenes project management work has been invaluable throughout this field season, and he has uncomplainingly done a tremendous amount of hard work to make things happen, while getting precious few opportunities to engage in the fun activities associated with the project.

John was kind enough to provide his perspective on the helicopter flight:

In 1947, Marjorie Stoneman Douglas wrote the "River of Grass", a seminal work on the Florida Everglades that focused attention on this very unique,yet misunderstood terrestrial ecosystem. Her intention was to describe the complexity and wonder of the interrelated habitats comprising the Everglades, and to try and convince people that the policy of channelization, damming, and draining risked the collapse of a system that people were only beginning to realize they were dependent on. In contrast to the "use or lose" policies of the early twentieth century, she advocated preservation and restoration, concepts that we are still struggling to implement today as the population

of South Florida continues to rise.

Even more recently, scientists have started to piece together the equally complex connections between the habitats and natural processes of the Everglades with those of Florida Bay and even the reef tract, that seemingly remote and narrow strand of living coral that is strung like a multicolored necklace off the Florida Keys -- a very fragile string of beads as we are now discovering.

The U.S. Coast Guard's HH65A Dolphin helicopter, normally used for search and rescue operations, is being used for a SSE photographic excursion.

With these thoughts in mind, I set out with Gale Mead, the editor of the Mission Log for the project, and Kip Evans, the National Geographic photographer for Sustainable Seas, to conduct a helicopter overflight of the region courtesy of the U.S. Coast Guard. Kip planned to film the verdant grasslands, hummocky mangrove islands, twisting channels, and the scatter shot brackish lakes of the Everglades that give way to Florida Bay where the peninsula slowly and subtly slopes below sea level.

From there, we would head out over the long and curving barrier band of Key Largo to film the ship and submersible which were conducting operations along the deep oceanfront drop offs of Carysfort Reef. We hoped that Kip's efforts would help demonstrate visually how each system is interrelated, blending in to one another. After all, it is these relationships that the scientists, using tools such as the DeepWorker and other techniques, seek to explore and understand.

As we lifted off from the Coast Guard base at Opa Locka, I was immediately struck by the vast wilderness stretching below. A wilderness of houses, industrial parks, warehouses, high-rise apartments and offices stretching skyward, all unruly in their orderliness and connected by a grid work of concrete roads, electrical lines, arrow-straight canals, and other man-made infrastructure. Through this amazing network snaked small, disparate and disconnected areas of vegetation. A ghostly vestige of what was, not too long ago, a tangle of forest and jungle occupying the resistant carbonate sediment bars that form a slight high ground between the ocean and the honeycombed and water eroded limestone underlying the Everglades. For some reason, I felt myself relax as we left all this urbanity behind.

From our vantage point several hundred feet above the earth, I began to discern a pattern to the landscape below. Changes in vegetation were defined by subtle variations in hue and shadow. I found myself gazing at a braided landscape filled with multiple twisting rivers of grass, complete with sweeping bends, backwaters, islands, and channels, all conforming to the underlying nearly level, but craggy and lumpy topography. I was reminded of a trip to the Flamingo area several years ago when standing on a soggy pathway surrounded by an apparent "prairie", the fact that I was truly exploring a river was hammered home in the form of several species of

brilliantly colored sunfish that were lazily finning in the almost unnoticeable traces of water and current; hidden ghosts living between submerged blades of grass upon what appeared to be a veldt.

Our guides, directed by Kip who was having the time of his life hanging out the open door filming the display, were very familiar with this area, often flying over it during the course of law enforcement and search and rescue activities. As we approached the edge of the Everglades, an area of numerous shallow brackish water lakes and expansive mud flats, the pilots noticed something suspicious.

Below us, in one of the larger, deeper lakes two small boats, an apparently abandoned center-console fishing boat and an jon-boat, were pulled up tight to the shore. A lone figure was in the jon-boat, and it appeared that he was attempting to salvage the other vessel. However, as the helicopter dropped lower and approached the scene, the man in the jon-boat hunkered down and quickly sped his craft around a small point and into a mangrove-shrouded creek where we were unable to see him. What in the heck was this guy up to? Drug running? Robbery? Murder? These and other theories of nefarious activity were debated and discussed as we spent the next 30 minutes tucking tight circles barely over the treetops attempting to catch sight of the jon-boat and its occupant.

John McDonough barely has time to pose for a picture he's been so busy planning SSE logistics.

I could not help but wonder if a bullet from a high-powered rifle might come ripping through the craft at any second. It wouldn't have been the first time something like that has happened. Unable to flush him, we gathered as much information as we could to assist the water-based Coast Guard crew that would be coming out to investigate. Kip captured all of this on videotape and promised to make a copy for the Coast Guard.

Prior to departing the Everglades, we made several passes over a particularly expansive shallow water area full of thick dark green patches of submerged vegetation interspersed with crater-like pockets of carbonate sands and mud. Crocogator and allidile country. We couldn't tell one from the other from our vantage point. All we knew is that the area was inhabited by several large reptilian forms hunting fish in the blood warm waters.

Several times as we flew over, scaring the abundant schools offish into a frenzy, the reptiles would suddenly turn and lunge (shockingly fast for such a large animal), jaws

snapping and water flying as a panicked fish flew by too close. Despite earplugs, a flight helmet, and the muffled sound of the helicopter's blades, I could hear in my mind's ear the slopping sound of the churning waters as these impressive creatures hunted. I imagine that they were sorry to see us depart as the noise faded and their prey calmed down, silently hiding among the abundant cover.

LT Joe Buzzella (pilot), LT Chris Roach (co-pilot) and flight engineer Jason Lee were excellent guides as they flew the SSE crew around the Keys.

After a stop in Marathon to refuel the helicopter and grab a quick lunch, we departed for our rendezvous with the NOAA ship FERREL which would soon be recovering the submersible after a morning spent exploring the seldom-visited deep forereef section of Carysfort Reef, and recording on film some of the larger predatory species that inhabit the area.

Following the spine of the Florida Keys toward the northeast offered a unique perspective. To our left lay the mangrove-island studded reaches of Florida Bay. Shallow hard bottom areas, where they almost broke the surface, formed extensive riffles as the wind and tide moved the water over their rough surfaces. Glinting in the sunlight, these riffles were easily discerned, and I could imagine the fish and other species positioned below them in the slightly deeper waters, awaiting a free meal of hapless smaller creatures caught in the current and swept into the deeper turquoise pools.

Directly below us lay the Keys themselves, ancient fossilized coral reefs, bone dead counterparts to the living reefs we see today. Connecting them like an artery we could easily make out the fixed and rigid trace of route 1, following the old path of the Flagler Railroad. To our right, the nearshore seagrass beds and hardbottom communities quickly sloped into the deeper, more murky waters of Hawk channel, and in the distance, the ultra-clear waters blanketing the Reef Tract itself. For an instant, all seemed in motion below me, bay water over riffle, currents surging through narrow channels between the Keys, and the flowing waters of Hawk Channel and the Atlantic where the waters finally meet and mix.

Battling a stiff headwind, our helicopter made its way out over the channel toward the ship, which was positioned several hundred yards seaward of Carysfort Reef. One of 18 Sanctuary Preservation Areas (SPA)established by the Florida Keys National Marine Sanctuary, public use ofCarysfort Reef is managed to reduce concentrations of activities that could have a detrimental effect on the reef and the species that inhabit the area.

Such protection is critical to Carysfort and other reefs throughout the Florida Keys since research conducted over the past 30years indicates that the coral communities and associated fish and invertebrate species have suffered significant decreases in abundance and diversity. Specifically, data collected from a number of permanently

established transects in the Carysfort area demonstrate that the quantity and quality of the habitat has declined from two primary causes: 1)shallow elkhorn and staghorn corals along the reef crest show signs of stress related to physical disturbances (storms as well as human-induced disturbance); and 2) deeper brain and sheet corals along the forereef have suffered due to increases in sedimentation and disease. The operation we were witnessing today continues the tradition of research and assessment that will provide managers with the information required to make decisions concerning human activities affecting the area.

Gazing through the open door of the helicopter at the scene below, I immediately noticed something so often taken for granted when running an operation such as this -- the seamless choreography of support that makes it all happen. As we once again began to pull some "Gs" while turning tight circles around the ship, I watched as Dave Savage, piloting the submersible, navigated toward the ship's stern and the recovery crew paid out the tow line so that it drifted down-current away from the ship.

Meanwhile, the RHIB (rigid-hull inflatable boat), with the support swimmer aboard, stuck close to the submersible, ready to assist at the given command. On deck, the recovery crew levered out the crane with its attached bridle. Everything was ready to go. As we continued to circle, Kip hanging out the door to get the best angle, the submersible thrusted into the position and the swimmer jumped into the water to attach the tow line. Without let up, the recovery crew winched the submersible slowly to the stern while the swimmer rode the back of the sub like a cowboy at a rodeo.

Within seconds, the recovery crew tossed the tag lines to the swimmer who attached them to the submersible. Then the crane operator lowered the bridle which was also attached. Without a hitch, the submersible was lifted into the air, its tendency to sway with the surge of the ship in the swell and chop of the ocean controlled by the line handlers, and deposited gently on the deck. After a few more passes to wave goodbye to our colleagues, we were off to get some footage of the reef crest and the Carysfort Lighthouse prior to heading back to Opa Locka.

Kip Evans, John McDonough, and Gale Mead make their way towards SSE operations at Carysfort Reef.

Having snorkeled at Carysfort in the past, I'd noticed the signs of stress discussed in the literature. I remember one particular trip when the waters were calm and particularly clear, and I spent several hours with friends from the Sanctuary exploring the backreef area behind the reef crest. At that time, the rubble from the broken corals outnumbered those that were healthy.

It was reminiscent of a cluttered clearcut, trees all tangled and jumbled on the ground with a scattering of untouched sentinels standing lonely watch over the destruction. From on high, this pattern is very apparent. What was once a multicolored scene of healthy living corals is now, in numerous large patches, monocolored piles of dead and dying reef. However, given the water clarity we were witnessing today, it did appear that the relative health of the corals increased with an increase in depth.

Finally, we got some good footage of the Carysfort Lighthouse, a 100' open-frame structure with an interesting history. Originally built in 1848, the lighthouse and the surrounding reef was named after the H.M.S. Carysford, a 28-gun British frigate that had run aground on the reef in 1770. The lighthouse was maintained by keepers on and off until the 1970s when the structure was outfitted with solar panels. Currently, the lighthouse is maintained by the Coast Guard.

At last, our time was up and our pilots headed back home, back over the upper reaches of Key Largo, Biscayne Bay, along the high-rise building buttresses of Miami Beach, and finally back to the airport. As we came in for the touchdown, scattered storms hung to the north. Heavy downbursts of rain could be seen washing the streets of distant Ft. Lauderdale, and an occasional snaking tongue of lightning licked the earth on the horizon. A satisfying end to a very productive day; all goals and objectives accomplished.

LCDR Dave Savage provided a writeup about his dive, and had this to say:

Today's two long submersible dives concentrated on documenting the deep reef structure offshore from the Carysfort Sanctuary Preservation Area in the Florida Keys National Marine Sanctuary. Dr. Phil Dustan of the University of Charleston dove the second dive of the day and I dove the first dive.

I had three main objectives during my 3 hour morning dive. My first objective was to get the submersible over a known point on the bottom to test the accuracy of the DeepWorker 2000 tracking system. I piloted the submersible up to the C boundary buoy pin for the Carysfort Sanctuary Preservation Area. We compared the tracking plot to the known differential GPS position for this location.

My second objective was to document large predatory fish over a high profile reef area in 70-80 feet of water. I was able to film three large Caribbean reef sharks, numerous large black and Nassau grouper, barracuda, and several large mutton snapper. The reef area where these fish are located lies within the no-take zone called the Carysfort Sanctuary Preservation Area.

The fact that these large fish are still there reaffirms to me that the Sanctuary no-take zones are working. Most areas on our reefs in the Keys are heavily fished and it is rare to see a legal sized grouper. It was reassuring to find an area where large predatory fish still thrive. These fish are at the highest trophic levels of the food chain and without them the balance of nature on the reefs will be eventually toppled.

LCDR Dave Savage prepares to dive at the Carysfort Sanctuary Preservation Area in the Florida Keys National Marine Sanctuary.

The third objective of my dive was to locate and explore coral walls off of the deep reef at Carysfort. I was able to map out and document two large walls over a .75 nm portion of Carysfort. I got footage of several large nurse sharks in caves along the wall and I also was able to document several large colonies of deep water gorgonians or sea fans which were waving gently in the current. An important observation which I made on the deep reef was that the stony or hard coral colonies are sparse, but the small colonies which do exist appear to be healthy when compared to their larger cousins at the top of the photic zone on the shallow reefs.

I filmed several Montastrea cavernosa or star coral colonies which appeared to be very healthy and disease-free. These colonies were very turgid, i.e. bursting at the seams in preparation for the upcoming coral spawn several days after the full moon on August 26. When I was hoisted onto the fantail of the FERREL I reflected on the mornings dive and had a real sense of accomplishment knowing that all three objectives for my dive had been met and that I had found some new walls in the deep reef area.

On board the FERREL, three of the high school students who were involved in the Student Summit had had a chance to come aboard, watch sub ops, and visit with the scientists and crew.

The three students collaborated on the following report of their experience:

Today we boarded a ship named the FERREL and our mission for today was to watch as the submarine was put into the ocean. We got to the dock at 6:30 a.m. and had to wait for the shuttle boat to come back. About twenty minutes later the boat came and we were on our way out to the FERREL. The ride out was a little on the rocky side and we bounced around.

Once we got on the FERREL we were not really sure what to do or where to go. When we got situated we noticed that all the staff was getting the sub ready for the dive. It was kind of crazy, people were running all around doing different things. Soon they were ready to launch the sub. One of us was allowed to go on the R.H.I.B., which is a rigid hull inflatable boat. Jackie was the chosen one . Well when Jackie got on the boat the sub was connected to the R.H.I.B. and we towed the sub to his drop off place at the beginning of the reef.

The swimmer jumped in the water with the sub and disconnected the tow line before they let him go on his way. Once the sub was under water he began to see lots of coral reefs and many different types of fish. Every 15-20 min he would report his life support and location status to the R.H.I.B. We then confirmed and he began exploring again. After that we just had to sit and wait until he needed us.

After one hour we came back to the FERREL and reported our data to the Captain. When Jackie got to the FERREL she gave a brief description of her experience on the R.H.I.B. Then we ate lunch and learned about the tracking system of the sub to the FERREL. We also watched the sub being lifted out of the water back onto the boat. We had a fun and educational day.

After Dave Savages dive was completed, the pilots worked to prepare the sub for Phil Dustans afternoon dive. Once pre-dive checks were completed, though, there were some delays while the ship was getting positioned at the dive site.

Phil waited patiently, sporting the cooling vest provided by CisLunar after Richard Nordstrom observed the difficulty we had in Grays Reef keeping the pilots from overheating. The vests have long vertical pockets front and back, which are filled with specially designed ice packs right before the pilot gets into the sub. The cooling effects of the ice packs make a tremendous difference in your comfort level while in the hot enclosed space of the sub. At first, Phil says he thought the vests might be more cooling than he needed, but he ended up being very, very glad he was wearing his.

Into the water, and towed by the RHIB to the dive site, Phil flooded his soft ballast, and sank like a stone! He was too heavy. So he started pumping out hard ballast, using the manual pump handle in the leg tube. Fifty pumps. A hundred pumps. A hundred and fifty! The tune I've been working on the railroad starts running through Phil's head as he pumps and pumps. Finally, after 200 pumps, he's removed all the hard ballast from inside the sub, and while he's still too heavy, the sub is light enough that he can maneuver adequately.

More frustrations ensue when he finds he needs to reboot the computer three times to get the video working properly, but finally he is able to get the camera systems sorted out to capture images of the reef. He reported that most of the corals in this site appeared healthy, although a few did show signs of disease. After shooting some footage at this site, he motored for the long transit to the other deep reef, in about 130 feet of water.

The transit was made more difficult by swirling currents that made it difficult to stay on course. Constant monitoring of the compass and constant course adjustments make for a tiring job at the helm. Eventually, as Phil got closer to the reef, he began to see a few snapper, and then finally the reef. Up and over and down the reef face to about 140-150 feet. A large black grouper, startled by the sub, swam away at a fast clip. He came upon large, hauntingly beautiful forests of gorgonians, with abundant and very large barrel sponges.

Corals at this depth tended to be flattened forms, the better to take advantage of the limited light that filters down to this depth. He observed one case of bleaching and one diseased coral, but for the most part, corals at this deep reef were much healthier than their shallower counterparts, with large areas of unblemished tissue.

Towards the end of the dive, Phil came across an outcropping with a mindboggling school of about 500 grunts. A grouper darted in and out of the school, corralling his lunch. A barracuda patrolled from above. And then a large loggerhead turtle cruised into view, sauntering his way along the bottom.

Phil said that to his knowledge, this lush and productive spot is the deepest reef community in the Keys that has ever been dived for scientific purposes. The reef extends to a depth of 152 feet and is a sill reef at the break in slope between 120 and 150 feet. This sub seems like it will be an excellent platform for establishing a coral monitoring program, as it has the range and cameras to capture the data needed to estimate coral abundance and condition. Tomorrows dive should bring more information and perhaps a more complete view of the extent of this reef.

(top) **RETURN**

August 25, 1999

Laddie Akins, Executive Director
Reef Environmental Education Foundation (REEF)

7 am: The day begins like a painting--an Arizona morning sky with puffy little clouds outlined in gold against a pale blue backdrop, a dark blue sea providing the contrast underneath. Sunup christens the day at exactly 7 am as we tender out to meet the NOAA ship FERREL. Bill Valley skippers the 25-foot Mako through the Channel at Port Largo, then heads north toward Carysfort Reef in the Florida Keys National Marine Sanctuary. This is home turf and it feels like the day is welcoming me back on the water. I've lived in the Keys since 1982 and have spent a good portion of the last 17 years diving and captaining divers on the very reefs we are crossing. My job with REEF keeps me in the office now more than on the water, and it feels good to be heading offshore.

My mission is to dive a deeper reef area just to the west of Carysfort Reef. I know the shallower bank reef well, but this will be a first for me in the deep area. During my dives I'll be conducting a series of fish surveys; first, transect surveys that follow along a straight line and record the exact numbers and size ranges of key species. The protocol was developed during the Atlantic and Gulf Reef Assessment (AGRA) conference in 1998. The second part of my dive will concentrate on using REEF's Roving Diver technique (also part of the AGRA protocol) to look at all species and their relative abundance. The REEF method was developed for use by volunteer divers and has been in place since 1993. In fact, a large number of surveys have come from the shallow Carysfort site via volunteers.

The Florida Keys National Marine Sanctuary has been an integral part in the development of REEF and many other volunteer programs. Florida Baywatch, Team OCEAN, Sea Stewards, and many other programs are facilitated through the Sanctuary's volunteer program. It may be one of the most progressive models for marine volunteer opportunities in the world.

REEF's program involves divers and snorkelers collecting information about fish sightings and abundance during their regular dives. Courses are available to train volunteers in the identification of common species. Then, divers enter the water with an underwater checklist and waterproof ID guide. Species are marked on the checklist as they are sighted and divers attempt to record as many species as they can find. Relative categories of abundance are also noted to indicate whether the number of

individuals in a species was observed to be only 1, in the range of 2-10, 11-100, or more than 100.

Following the dive, the volunteers fill out report forms and return them to REEF for scanning into the data base. The program had its humble beginnings in Key Largo in 1993 and has since spread throughout the Caribbean, Gulf of Mexico, South Atlantic, and Pacific (including British Columbia) coasts. The program is being expanded to include the Gulf of California, the Mid-Atlantic, and soon, Hawaii. More than 17,000 volunteer fish surveys have already been completed and entered into the REEF data base. The information is accessible via the Internet on **REEF's Web site**.

(top)

How does my Sustainable Seas Expedition dive tie into the REEF program? The focus of my submarine work will be to observe the deepwer-water reef fish assemblages using the same methods and materials that volunteers use in the shallow- water reefs. The data will be entered into the REEF data base and will allow comparisons between sites and at the same site over time. Beginning next week, the REEF Advanced Assessment Team, made up of highly experienced volunteers, will begin their annual Keyswide fish survey project. This will be the third year of surveying more than 30 sites, including the no-take Sanctuary Protected Areas and corresponding reference areas (implemented in 1996). The work is funded partly through a contract with the National Marine Fisheries Service and involves more than 20 divers and 300 dives. It will be very interesting to see how the two data sets match up.

On my Dry Tortugas dive last week to Sherwood Forest, I was terribly disappointed. Only one year ago, during the Advanced Assessment Team dives, I was ecstatic to find numerous large groupers on a 20-minute dive at Sherwood Forest. This year on my SSE dive, I saw only two very small scamp during more than two hours at the same site. It is difficult to make concrete conclusions based on only two dives, but if my observations are accurate, the Sherwood Forest area is being hit heavily by the grouper fishing boats. The Tortugas 2000 Reserve Plan will provide some much needed protection for these and other reef inhabitants.

Now, at Carysfort Reef, I'm hoping to find an abundance of large grouper in the deeper waters. I'm also hoping to find some species that don't tend to frequent the shallows.

1:15 pm: Phil Dustan has just surfaced and come on deck from a long morning dive on what we have termed Carysfort Deep Deep. It appears to be the third in a series of reef systems paralleling the shore. Dave Savage, Manager of the Upper Keys region of the sanctuary, completed a dive yesterday on the second of the three. He returned with footage of a number of groupers and sharks, and I'm torn about whether to visit the second or the third deep reef. Since Phil has collected a lot of benthic and coral data on the third reef, we decide it's best to gather fish data from the same site. My plan is to cover the area to the south of his marker, where most of the coral data was collected.

2:15 pm: Pre-dive details are complete and I'm in process of being launched. As I set down into a glassy calm sea, Dave Savage and Larry Benevenuti join me on scuba. Larry is a very well known photographer who is documenting the day's activities, and he shoots for a few minutes as I hover at 30 feet. I give him the thumbs down decsent signal and he waves as I drop the remaining 110 feet to the bottom. Topside sends me "West, young man," and in a few short minutes I'm coming into the deeper region of our reef.

Scattered clumps of hard bottom marked with gorgonians seem to prevail here. I move a little further west and begin to see the gentle slope toward the top of the reef. This is exactly what I'm looking for. I make a southerly turn and ready my transect data form. I'll head into the current as I follow the contour of the deep reef's offshore (eastern) side. My course is about 210 degrees. I move off, marking species as I go. The first fish I see are squirrel fish. They are not on my list of key species but I make notes anyway. Most of the squirrel fish I've seen have been in the shallower, low-profile reefs. Their close relative, the long-spine squirrel, seems to prefer the higher-profile areas. I would classify this reef as low profile.

As I follow my transect course I'm marking off familiar friends; the blue angel fish, bicolor damsel fish, tobacco fish, all species that are also common to the shallower reefs. I record only those species that fall into a swatch two meters wide in front of the submarine. I judge the distance by using the 6-foot width of the submarine as a guide. Suddenly, a thin movement catches my eye. Cruising past my starboard side is a blue-spotted coronet fish. A rare sighting. About 6 feet long and thin as a hotdog, the coronet fish is a close relative of the common trumpet fish found in shallow waters. The main difference is the coronet's long, whiplike tail extension, and, of course, the bright blue spots all over its body. I don't want to disrupt my transect data so I refrain from following the coronet down the reef. It continues on and I wonder if I've captured it on the video.

(top)

4 pm: I've run a good series of transects on the deep edge of the reef, so now I move up and over the top, toward the shallow side. The reef appears to be about 30 to 50 meters wide, and about 115 feet tall at its top. The top is much higher in profile and as I pass over, I see living corals decorated by gorgonians. The shallow side drops back down to a little over 120 feet and a sandy bottom. I decide to follow the shallow side, drifting with the current and running a few more transects. I see similar species and note a few changes.

No more squirrel fish--they were only on the deep side. Clusters of sunshine fish and purple reef fish dance in the current. These are plankton feeders and this is where I would have expected to find them. I am increasingly disappointed by the lack of groupers. I've seen two small scamp and a graysby on the deep side, but no other species and certainly no large groupers. A small part of me wishes I would have visited Dave Savage's second reef, but it's just as important to know where the fish aren't as it is to know where they are. I finish my transect runs and get the word from topside that I still have close to an hour before my dive ends. It's time to use the

REEF technique and see what I can find.

4:30 pm: I've just finished one REEF survey and get word that I'm close to the third reef marker. Thirty seconds later I see the buoy line and move over so that topside can get a good position on the bottom. A perfect little patch of sand is just to the south, so I set the submarine down and film a huge barrel sponge for a few minutes while topside gets its latitudes/longitudes. I turn the submarine and film the marker on the bottom, then head south against the current again.

Five minutes later I'm looking up ahead for anything new, when I see what appears to be the bottom moving! I know that nitrogen narcosis can affect a diver, but I'm still at surface pressure and immune. I move closer, and at the edge of visibility I begin to see a massive, no, huge, no, vast and extensive school of cottonwick grunts. Many, many thousands of them, all packed tightly together just above the bottom. They cover an area of maybe 500 square meters. They are so dense that it is impossible to make out any feature on the bottom just underneath the school. They aren't going anywhere, but the group slowly fluctuates its position, like a single living thing. Individuals keep their 2-inch distance from each other, and I manage to slowly move the submarine in on them without disrupting the school.

Questions flash through my mind. Why are they here, at this one place on the reef? Why don't we see more of these cottonwicks up in the shallows? How many thousands of them are here? All good questions, some with answers. I work to film the school for 10 minutes, before I get the call from topside to surface. The good stuff always happens at the end of the dive!

I rise off of the bottom and slowly thrust toward the top. I can see the reflection of the surface from more than 100 feet down. Flat, calm and sunny. A perfect day on top and a perfect day underneath. The sun is reflecting in the surface image, so I tilt the camera up to film my approach. As I get closer, a red flare appears on the video monitor, shooting straight down from the sun. What an incredible image to finish the dive.

5 pm: Arriving back on deck, I'm already thinking about next year's dives on Carysfort Reef. We should visit this site again, but we also have more work to do at Dave's second reef. I would like to document the groupers there and have some good benthic data to overlay as well. Maybe the groupers frequent the shallow-water no-take zone there due to the protection it affords them. More deep work can help us answer the question. Next year's mission plan is already taking shape.

(top) **RETURN**

August 26, 1999

Mary Tagliareni, Interim Education Coordinator
Florida Keys National Marine Sanctuary

Steve Drover, Submersible Specialist
Nuytco Research, Ltd.

Dr. John Ogden, Researcher
Florida Institute of Oceanography

The planned dive site for today is Conch reef. Conch Reef is about 6 miles offshore from Key Largo. There is a shallow back reef section with depths of 5ft &endash; 20ft, an intermediate reef in the 20ft - 40ft range, and a deeper reef starting in about 60 feet and extending out to over 100 feet. A section of Conch Reef is designated as a Sanctuary Preservation Area while the area around the Aquarius is a Research Only area.

A little about the Aquarius: It is an underwater laboratory located in 60 feet of water. Up to six scientists at a time can live and conduct research from the habitat for weeks at a time. Here's how it works: When you scuba dive, nitrogen starts to accumulate in your bloodstream. If you're at 60 feet deep for much more than an hour, you have to stop to decompress on your way to the surface, or face serious, life threatening consequences. The longer you're under, the longer you would have to spend decompressing, up to the point where you've absorbed as much nitrogen as possible, at which point you're saturated, and it won't matter how much longer you stay under, the decompression time will stay the same. So divers on the Aquarius can stay at that depth for extended periods of time, making scuba excursions as much and as often as they want to, and they only have to decompress once. When they're finally ready to return to the surface, they have to spend 20 hours letting all the gases slowly leave their bloodstream.

The life support system is contained in a 30ft diameter surface buoy. The Aquarius is managed by NURC (National Undersea Research Center) through an agreement between NOAA and the University of North Carolina. There are multiple objectives planned for the morning dive today. First, position the two subs, piloted by myself and Dr. Sylvia Earle, with the Aquarius habitat, and have National Geographic photographer Kip Evans take still photos and video. Second, complete my dive plan of running transects from shallow to deep. Third, explore the "Conch Wall."

The day started at 6:15 AM with a shuttle ride on a small boat to meet the NOAA ship FERREL at Conch Reef. I boarded the FERREL and immediately began my pre-dive checklist. Luckily, Steve Drover and Jeff Heaton, the Nuytco technicians, had started it prior to my arrival. I knew it was going to be a hectic morning due to the complexity of the dive mission. All staff involved in the morning mission, including divers, photographers, dive supervisors, and sub pilots held a pre-dive briefing to review the photo plan, the course for the subs to navigate into the Aquarius area, and how to proceed to the second part of the mission.

DeepWorker is approaching Aquarius, an underwater laboratory located off Conch Reef, 60 feet below the surface.

I was in sub 7 and was launched first, towed to the Aquarius site by the RHIB, and patiently waited for Sylvia in sub 6 to be launched and towed to the site by the Robalo. The sun was pretty intense through the dome of the sub and it was heating up in there. Once we were both on site, Lt. Dana Wilkes entered the water to serve as the "sub-pilot controller" giving us directions. We needed to enter the Aquarius area and approach the Aquarius through a triangular shaped section bordered by ropes that are attached to buoys surrounding the Aquarius. I was following Dana forward and descending.

I lost sight of Sylvia, turned my head to look for her to keep visual contact, and drifted into one of the ropes from the Aquarius excursion lines. I wasn't sure if I was snagged on it because I had come at it from the side and thought maybe I was just on top of it. I tried to thrust upwards to see if I could remove myself from it but it became very clear that I was entangled. I could still hear the words from training- "Don't let yourself get entangled!" Gads- I now had to radio the surface and tell them I had done expressly what we had been told never to do.

The response from topside was calm and cool even though I thought Larry Shumaker, the dive supervisor, would have probably liked to say a few other things. He asked if I was OK and I told him I was fine but I was stuck at 45 feet. Larry asked me to hold tight- actually I didn't have much of a choice at this point did I? The rest of the group continued with the dive plan and photo shoot. I watched the fish, which was enjoyable because I wasn't moving and scaring them away so they approached really close to the sub. After about 45 minutes, into sight came Dave Savage on SCUBA and wielding a knife. He didn't have to cut the line but was able to unwrap it from around the thruster casing. Yea- I was free!!!!

(top)

For another perspective on the morning's events, here's Nuytco's Steve Drover:

"It was a gray morning. The seas were crashing on the deck like an angry beast in a rage. The valiant sub crew prepared for one final dive which would mean life or death for the stranded submariners below... No, wait, that was my dream the night before!!

"Today started as perfectly as one could hope for. The sea was calm, not a cloud in the sky and the crew was anxious to get to work. We started our pre-dive checks on both submarines 6 and 7 as the FERREL steamed towards the dive station above the underwater habitat Aquarius.

"We would be doing a dual sub operation today with both Sylvia Earle and Mary Tagliareni piloting the subs around the dive site. Both seemed excited to get in the water and start the dive. With the ship on station we completed the dive checks and deployed first sub 7 with Mary on board. She was put under tow and moved towards the site. As soon as Mary was clear of the ship, Sylvia climbed into sub 6, sealed the hatch and was lowered into the ocean.

"I had the lucky job of getting to jump into the cool, clear water to release the sub from the lift lines. With the lines removed, a towline was attached to the chase boat and with myself and dive supervisor Larry Shumaker on board, the journey to the habitat began. Sooner than expected we arrived at the site to discover that there was a current of about 1-knot running.

"Quickly our supervisor Larry decided that we would hold the sub in place with the chase boat, have the sub start to flood ballast and at the last moment release the towline in order not to drift off site. That meant another jump in the drink for me. We got set and off I went. Immediately I could see Sylvia about 30feet away and I started swimming towards her to release the lines. The sub started to flood it's ballast, and things were looking good when I noticed the several LARGE barracuda swimming over for a look see. Knowing that they are curious but mainly harmless, I released the sub and scanned the area below. To my right there was the habitat itself, In front of me was Sub #6 and behind that and lower down was sub 7. And around all of us there were hundreds of fish. Tarpon, barracuda, snook, grouper, and a dozen more types which I probably could not pronounce. The view was absolutely spectacular and it was disappointing to leave it and get into the chase boat.

"The dive continued with Sylvia and Mary exploring the area, when an incident occurred which made our hearts race a little. With the current racing through the area, Mary accidentally became entangled in an excursion line used by the residents of the habitat. It was a minor problem but it had the potential to become major. The situation was quickly assessed by the safety divers who were following the subs around and to everyone's relief, especially Mary's, the sub was released a short time later."

Mary continues:

"After thrusting to the surface, I was reattached to the towline so the RHIB could tow me to the beginning spot of my project dive. The sun was beating in again except it was higher in the sky so it was getting hotter quicker. I was starting to have sweat

puddles form on the seat!

"Sub 6 and sub 7 were towed out to the spot, released and given permission to descend. We went down to about 120 feet facing each other with good visual contact. Upon reaching the bottom I attempted to contact topside and tell them we had made it to the bottom. I received no response back. I tried a few more times to make contact with the surface with no success. In between tries I checked the connections, adjusted the position of the microphone, and listened keenly for any sound of a voice talking back to me. There was no response no matter how hard I tried to hear one.

"During this time Sylvia has been taking pictures of my sub from inside her sub. I tried to use hand signals to ask Sylvia if she can hear the surface but we were not communicating too effectively. The emergency procedure that we were taught was that if you never established communication on descent you are to surface immediately. I had not heard a voice since switching from VHF to through water communications- so back to the surface I went. After reaching the surface and switching back to VHF, we realize that I thought Sylvia had communications with the surface and she thought I had communication with the surface but actually neither of us had ever had communications. Once again I am sitting on the surface with the sun beating down--even hotter and more intense than last time.

"After a few tests on the surface, we determine that my through water communications will work however Sylvia's do not and she will need to abort the remainder of her dive. Once again, I descend to the bottom to begin my project dive. Upon descent I was in approximately 120 feet of water with sparse small sponges and soft corals. The current was fairly stiff to the southwest. I motored in the direction of the reef, and at 110 feet the reef abruptly began. I 'crabbed' along the wall to the left for a little while exploring it. I then ran four transects back and forth across the reef from deep to shallow and back approximately 100 yards apart.

"It is difficult to video when proceeding from shallow to deep because the drop is so abrupt that I am left over the edge with nothing in my camera frame. It is much easier to go from deep to shallow. There was virtually no current on the reef so navigation was easier than it was at the Aquarius. I had to navigate around a few lobster trap lines and I gave them an extremely wide berth so I wouldn't get tangled up again.

"I have now been in the sub for three and a half hours and I know how the pot roast in the pressure cooker on the stove feels. At the end of my fourth transect it is time to ascend and be pulled from the water. I surface, motor over to the FERREL and am uneventfully pulled from the water and back on to the fantail of the FERREL.

"We had reviewed the emergency procedures often during our DeepWorker pilot training, and yet, like the emergency procedures they announce at the beginning of every airline flight, you never expect that you would have to use them. Today, I proved that thought wrong! I probably set an SSE record today by having two 'emergencies' in one dive: entanglement and loss of communications. I was never in danger and we will take lessons away from the dive today. It was certainly a learning

experience! I am looking forward to my dive tomorrow and hope it will be uneventful but productive."

Steve Drover sums up the excitement of the day:

"At the end of another eventful day, the final dive was over, and the submarines were hosed off and shut down for the night. Everyone has learned some lessons today about the potential hazards of sub operations, as well as how successfully even complex dive operations can be conducted, with proper planning and experienced crews."

(top) **RETURN**

August 27, 1999

Mary Tagliareni, Interim Education Coordinator
Florida Keys National Marine Sanctuary

Dr. John Ogden
Florida Institute of Oceanography

Mary Tagliareni writes:

The last day of the mission has finally arrived--the past two weeks have flown by. There was always something happening aboard the ship--subs in, subs out, divers in, divers out, tracking the subs, copying videotapes, steaming to the next location, writing mission logs, and conducting passenger transfers to the smaller boats bound to and from shore. Many long days and short nights have made for a tired crew. However, we have two more dives to concentrate on, and we don't want to waste a moment of the valuable time we have left with the DeepWorkers.

Throughout the mission, both scuba dives and submersible dives have been conducted in or adjacent to zoned areas of the Florida Keys National Marine Sanctuary. During the first week in the Tortugas, all of the dives helped us to learn more about that special region, and to collect data to assist with the planning of the Tortugas Ecological Reserve. The beginning of the second week was spent in the Upper Keys on the deep reefs of Carysfort Reef, adjacent to the Carysfort Sanctuary Preservation Area. Today, we conclude the mission with two dives, adjacent to the Western Sambos Sanctuary Preservation Area and the Eastern Sambos, a Special Use-Research Only Area.

Dr. Ogden expresses his viewpoint of the Special Use- Research Only Areas:

The Zoning Plan of the Florida Keys National Marine Sanctuary is unique for its provision of a number of zones specifically designed to protect and understand the fragile marine life of the Florida Keys. The several research-only areas in which all direct human disturbances--including fishing and diving-- are excluded, are critically important. The overall goal of the sanctuary management plan is to ensure the long-term health of the marine environment while still allowing controlled human uses of marine resources. Research-only areas allow sanctuary managers to judge the effectiveness of their work by comparing, through long-term monitoring, the trends in populations, communities, and ecosystems within the protected areas to comparable areas outside that are subjected to managed levels of human disturbance.

If, for example, the "trajectories" of these indicators outside of the protected area fall significantly below those inside, this provides the best clue that the management plan should be strengthened. This merging of scientific data with management is called "adaptive management," and it has been the key to our growing success in understanding the nature and extent of human disturbances on land. We have every reason to think that it will work as well in coastal waters. The Florida Keys National Marine Sanctuary leads the nation in testing this principle.

(top)

Mary continues:

Dr. Ogden is scheduled to dive first, so we begin the pre-dive checklist at 7 am to prepare the sub for an 8:30 launch. No major problems are discovered this morning, and the sub is launched 15 minutes ahead of schedule in 100+ feet of water at Western Sambos Reef. Dr. Ogden reports that the visibility is limited but that he is shooting some good video. As he worked his way around the reef, the visibility diminished. He experimented with trying different depths and found that above 40 ft. the water was semi-clear, but below 40 ft., the visibility was less than 10 ft. It will be interesting to analyze the data from the CTD for correlations in salinity, temperature, and/or dissolved oxygen with this dramatic change in visibility. After 90 minutes and ever-diminishing visibility, Dr. Ogden reports that he will be surfacing and is ready to be brought aboard the ship.

The next pre-dive begins immediately after Dr. Ogden exits the sub. The faster we can get the sub ready to go back in, the longer my dive can be. While performing the pre-dive, the FERREL steams up to Eastern Sambos reef and positions for the final sub launching of the Florida Keys National Marine Sanctuary Sustainable Seas Expedition. I reach the bottom at 120 ft. and 7 ft. of visibility. My goal for this dive is to run multiple transects perpendicular to the reef, from shallow to deep and back again. I will be videotaping the transects with audio narration for future reference.

I make my way towards the reef line on a bearing of 330 degrees. The water is a milky blue and I am straining to see the bottom and any objects in front of me. At 95 ft., I see a "darkness" in front of me and approach very slowly. It's almost as if I'm looking though a fog bank. I can see corals, sponges and fish. It's too murky to videotape but I hope it will improve if I work my way to shallower water. On the previous dive, Dr. Ogden stated that the visibility had improved in the shallower depths. I worked my way to a depth of only 45 ft., but there was no improvement in visibility.

I turned on the sonar and could clearly see the coral reef highlighted as dark red "hits" on the computer screen. I radioed topside and told them about the conditions I had found: no visibility and using sonar to navigate--not a good combination on a coral reef. I did not feel comfortable with the situation and informed them that I would not stay in such close

proximity to the reef for fear of doing damage it. It was a disappointment to plan for so long to conduct this dive only to have it be "washed out," but the potential for damaging the reef was simply too great.

In spite of this disappointment, we are pleased and proud of how much we were able to accomplish during this mission. When the Sustainable Seas Expeditions visit the Florida Keys next year, we'll have time to do more dives and apply what we've learned this year to creating even more successes. But for now, the folks in the Florida Keys will get busy synthesizing the information we've gathered, while the FERREL and the SSE team make their way into the Gulf of Mexico for the Flower Garden Banks mission, scheduled to start on September 2, 1999.

A beautiful sunset over the Florida Keys is a fitting end to a successful Sustainable Seas Expedition.

(top) **RETURN**

Summary of Investigations

The 1999 Sustainable Seas Expeditions in the Florida Keys National Marine Sanctuary provided scientists and resource managers with an opportunity to explore relatively unknown marine environments near the Dry Tortugas region where a proposed no-take reserve may be established. Over a several day period, DeepWorker pilots conducted 19 dives with the deepest at 165 feet. Investigators explored an area known as Sherwood Forest, an atypical formation of unique corals. Furthermore, along the reef tract, pilots were able to run deep water transects, adding a new dimension to information collected in shallower areas of the reefs.

Sherwood Forest, located in the Tortugas Banks, is a unique reef that was explored and characterized during the Sustainable Seas Expeditions in the Florida Keys National Marine Sanctuary. (photo credit: John Halas)

Exploration and characterization of the proposed Tortugas Ecological Reserve

Establishing the sanctuary's second no-take ecological reserve in the Tortugas region is a high priority for NOAA. As both a source and a sink for marine biodiversity, the region plays a critical role in sustaining the health of the Florida Keys National Marine Sanctuary. The boundaries for the reserve are under development and the reserve is scheduled to be initiated in 2000.

This study was designed to explore new deepwater areas in the Tortugas and provide critical baseline information on benthic habitats and fish populations. These objectives were accomplished through 10 dives completed by Sustainable Seas Expeditions investigators Walt Jaap, Pamela Hallock Muller , Erich Mueller, and Laddie Akins as well as Sylvia Earle. The results of this study will help characterize the proposed ecological reserve.

Gulf of Mexico influence on coral reef health

Dr. Erich Mueller of Mote Marine Lab collected salinity, temperature and depth data and video transects of coral habitat which will lay the foundation for a long-term

study on the effects of water quality on coral reef resources. Tortugas is the ideal place to conduct this study because of the lack of coastal runoff effects.

Deep water coral reef health

Dr. Phillip Dustan of the University of Charleston has been monitoring shallow coral reefs in the Upper Keys since 1979. Sustainable Seas Expeditions enabled him to extend these investigations to deep water to measure the vitality of corals. Shallow water corals have been on the decline for many years but little is known about the status of deepwater corals. Seven dives were conducted at Carysfort, Conch, and Molasses reefs to investigate coral health and fish populations. Laddie Akins of Reef Environmental Education Foundation surveyed fish populations.

(top) RETURN

SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

April 23, 2001

2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific Time)
A New Era of Ocean Exploration

> "We cannot protect what we do not know, and thus, without ocean exploration, we are ignorant of what needs to be conserved in a realm that covers most of the surface of the Earth."
>
> Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration

Introduction

The Sustainable Seas Expeditions (SSE), along with many other deep sea missions, have been conducted over the past decade. Why, at the beginning of the 21st century, this emphasis on a new era of ocean exploration? There are many reasons why ocean exploration is so important in this day and age. A serendipitous discovery could create a new industry in marine biotechnology that could show impressive returns. An entirely new ecosystem could be uncovered in the deep sea, affecting the very way we experience our lives. Or, the cure for cancer may lay at the ocean depths in this biologically rich and diverse ecosystem that is known to contain many times the biomass of all of Earth's rainforests and terrestrial biota. Less than 5% of the world's oceans have been explored in even a cursory sense. If we wish to make the most of our Ocean Planet, we must make the commitment to investigate and explore the marine environment. What lies below? What lies ahead?

Panel of Experts

Dr. Steve Gittings

Dr. Gittings conducting research in a national marine sanctuary

Dr. Steve Gittings is Science Coordinator for NOAA's National Marine Sanctuaries System. He facilitates research in the nation's thirteen marine sanctuaries, with emphasis on strategic planning, partnership-building, and program development for regional and system-wide monitoring and research. His field experience includes about 150 scientific research cruises, 1,200 scientific dives, the direction of many scientific diving operations, Remotely Operated Vehicles (ROV) operations (40 dives), and submersible use (Diaphus, Johnson Sea-Link, Nekton Gamma, NR-1, and DeepWorker). Dr. Gittings works with Dr. Sylvia Earle and leads the Science Team for the Islands in the Stream SSE Mission.

CDR Craig McLean

Commander Craig McLean is the Director of NOAA's Office of Ocean Exploration, created to conduct and promote a new era of exploration of the sea. Based on science and discovery, Ocean Exploration targets unexplored and unknown aspects of the sea. Commander McLean is an active duty officer in NOAA's Commissioned Corps, with 19 years of service within the agency at sea and ashore. The NOAA Corps is one of the Nation's seven uniformed services. Originally from New Jersey, near New York City, he began working in boatyards and trained early in scuba diving, exploring deeper shipwrecks and decompression diving while in Junior High School. These experiences lead to his appreciation for marine resource issues, maritime industries, and diving -- a skill that has taken him from the Amazon River searching for freshwater dolphins to the north of Scotland exploring sunken battleships from World War I. He has more recently held the positions of Legal Advisor to the Director of the NOAA Corps, Special Assistant and Counsel to the

Director of the National Marine Fisheries Service, and as Deputy Director of the National Marine Sanctuary System.

Preparation

To help you prepare for the live event on April 23, the SSE Education Team has provided some pointers to Web sites where you can learn more about ocean exploration. We have also provided links to past expeditions that have left a legacy of new knowledge, and to upcoming expeditions that are preparing to dive deep into the ocean realm for new discoveries that may change the way we view this blue frontier.

First, we challenge you to answer some questions! We hope that as you explore the suggested Web sites for answers, you will come up with some questions of your own to ask our panel of experts. We invite you to leave your own questions in the chat room before the event, or ask them during the live program.

Activity one

Challenge Question 1: What is the deepest depth of the ocean, and where in the world's oceans is it located? What is the average depth of the ocean?

Extreme Science: Deepest Place in the Ocean
Learn more about the Challenger Deep

Challenge Question 2: How much of the oceans have been explored? Why is this so significant?

President's Panel on Ocean Exploration
A U.S. Strategy on Ocean Exploration

Challenge Question 3: What and when was the first expedition organized specifically to gather data on a wide range of ocean features, including ocean temperatures seawater chemistry, currents, marine life, and the geology of the seafloor?

The Challenger Society for Marine Science
Learn about this fascinating 19th century ocean expedition

Challenge Question 4: In the 21st century, what kind of technology is now being used to explore and study the undersea environment? Check out the following links, and keep in mind that this list represents only a few of the technologies that are currently being used for expeditions.

DeepWorker 2000

A single-person human-occupied submersible

Gordon Gunter
A NOAA oceanographic vessel

Aquarius
The world's only underwater habitat

Alvin
Deep submergence vehicle

Shinkai 2000
Human-occupied Japanese research submersible

Russian Mir I & II
20,000 ft. diving Russian submersible

Tiburon
A unique remotely operated vehicle

Clelia
1,000 ft. diving research submersible

Delta
Research submersible

Sondes
Water monitoring systems

ABE and REMUS
Autonomous Underwater Vehicles (AUVs)

Email your responses to the challenge questions to SSEeducation@noaa.gov and your can receive a free Sustainable Seas Expeditions sticker!

Explore the Web
You may also want to explore these Web sites in order to get a preview of past ocean exploration and research missions as well as upcoming expeditions you can follow along during the school year and summer months.

Sustainable Seas Expeditions

DeepWorker 2000 rendezvous with the Atlantis submarine in Hawaii. Photo courtesy of Kip F. Evans, National Geographic Society

A project of ocean exploration, research, and public education and outreach

National Geographic Society's Blue Frontiers
Ocean exploration expeditions

Ocean Explorer
Learn more about various voyages of discovery

Dive and Discover: Expeditions to the Seafloor
An interactive distance learning Web site designed to immerse you in the excitement of discovery and exploration of the deep seafloor

Into the Abyss
A NOVA Online adventure

Zegrahm Deep Sea Voyages
Submersible dives to Titanic, Bismarck, the North Pole and more

Ocean Adventure
Travel with us to hydrothermal vents in the sunless depths of the world's oceans

Extreme 2000 Voyage to the Deep
Uncover mysteries of hydrothermal vents

A vent crab at an undersea hydrothermal vent.

Gulf of Mexico Alvin Expedition 2000
Exploration of the Northern Gulf of Mexico Continental Slope

Kaikoura: In Search for the Giant Squid
Explore the deep-sea world of New Zealand's Kaikoura Canyon

Web Chat Transcript

Claire / Chat Host - It is an exciting time for the Sustainable Seas Expeditions (SSE)--this summer, we will be conducting a project called "Islands in the Stream". On April 23, the NOAA ship McArthur will be arriving in Key West, Florida where all of the project personnel including the submersible crew, mission planning team, science group and technicians will begin mobilization of the oceanographic vessel for the third

field season of SSE. After equipment tests and training, the ship will begin its transit to Belize--here the adventure of ocean exploration and research begins. Why is ocean exploration so important to all of us? Join us during the live Web chat on April 23 to find out. Feel free to post your questions to the panel of experts today, or come back at 2 PM EST/11 AM PST on April 23, 2001 and have your questions answered live via the Internet!

Dr. Steve Gittings - Hi everyone - Welcome! I am looking forward to our chat. After that, I hope you all will joint the Islands in the Stream Expedition, which begins late next week in Belize. I am heading to Key West this Thursday to do a bit of refresher training in the subs we will be using - I guess they think I might be a bit rusty after a year of sitting at a desk! Probably right. We begin diving in Belize around the fourth or fifth of May. Follow along on the Web site at http://sustainableseas.noaa.gov.

Claire/Chat Host -Welcome to today's live Web chat discussing the importance of ocean exploration with our panel of experts, Dr. Steve Gittings and Commander Craig McLean. Dr. Steve Gittings is the research coordinator for the National Marine Sanctuary System and he leads the science team for the Sustainable Seas Expeditions, with Project Director, Dr. Sylvia Earle. Commander McLean has been the Commanding Officer (Captain) of the NOAA ship Gordon Gunter and currently is the Director of NOAA's Office of Ocean Exploration, created to conduct and promote a new era of exploration of the sea. As you prepare to ask questions to Steve and Craig, please list your name and either the school you are from or what state you are in. Thank you and enjoy the Web chat.

Commander McLean - **RE: [Charlie/California] Will human occupied vehicles be the primary technology used during voyages of discovery and ocean exploration?** We will use both. The right tool for the right job is always the best solution. While the imagery of Telepresence is a reality, there are still some jobs in which the scientists prefer to be right on the site and directly observe the action. We will use the Alvin from Woods Hole, a manned submersible, and also ROVs in our projects.

Dr. Steve Gittings - **RE: [Cathy/Georgia] What are the three most important questions this mission hopes to answer? How will the information gathered be used? What is the best thing that has happened so far? What is the most bizarre creature or phenomenon observed to date?** This year's Island in the Stream Expedition will focus on issues that are international in scope. We will study the connections between the waters of Belize, Mexico and the US. We will explore sites in each country rich with species, and compare their condition. We will look at places that are protected from activities that are destructive and compare them to unprotected areas. And we will study unusual phenomena, including the mass spawning of mutton snapper in Belize, which draws huge whale sharks interested in feeding on the tiny output of the fish. Along the way we will expect surprises. Last year a six foot swimming octopus stared into one sub for over an hour. As it turned out, that particular species had only been seen twice before (only once alive), and this individual was pregnant! So no matter how much we prepare, the ocean will find a way to surprise us - in fact, I am counting on it!

Commander McLean - **RE: [Phil] how dos college students become involved in active research with this project?** Welcome to the session. I hope you have a chance to learn something about our Office of Ocean Exploration, and the projects with which we are involved. Learning more about the oceans and solving unknowns about the oceans, is what we do.

Commander McLean - **RE: [Phil] How do college students become involved in active research with this project?** My last answer was directed at a more general question. College students should look to internships and volunteering their time in projects that might be close to their areas of interest. Marine studies are very rewarding in personal gratification, but also very competitive for that very reason. Volunteering is key, and if you're lucky to find a paying job near your area of interest, take it. Do well in your studies too, since the competition is often sorted out by grades and work experience. Good luck.

Claire/Chat Host - **RE: [Phil] How do college students become involved in active research with this project?** There are numerous ways a college student can get involved with the Sustainable Seas Expeditions (SSE) or with organizations that relate to the marine environment. For starters, there is a Web site called Volunteering for the Coast [http://volunteer.nos.noaa.gov/] that has a searchable database for volunteer and intern opportunities throughout the country related to the marine environment. Also when SSE visits different sanctuary sites, often times the site interns and volunteers reap the benefits of meeting the submersible pilots and working with the science team and mission personnel. Volunteering is always a good way to go to get your foot in the door.

Commander McLean - **RE: [Samantha] Are the DeepWorker subs capable of going to the deepest depths in the ocean? If not, what subs are?** The DeepWorker subs are one person submersibles, rated to a working depth of 2000 feet. The deepest part of the ocean is significantly deeper, as you know. The last manned submersible or actually a bathyscaph, which visited the Challenger Deep in the Marianas Trench, was the Trieste, a vehicle that has since been retired. Presently, there are no known manned vehicles that can visit the deepest ocean, but several groups are attempting to design and build one.

Dr. Steve Gittings - **RE: [Samantha] Are the DeepWorker subs capable of going to the deepest depths in the ocean? If not, what subs are?** Samantha - DeepWorkers can go "only" to 2000 feet. The deepest part of the ocean is about 7 MILES deep. A small number of subs can go to a few thousand meters, but none can yet go to "full ocean depth."

Claire/Chat Host - **RE: [Trish/GA] Are there any teacher/student at sea activities planned with this year's mission? If so, when, where, how do we get involved?** Hi Trish. This year we have plans to be conducting teachers and students-at-sea activities in Belize, Mexico and the United States. Currently we are continuing to plan Leg II of the Islands in the Stream mission and will have a clear vision on when these opportunities will be available. Often times we struggle with the fact that dive sites are quite far from shore and would require a VERY long transit ride to get teachers and students out to the research platform. When these opportunities

do become available you will be able to see a schedule of activities for the Islands in the Stream mission at http://oceanexplorer.noaa.gov/.

Commander McLean - **RE: [Trish/GA] How will this mission differ from last year's studies in the Gulf?** This year's mission has a theme and focus that ties each of the areas visited together in a larger context. If your reference to last year's work looks at the SSE efforts in the Gulf (versus other science programs) this year is more expansive and relates adjacent areas and the science of the adjacent areas to the larger context: the Gulf Stream and its influence on the diverse areas it covers. Note also, that NOAA and other scientific institutions engage in other types of research in the area, including fishery resource surveys, marine mammal surveys, and some deepwater dives by the ALVIN of Woods Hole, last year. All of these important projects add to our knowledge and understanding of the oceans. As science usually does, we take what we have learned and challenge those findings with new opportunities.

Dr. Steve Gittings - **RE: [Jenny, CA] How will the sanctuaries use the information and technology gained through this expedition? Approximately where does the Gulf Stream originate and end?** The sanctuary program's interest in this expedition is to understand what areas the US depends on for critters and for good water. We all know that sanctuary boundaries are invisible to anything but humans. The health of any ocean area depends on input from other places, and that is what this expedition is looking at. Recent genetics studies show that reef in the northwest Gulf of Mexico, called the Flower Gardens, receive larvae from as far away as the Yucatan Peninsula. So what if the reefs of Mexico were destroyed by uncontrolled human activities? One of our jobs is to answer that question. The other job we have is to ensure that we communicate with our neighbors so we can both do the best we can to avoid destroying important ecosystems.

Claire/Chat Host - **RE: [Shari, HK/WI] thank You for your response Claire** You are very welcome. Another great Web site that may guide your future decisions is http://marinecareers.net/.

Commander McLean - **RE: [Trish/GA] Are there any teacher/student at sea activities planned with this year's mission? If so, when, where, how do we get involved?** Trish, I see that you are from Georgia. If you are near Charleston, SC, you may want to look at the weekend of September 29-30. We expect that two major projects, the Islands in the Stream cruise, and the Deep East cruise, will both end in Charleston and have at least two interesting ships in port for the public to see. The Islands vessel will be from the Harbor Branch Oceanographic Institute in Florida, and carrying the submersible Johnson Sea Link or JSL. The Deep East cruise will be aboard the Atlantis II, from Woods Hole Oceanographic Institution, and carrying the submersible ALVIN. So far as teacher and student opportunities, we have a Teacher at Sea program in NOAA where a teacher is selected to participate for a period of time aboard a NOAA ship. One is currently aboard the NOAA Ship Ron Brown, headed for Japan and some mid-Pacific research. Students can be a part of our trips, as Claire has said, and this is often dependent upon logistics. There are also opportunities to participate in research cruises in which volunteers are allowed, usually college age students, and they work through specific investigations or labs to arrange these. You

might look within the NOAA Web site to the National Marine Fisheries Service, and the Pascagoula, MS, Laboratory. Through their site you can get information about volunteering aboard Gordon Gunter. Good luck.

Dr. Steve Gittings - **RE: [Jenny. CA] How will the sanctuaries use the information and technology gained through this expedition? Approximately where does the Gulf Stream originate and end?** I guess you could debate the origin of the Gulf Stream all the way back to the sun's effect on the atmosphere, but we don't have time for that! In my opinion, the Gulf Stream really originates where the Caribbean Current squeezes through the Yucatan Strait. There it is called the Yucatan Current, which head north. In the Gulf, they call it the Loop Current because in swings back to the south off Western Florida. As it squeezes through the Florida Strait, it is called the Florida Current, becoming what we call the Gulf Stream somewhere off the upper Florida Keys. From there it of course heads north until it reaches North Carolina, where it heads offshore to the northeast past Bermuda and finally carrying its warm waters toward Europe.

Commander McLean - **RE: [Johnny/Maryland] What experiences have you had with regards to ocean exploration that were the most exciting?** Johnny, I can think of several highlights in exploration, but the common denominator was being introduced to scuba diving at an early age. That experience and responsibility gave me a different perspective on many things. From that I have been able to dive on sunken and historic ships, be the first person to see several shipwrecks, and also share the thrill of locating a ship with the others in the expedition. Other exciting experiences are diving with whales, which, by their location, were likely never accompanied by humans before. Another aspect of ocean exploration is the fact that you have to be out on the sea in order to explore it, and there you will always find the daily thrill or boredom of weather. The most predictable thing about weather is that it always changes, and can get quite nasty. Sailing in hurricanes is always a thrill, and usually is totally separate from the reason why you are at sea. We try to avoid them! But, going through one is an experience. Truly, one of the most gratifying experiences in exploration is being able to share it with interested people, such as you.

Dr. Steve Gittings - **RE: [Johnny/Maryland] What experiences have you had with regards to ocean exploration that were the most exciting?** Most exciting? It's a tough call. So much the ocean has to offer is exciting. I guess it's the surprises that top the list. I have seen spectacular light displays at night by ostracods rising from the reefs of the Gulf of Mexico, and mass spawning by corals, which make the water column look like an upside down snowstorm. Some night dives in a sub off the south coast of Lanai were incredible. Seeing oil seep out of the bottom at 1200 feet in the Gulf, only to be used by bacteria that live in the gut of tubeworms that flourish right next to the oil! Seeing pools of water seven times saltier than seawater sitting in basins at over 200 feet - they look like mountain lakes. Then seeing bacteria living right next to the noxious broth, using the hydrogen sulfide like plants use sunlight to make food. These are the wild and weird things that make the ocean magic!

Commander McLean - **RE: [Samantha/Hawaii] What are some of the activities that the Office of Ocean Exploration will be conducting? Are there going to be any in Hawaii in the next year or two?** Samantha, We are very

interested in Hawaii. We expect to be working in Hawaii for the next several years. This year, NOAA and other agencies are working in the Northwestern Hawaiian Islands in response to the Coral Reef Preserve established to protect the entire NWHI. In the coming years, we expect to be surveying the multiple islands and submerged banks, and conducting some submersible dives and ROV dives to look at the areas underwater. Much of the area is relatively unknown at a higher level of detail. Other than knowing that is quite pristine and highly valued, we don't know much about the biological communities that exist there. The main Hawaiian Islands are home to the Hawaiian Island Humpback Whale National Marine Sanctuary. I hope you are familiar with it and the important work they do. The Sanctuary always has interesting activities that involve the whales and their habitat. Good luck, and thanks for all the support that the students, teachers, and all the people of Hawaii have shown to our ocean exploration efforts, and the Sanctuaries.

Dr. Steve Gittings - **RE: [Trish/GA] Are these same type of genetic studies being done with sport/game fish species? Will we ever be able to enforce "no take" areas that are not close to shore?** I am not sure whether sport fish are being looked at, but the second question is really the key. In fact, enforcement is a problem near shore as well. There are too many examples of marine parks that have no staff, and parks with no enforcement at all. If that is so, how can we ever hope to patrol offshore waters and stop illegal fishing by foreign or domestic vessels? I don't know that answer to that, but I do know that the only way to address the need is to make a sincere commitment to doing the hard work and not just the paperwork for marine protected areas.

Commander McLean - **RE: [Trish/GA] As education becomes more bureaucratic and more emphasis is placed on "testing"...how can classroom teacher instill "adventure" and "exploration" into the next generation? These chats and video broadcasts have been a true blessing...**Trish, Are you a teacher? That's a great profession, and one that should be as highly valued in society as our sports heroes. The opportunity of exploration, whether you and others join us in person, or through the web, is the excitement of discovery. Classroom lessons that are basic to education can be enhanced by using the technologies employed to explain other things: a few examples . . . Diving and photos of divers or submersibles are an excellent means to convey Boyle's Law and other laws of gas physics. Subs are one-atmosphere systems, while the diver is exposed to the actual external pressure of the sea, and its physiological consequences, like bends. These illustrate the consequences and application of the science basics. Exploration gives us a chance to apply the lessons, rather than learn the lesson for the lesson's sake. Another example is navigation. Its nothing more than geometry, a subject that usually doesn't excite students until it is applied. Navigation does that. Since we've just gotten started in the Ocean Exploration office, we have not completed a teaching module for the subject, but one is being developed. So much to do in a short time ...keep up the good work.

Dr. Steve Gittings - **RE: [Shari] Dr. Gittings, what is your educational background?** I did a bachelor's degree in Biology at Westminster College, in PA, then masters and Ph.D. degrees in Oceanography at Texas A&M University. My emphasis at A&M was Biological Oceanography, and I studied the influences of a brine seep

system in the Gulf for my masters work, and the processes affecting the recovery of a coral reef destroyed by a large vessel in the Florida Keys for my Ph.D. research.

Commander McLean - **RE: [Trish/GA] Are these same type of genetic studies being done with sport/game fish species? Will we ever be able to enforce "no take" areas that are not close to shore?** Genetic studies on fish are very important. Charleston, SC has a forensics lab for fish and marine mammals, to look at the genetic and chemical influences on marine creatures. Sometimes, the enforcement of regulations can depend on the exact sub-species of fish, perhaps relating to a stream of origin or spawning area. These studies confirm such knowledge that was unheard of just a few years ago. On to the other idea, offshore no take areas. As marine area management expands to influence, not necessarily prohibit, human activity, the solution to some issues may be a no-take zone. Other circumstances are addressed by lesser means. The hopeful remedy is to fit the circumstance with the correct solution to protect and manage the resources. The Florida Keys National Marine Sanctuary has a good start at this process, in which zonal management has been implemented and is successfully proving itself. The key has been community involvement and demonstrating the need, and the appropriate fit of the solution. Can we do this in offshore areas? As a society I think the answer is yes. It can be done proscriptively, but the greater hope is in a community-inclusive solution that gains support for the proposition, not just prohibition. The public view of protecting the marine environment is expanding, and so are the solutions.

Dr. Steve Gittings - **RE: [Trish/GA] As education becomes more bureaucratic and more emphasis is placed on "testing"...how can classroom teacher instill "adventure" and "exploration" into the next generation? These chats and video broadcasts have been a true blessing...**Trish - I read Craig's answer, and it made me think. I often wondered how I would use all that is on the web if I was a teacher. I am not sure I know the answer, but I do know that I wish I had had such access to information as a student. In addition to that, I hope that more teachers can get involved with government initiatives like Craig's when it comes time to develop educational materials like those he described. After all, navigation really is just geometry, and diving is physics, and oceanography itself is a derived science that is fundamentally either geology, chemistry, biology, or physics. My career path was changed by a teacher who showed so much interest in ecology that he arranged a trip to the tropics for his students. It was another world from a kid who grew up in a steel mill town on Lake Erie, and it changed everything for me.

Claire/Chat Host - **RE: [Trish/GA] I look forward to monitoring your missions through the next few months...I will find a way to incorporate as many sessions as possible into my classroom...The explorations of the HMS Challenger are as fascinating today as they were in the 1800's With today's technology, we should be able to find even more fascinating "critters" and phenomena to show that science is a dynamic being! Thanks for making these types of sessions possible.** Thank you for joining us, Trish. We look forward to hearing from you again in the near future.

Claire/Chat Host - **RE: [Paul/CA] I hear that the Sustainable Seas Expedition is coming back to the West Coast next year. What will be the focus?** There are

plans to have the Sustainable Seas Expeditions "Follow the Grays" from Bering to Baja next year. I imagine that along this route, the expeditions will be stopping at the national marine sanctuaries along the west coast, such as the Olympic Coast, Gulf of the Farallones, Cordell Bank, Monterey Bay and Channel Islands. There have been preliminary discussions of what the focus of these operations would be; yet it is uncertain at this point.

Claire / Chat Host - Thank you to the experts, Dr. Steve Gittings and CDR Craig McLean for taking the time out of their busy schedules to join us for an hour on this live Web chat. You have all asked some great questions and we appreciate your participation. Our next live Web chat will be on Thursday, May 17, 2001--join us as we discuss the biological connections and the effects of human use on the ecosystems that are being explored during Sustainable Seas Expeditions 2001. This week the NOAA ship McArthur is being mobilized in Key West and will depart for Belize on May 1st, you can follow the Islands in the Stream mission through log updates from the field at http://oceanexplorer.noaa.gov/.

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SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

May 17, 2001

2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific Time)
Biological and cultural connections between the "islands" and the "stream"

Introduction

The Sustainable Seas Expeditions (SSE) has officially kicked off the third field season and begun exploration and research in Belize. While in Belize, the chief scientist, Dr. Sylvia Earle, mission personnel, and select Belizian researchers will be using the DeepWorker 2000 submersibles to document and research interactions between mutton-snapper and whale sharks. This research will be taking place in the Gladden Spit and Glover Reef off of Belize. Shortly after that, the research team will be joined by two trained pilots from Mexico and will conduct reef assessments and characterization of the local habitat. How do these hard bottom communities in Belize and Mexico affect the Flower Garden Banks and Gray's Reef National Marine Sanctuaries (NMS)? Join us as we talk to Emma Hickerson, Research Coordinator of the Flower Garden Banks NMS and Cathy Sakas, Education Coordinator of the Gray's Reef NMS, about how the hard bottom communities, the Loop Current and Gulf Stream impact the off-shore sites in the United States they work to manage and protect.

Panel of Experts

Emma L. Hickerson was born in Sydney, Australia, where she lived until completing High School. She then completed a B.S and M.S. in Zoology at Texas A&M University. Emma's thesis project was a satellite tracking study involving the loggerhead sea turtles at the Flower Garden Banks National Marine Sanctuary (NMS). Since completing her degree, she has actively pursued a career in Marine Biology. She has

Emma L. Hickerson

held the position as Research Coordinator at the Flower Garden Banks NMS since 1997. She has conducted approximately 500 SCUBA dives globally. Emma was trained as a DeepWorker 2000 submersible pilot in 1998 with the Sustainable Seas Expeditions and has conducted a total of 9 dives, including training dives. Her interests include Marine Biology/Ecology, Coral Reef Biology/Ecology, Underwater Photography/Videography, and Underwater Exploration.

Cathy Sakas in the DeepWorker

Cathy Sakas was born in the southernmost tidewaters of Virginia's Chesapeake Bay, her lifelong love of the ocean began at the age of three when a huge wave knocked her face flat onto the beach. In 1976, Cathy began her academic and professional career by earning a Bachelor of Science degree in Biology from Armstrong-Atlantic State University in Savannah, Georgia. Ten years later she added her Masters of Education in Science from the same institution. For the past 25 years Cathy has been a professional interpretive naturalist specializing in tropical and subtropical marine and terrestrial environments. In 1994 Cathy's second Coastal Naturalist series, an Emmy nominated nature documentary, was first broadcast on Georgia Public Television. Like her first series on the habitats of the southeastern seaboard, she created, wrote, hosted and narrated this second five part series on its vertebrates. Cathy is presently employed at Gray's Reef National Marine Sanctuary where she serves as their Education Coordinator. In that capacity she teaches programs via distance learning television about Gray's Reef, Right Whales and Manatees to middle and high school students throughout the state of Georgia. She has also been charged with the mission of reporting on the many undertakings of Gray's Reef through radio ads on commercial stations and through reports on public radio. Cathy is also a co-host on a local cable channel talk show and helps produce educational videos. So far her favorite jobs at Gray's Reef has been SCUBA diving and becoming a pilot of a one-person submersible called DeepWorker 2000.

Preparation

To help you prepare for the live event on May 17, the SSE Education Team has provided some pointers to Web sites where you can learn more about the Gulf Stream, Loop Current and the areas being explored.

We challenge you to answer some questions and hope that as you explore the suggested Web sites for answers, you will come up with some questions of your own to ask Emma and Cathy. We invite you to leave your own questions in the chat room before the event, or ask them during the live program.

Activities

Challenge Question 1: The Sustainable Seas Expeditions: Islands in the Stream will be exploring and conducting research in what region during the summer of 2001? Why is it important to conduct an expedition such as the Islands in the Stream mission? Are there any biological ties between underwater communities found in the same loop current?

Path of the Gulf Stream
Learn more about the loop current, Yucatan Channel and the Florida current

Challenge Question 2: How might coral reefs and resource use practices in other countries affect the waters of the United States? How might coral reefs and resource use practices in the United States affect other countries? How might our daily activities on land affect coral reefs and other coastal and ocean ecosystems?

Hint: Check out the Gulf of Mexico watershed, and your own neighborhood's watershed, on the following Web sites.

Gulf of Mexico Watershed Map
Map of the United States and associated watersheds

Environmental Protection Agency Region VI
Water quality protection division

Global Learning and Observations to Benefit the Environment (GLOBE)
Science and education

NOPP Drifter Buoy
Drifter buoy animation from around the world

Email your responses to the challenge questions to SSEeducation@noaa.gov and your can receive a free Sustainable Seas Expeditions sticker!

Web Chat Transcript

Claire/Chat Host
Welcome to the Sustainable Seas Expeditions (SSE) chat room. We plan to discuss the biological and cultural connections between the "islands" and the "stream" that are being explored and researched during SSE 2001. Please feel free to leave questions in the chat room now, and come back on May 17, 2001 to see what the experts had to say in responding to your questions, or join us live from 2:00 - 3:00 PM Eastern and interact with Emma Hickerson of the Flower Garden Banks National Marine Sanctuary (NMS) and Cathy Sakas of the Gray's Reef NMS. We look forward to your participation and great questions!

Cathy/Gray's Reef National Marine Sanctuary (NMS)
Hello from the office of Gray's Reef National Marine Sanctuary on beautiful Skidaway Island in historic Savannah, Georgia! I am looking forward to being on this Web chat and to telling you of my experiences in ocean exploration.

Emma/Flower Garden Banks National Marine Sanctuary (NMS)
Hi! This is Emma from the Flower Garden Banks National Marine Sanctuary - the northernmost coral reef on the US continental shelf - located 100 miles south of the Texas/Louisiana border in the Gulf of Mexico.

Claire/Chat Host
RE: [mark] Hi, Is this SSE mission part of the new Ocean Exploration Program and is there a mission schedule for the coming months?
Hi Mark. The Sustainable Seas Expeditions (SSE) is a 5-year project of the National Geographic Society and the National Oceanic and Atmospheric Administration (NOAA) for ocean exploration and public education. SSE is in its fourth year (third field season) and NOAA's Office of Ocean Exploration is a new division. We (mission personnel) work closely with the Ocean Exploration Office and will collaborate on a number of voyages of discovery in the near future. As for mission schedules, for the summer of 2001, you will be able to follow the daily progress of a number of expeditions through the **Ocean Explorer** Web site that will debut June 1, 2001.

Emma/Flower Garden Banks NMS
RE: [Efrat] Dear Emma and Cathy, my name is Efrat Sharvit. I'm a second year student in the Naval College of Israel. In the context of a course called "research methods" that we are taking, I have become interested in the use and operation of the "DeepWorker 2000" Can you give me details about the dives that you both took during your research with the "DeepWorker 2000"; What were their purposes? How was the DeepWorker actually used? Thank you for your time, Efrat.
Hi Efrat. Back in 1999 I had the opportunity to pilot the DeepWorker sub at the West Flower Garden Banks. Laddie Akins and I dove 2 subs simultaneously, and conducted REEF fish surveys at deeper depths than either of us had been at this site (to around 300 feet, 100 m). **REEF** has a database of several 1000 of surveys from the Flower Gardens.

Emma/Flower Garden Banks NMS
RE: [Rob] My question is about "stream" velocity and what difference it

makes in types of coral found and in variety and number of fish found. Is my assumption correct that Flower Garden Banks is at the outer edge of the Gulf loop current and thus experiences a stream of relatively low velocity? If so, how much LESS are the variety/number of the coral/fish found compared to locations like Tortugas South, close to a stream of higher velocity?
Hi Rob. The Flower Garden Banks differ quite a bit from other coral reef areas in the Caribbean. For instance, we have documented around 28 species of coral - about 1/3 the number found in other tropical Caribbean reefs. We have no branching corals (e.g. Acropora), and gorgonians are scarce. Around 275 fish species have been documented, again, about 1/3 the numbers found on other Caribbean reefs. A reason for this may be the longevity, durability of the larval stages of these coral reef inhabitants. The more durable species make it to the Flower Gardens via the ocean currents from other reef sources. Some species of fish are hypothesized to "island hop" across the Gulf via oil and gas platforms - e.g. sargeant major and yellow tail snapper.

Emma/Flower Garden Banks NMS
RE: [AyamiPHS] What are the similarities and differences between the Australian coral reef and the Belize reef?
Ayami - The most dramatic difference I can comment on is the numbers of different species of corals found in these locations - around 60 species on the Belizean reefs, and 600 on the Great Barrier Reef!!! Imagine taking on the awesome task of taxonomy on that Reef!

Emma/Flower Garden Banks NMS
RE: [Phil/SantaBarbara] How do the coral reefs in Mexico and Belize affect the habitats in other parts of the United States? Is there really a connection?
Phil, researchers are currently delving into that question by conducting genetic analysis of corals, fish, and algae from sites in Belize, Mexico, and the U.S. reefs. We suspect, here at the Flower Garden Banks, that there is an upstream effect - i.e. the Belizean Reefs supply larvae to the Mexican reefs upstream, which, in turn supply recruits to the Flower Garden Banks coral reefs - so it is essential for our reefs in the U.S. that the reefs DOWNSTREAM are kept healthy.

Claire/Chat Host
RE: [Timothy] Hello from all the team at Camp Internet. We are very interested to learn about the SSE work in Belize this year. A question from the Home School group here with me today - Will you be doing any work that will provide information about Global Warming.
Hi Timothy. Welcome to the Camp Internet group. The Sustainable Seas Expeditions are currently underway in Belize and will be beginning operations in Mexico in a matter of days. With regards to operations in Belize, one of the main thrusts of research was to document and study the interactions between the mutton snapper and whale sharks. Whale sharks are the largest fish on Earth, off of Gladdin Spit in Belize these species are feeding off of the mutton snapper spawn. Pilots of the DeepWorker submersibles and SCUBA divers have been witness to some amazing views of volcanic-like spawning behavior of tens of thousands of snapper, with whale sharks swimming through and feeding on the murky spawn. Those that have had a chance to observe this from underwater state that it has been a career highlight and worth all of the hard work in planning for the Sustainable Seas Expeditions. To

directly answer your question, I am not sure whether or not some of the research in Belize will provide valuable background information about Global Warming.

Emma/Flower Garden Banks NMS

RE: [Edward] How do weather patterns effect the stream if at all? Are there records to track the stream velocity and locations dating back very far?

Hello Edward. The advancement of technology - especially satellite technologies - have really allowed for us to track weather patterns through our Sanctuaries - visually. We maintain buoys on site that you can access the Web to obtain real time data on currents, water temperature, and windspeed. **This buoy is located at the East Flower Garden Bank.** Other useful Web sites to check on are **Gulf sea conditions** and for **forecasts** to determine whether we are able to get offshore to the Sanctuary.

Cathy/Gray's Reef NMS

RE: [Efrat] Dear Emma and Cathy, my name is Efrat Sharvit. I'm a second year student in the Naval College of Israel. In the context of a course called "research methods" that we are taking, I have become interested in the use and operation of the "DeepWorker 2000" Can you give me details about the dives that you both took during your research with the "DeepWorker 2000"; What were their purposes? How was the DeepWorker actually used? Thank you for your time, Efrat.

Hello Efrat, I have used the DeepWorker on two missions. The first mission was the summer of 1999 on Gray's Reef, which is located 20 miles or 37 kilometers off the middle of Georgia's coast in 70 feet or 23 meters of water. Since the submersible was originally designed to access deeper areas inaccessible to divers Gray's Reef was hardly deep to warrant the use of the subs. The application I used the sub was to sit on a site and watch the change in communities over a four-hour period that began at 7 PM on July 31st an hour and a half before sunset and continued until 11 PM well after the sun had set. I was able to observe changes in fish populations and mobile and to some extent sessile invertebrates from diurnal through crepuscular and on into the nocturnal periods. I even had a six feet long scalloped hammerhead come to the sub for a quick visit. The most spectacular part of that mission came when I turned off all the lights on the sub and switched off all internal indicators to achieve complete darkness. I was treated to the most incredible display of bioluminescence I have ever seen. As my eyes adjusted to the darkness the bioluminescence closest to me was the brightest and visible first. As minutes passed "lights" further down the ledge I was observing became visible. It was like I was a giant sitting on a mountaintop looking into a tiny valley below as darkness descended on the Lilliputian village. One by one lights in the homes shown through their tiny windows. There were also areas where the bioluminescence extended upwards in straight lines up from the ledge which looked like radio tower lights. I'll never forget that image for as long as I live. The other mission for which I used the sub was in the Florida Middle Grounds in the Gulf of Mexico just offshore of the Big Bend area where Florida's Panhandle meets its Peninsula. The mission was to explore the ocean bottom to see what was there. As we were using side scan bathymetry to map the floor strange shapes appeared on the screen. One looked like a pyramid. My job was to use the sub to explore the structure and to shoot video of it as much as I could. The structure as it turns out was part of an ancient shoreline. The pyramid-like appearance of it was caused by the strong currents that had sculpted this remnant referred to as a seamount. The side facing

the current was craggy and presented an almost vertical face while the other three sides were more gently sloped and covered with sand. All four sides and the small round top were colonized with octocorals and algae, which in turn attracted small fish like damselfish and angelfish. The top was just large enough for me to land the sub on it and change tape in the cameras. Again this dive was done over the change in photoperiods. The bioluminescence wasn't nearly as spectacular as it had been at Gray's Reef, but it was still beautiful. The other nice part to this mission was that the chief scientist named the seamount in my honor, Mt.Sakas!

Emma/Flower Garden Banks NMS
RE: [TimothyCampInternet] Are you creating GIS (Geographic Information Systems) maps of the SSE research as it is progressing?
Hi Timothy - glad you asked! We have been working hard on creating our GIS program, and are making full use of it to plan our DeepWorker dives. We recently conducted ROV surveys of the Sanctuary, and were able to have real-time locations plotted of the ship overlaid on high-resolution bathymetry of the Banks. Of course, we were able to create maps later with this data, to plan future expeditions. We have some great video from that cruise also. And we know where we were during the filming and hopefully can get back to these places with the subs. The dives conducted during SSE will also be geo-reference and incorporated into our GIS program. Our GIS research specialist is **Kevin Buch**, if you have specific GIS questions later you can email him.

Emma/Flower Garden Banks NMS
RE: [MorganaPHS4thgrade] Is the coral reef in Belize a major habitat for fish?
Morgana, The Belizean has fabulous fish life! Several sites on the reefs have been identified as critical habitat for spawning aggregations of snapper and grouper.

Claire/Chat Host
RE: [Marcy/CampInternet] Is Dr. Earle focused on a specific topic of study for this expedition?
Dr. Sylvia Earle has joined forces with numerous researchers and scientists in Belize and Mexico to help further along their studies. As in past expeditions, SSE has actually trained 4 Belizian pilots (2 Americans that have been studying in Belize for a number of years and 2 actual Belizian pilots), as well as 2 Mexican pilots to continue their research in Mexico. With this in mind, Dr. Earle's focus for Islands in the Stream is to learn more about the hard bottom communities in waters such as Belize and Mexico and better understand how they affect areas like the Flower Garden Banks and Gray's Reef National Marine Sanctuary. SSE will also be deploying 2 drifter buoys during Islands in the Stream to study the patterns of the Gulf Stream and Loop Current. We hope that in the near future school children will be able to access the drifter buoy data real-time and work on lesson plans that will have been developed by then.

Emma/Flower Garden Banks NMS
RE: [AyamiPHS] Emma - why is your reef called the flower gardens? Are there really underwater flowers or are they living creatures? And what is the URL to learn more about them?

Ayami, The **Flower Gardens** were named such by snapper and grouper fishermen back in the 40's and 50's - they would pull up bits and pieces of colorful reef organisms (sponges, marine plants, etc.) and likened them to flowers - the name has stuck!

Cathy/Gray's Reef NMS
RE: [TimothyCampInternet] Are you creating GIS maps of the SSE research as it is progressing?
Hi Timothy, GIS maps are incredible tools, and I know that many of our sanctuaries within the National Marine Sanctuary System do have GIS maps. You can check on the SSE Web site to see if this is, or will be, available on the missions.

Emma/Flower Garden Banks NMS
RE: [Marcy/CampInternet] Is Dr. Earle focused on a specific topic of study for this expedition?
Marcy, another way Dr. Earle and other researchers are looking at the ties between the reefs is looking at the genetic ties between the corals. Small samples of certain species will be acquired at each reef, and analyzed genetically.

Claire/Chat Host
RE: [Marcy] Our Camp Internet students will be studying the Global Garden theme this coming year - including underwater gardens. Is there any mariculture going on in Belize? And what types of plants are present on their coral reef?
Hi Marcy. Unfortunately, myself and the experts online right now are not aware of any mariculture activities in Belize.

Cathy/Gray's Reef NMS
RE: [MorganaPHS] Do whales migrate in the stream? Or are they only out in colder waters?
Hi Morgana, Have you ever heard the phrase "going with the flow"? My experience is that animals use natural pathways to their advantage. When whales migrate they do go with the flow. The Gulf Stream usually flows at 4 knots or nearly 4 miles per hour. That doesn't seem very fast by land standards but in the ocean that is quite fast. So whales do make use of the currents and swim with them as much as they can. Whales occur in all waters of the world not just in the colder areas. They do go to areas that serve their needs at various times of year. When needing to eat they go to areas where food is abundant and when the females are giving birth they travel to warmer protected waters which usually are shallow near shore areas.

Cathy/Gray's Reef NMS
RE: [Edward] Cathy at Grays Reef - what is the URL to learn more about your reef? How does its plant and animal life differ being exposed to the Atlantic?
Hi Edward, Check out more information about **Gray's Reef**! Our reef is referred to as a live bottom habitat and it is considered a sub tropical reef. It has characteristics of both temperate or cold live bottoms and tropical or warm water reefs. Because Gray's Reef is located at 31 degrees of latitude it is outside the tropical band. We don't have the big brain corals but we do have smaller oculina hard corals called ivory bush coral and soft corals and sponges with lots of fish. In the summer we get sargassum weed

but in the winter our water temperature drops to around 50 degrees F for a month and a half which kills it. Our reef is spectacular in its own right however, and I hope you get a chance to visit it one day.

Claire/Chat Host
RE: [Melissa] Are there any underwater archeological sites in Belize?
Hello Melissa. What a great question. Unfortunately I do not have an answer for you at this time. I will get in contact with our researchers and see what they know about the cultural side of Belizian waters. I imagine that there are some archaeological sites in Belize and am interested in finding out more myself. Check back to the archive of this Web chat, I will have found an answer for you by then.

Emma/Flower Garden Banks NMS
RE: [Regina] Are there any illnesses evident in the life on the reefs today? Caused by pollution, fishing or other human activities?
Regina, there are many well documented impacts causing problems on reefs today including groundings, pollution, divers impacts, over-fishing, destructive fishing techniques - the list goes on, but with all of these negatives, we are happy to report at the Flower Gardens, that we have a close to pristine coral reef system. We do see evidence of fishing and industry (e.g. gear and cables on the reef), but not nearly to the degree that many of the reefs around the world are facing. The distance from shore plays a major role in the good health the coral reef enjoys at the Flower Gardens. This doesn't mean that we don't need to be on our guard. It's important to understand the threats and not disregard them as "they won't happen here" - measures should be taken so they won't happen.

Emma/Flower Garden Banks NMS
RE: [AyamiPHS] Does this mean that all of the plant-looking organisms on a reef are actually living creatures and not plants? Or is there a mix?
Ayami, Marine PLANTS play an important role on coral reefs - and can be quite colorful - vibrant reds and greens, as well as your duller browns. They can be microscopic, as well as very leafy varieties. There are some animals that look like plants - such as the animals associated with Sargassum (a type of marine plant that floats around in the currents in massive mat-like floats. Sargassum fish, crabs, etc. all take on the form of the Sargassum - which provides protection for them from predators. So, yes, there is a mix!

Claire/Chat Host
RE: [Regina] Are there any illnesses evident in the life on the reefs today? Caused by pollution, fishing or other human activities?
One thing that can also be added, is that the International Maritime Organization (IMO) is making the Flower Garden Banks National Marine Sanctuary the first location in the waters of the United States to be declared a no-anchoring zone. This is a huge relief for the reef, seeing as large barges, tankers, and commercial vessels that are passing through will no longer be able to set anchor on the valuable reef and marine life of the Flower Garden Banks. When these ships are in the channel in extremely deep waters and they need to tie up for the night, they were able to hover over these salt domes off shore of Galveston, Texas, which increased the human pressures on the reef. Starting June 1, 2001, the IMO designation of a no-anchoring zone in the Flower Garden Banks National Marine Sanctuary will take affect and this is a great

precedence!

Emma/Flower Garden Banks NMS
Marcy - I have a point to clarify regarding the IMO - the Flower Garden Banks National Marine Sanctuary will be designated the first "No-Anchoring Zone" not only in the U.S, but in the WORLD under this organization!

Emma/Flower Garden Banks NMS
RE: [Edward] Will samples be taken to determine how old the coral reefs are?
Edward, No samples are planned to determine the age of the corals (on this mission). This usually requires coring with special equipment. We have done some of this work at the Flower Gardens to a certain depth, but never all the way through to the bottom of the coral cap - but it is definitely in our plans to do so! We say about 10-15,000 years old, but we won't know for sure until we do the coring project.

Claire/Chat Host
RE: [TsunamiTyndall10thgrade] What is the oldest part of the coral reef you are studying in Belize?
That is a great question and yet another one that we will have to get back to you on. Check out the archives in about a week and this question will be answered.

Cathy/Gray's Reef NMS
RE: [Regina] Are there any illnesses evident in the life on the reefs today? Caused by pollution, fishing or other human activities?
Hi Regina, Unfortunately many of the world's reefs are suffering incredible losses. The reefs closest to human habitation are the ones that suffer the most. In some areas the reefs are completely dead. Coral bleaching is a disease that causes the live coral to expel the mutually symbiotic bacteria called zooxanthellae. The zooxanthellae gives the coral its distinctive color and photosynthesizes to produce food for the coral, and the coral offers protection for the zooxanthellae. When the zooxanthellae is gone the coral turns white. Anyway, warm temperatures are thought to be one reason coral bleaching occurs as well as pollution and saltier water than the coral is accustomed. There is also one other factor that is affecting the corals and that is bacteria from Africa that becomes wind born and falls out in areas with coral. This is also causing a lot of damage to corals.

Emma/Flower Garden Banks NMS
Congratulations on being an attendee to the Flower Garden Banks NMS Teacher Workshop. Shelley Du Puy, site education coordinator will likely have numerous great activities and field experiences for you and the educators that will be attending. Jeanne, you'll be immersed in coral reef ecology for 4 days! We'll be onshore for the first round of activities, and then head offshore for three days of SCUBA diving and in the field experiences - you'll be learning to identify fish - and since it will be July (that is, the month of the Great American Fish Count), you'll be filling in **REEF** fish census forms and submitting them to be included in the huge database of fish surveys from the Flower Garden Banks. People all over the country will be invited to count fish and fill in the REEF forms during this month long event.

Claire/Chat Host
RE: [Melissa] When you research the archeology question above, please also let us know if the Maya in Belize made use of coral for jewelry or other art and crafts. Did they dive for it or use coral washed on shore? Thanks.
I will try my best.

Claire/Chat Host
RE: [Marcy/CampInternet] We heard there is a new coral reef coming under Sanctuary protection in Hawaii? Where is it located?
On December 4, 2000, President Clinton designated the **Northwest Hawaiian Islands Coral Reef Ecosystem Preserve**. There have been discussions about making the pristine waters of the Northwest Hawaiian Islands a part of the National Marine Sanctuary System. As for a date of when this will happen, it is anyone's guess.

Cathy/Gray's Reef NMS
RE: [Marcy/CampInternet] We heard there is a new coral reef coming under Sanctuary protection in Hawaii? Where is it located?
Hi Marcy, There is a new marine sanctuary in the works for Hawai'i. It will be called the Northwest Hawai'ian Islands Coral Reef Ecosystem Reserve. The sanctuary was initially identified by President Clinton before he left office, and the Bush Administration is continuing the process to get it designated.

Claire/Chat Host
RE: [AyamiPHS7thgrade] How many species of fish are there in the coral reef in Belize?
Far too many to count!

Emma/Flower Garden Banks NMS
RE: [Edward] If the coral reefs can be over 10,000 years old, (amazing) then they would have been closer to shore during the ice age, which is very interesting. Might this mean there may be coral reefs even further out that have yet to be discovered (that were closer to shore during the ice age)? Which would also mean the stream would have been further out?
Edward, there are some biological communities that support some coral a little further offshore than the Flower Garden Banks, but not reefs - If you go about 20 miles south of the Flower Garden Banks, you hit the edge of the continental shelf, and go for a downward plunge to 1000's of feet deep - beyond coral reef physiological limits.

Emma/Flower Garden Banks NMS
RE: [Buck/GeoQuest] What are some of the sustainability issues being studied in the SSE and what principles of sustainability are being advanced in the Flower Gardens and other reefs in the stream?
Buck, we are looking at the fish populations and spawning aggregations, and asking hard questions about how fishing would impact these populations. This is just one example of sustainability questions that will be on our minds as we dive the subs into this incredibly beautiful underwater world.

Cathy/Gray's Reef NMS
RE: [TsunamiPHS] In Hawaii there are beaches that seem to be made of

crushed coral - is this true around other reefs?
Dear Tsunami, Beaches are composed of the materials that are on land and offshore. For instance in Georgia our beaches are made of fine white sand because the sand grains were originally mountains. As the mountains erode they break into smaller rocks and those rocks make their way to the coast through rivers and streams. By the time the rocks travel several hundred miles to the coast they have been ground down to sand grains. The sand grains are deposited near shore where the river meets the ocean. Then the currents and waves push the sand up to make the islands. In other areas the corals do contribute to the beaches as do shells and even coraline algaes. In the Bahamas there are beaches that are pink! They are made primarily of the pink coralline algae that is just offshore.

Cathy/Gray's Reef NMS
RE: [Marcy/CampInternet] I once experienced a bioluminescent tide swimming off the coast of South Carolina - what causes these to happen and are their annual?
Hi Marcy, I am so glad you had that experience! I too have been swimming in the ocean and salt water rivers at night in coastal Georgia and have been totally transfixed with the green sparkling water. Bioluminescence in the water is caused by dinoflagellates which are microscopic animals that have the ability to give off cold light like lightning bugs do. The chemcial reaction is an enzyme luciferase dissolving a protein called luciferin. The reaction is referred to as a cold light reaction because no heat is produced in the process. Anyway, when the dinoflagellates are disturbed perhaps when they hit something like your body or that of a fish they light up. It seems that the dinoflagellates off the South Carolina and Georgia coasts are more abundant at times when the water is warmer. So from Spring through Fall the bioluminescence is the best. The two most abundant dinoflagellates in our waters are Gonyalax and Gymnodidium.

Claire/Chat Host
We hope that you will all join us again for our next live Web chat on June 26, 2001. During that Web chat we will be discussing the topic of natural vs. artificial reefs and how they affect the marine ecosystem as a whole. Lastly, if you will be in or near Galveston, Texas on June 1, 2001--join the Sustainable Seas Expeditions (SSE) and the Flower Garden Banks National Marine Sanctuary for Ocean Discovery Day as we kick off the America portion of this year's SSE mission, Islands in the Stream.

Emma/Flower Garden Banks NMS
I really enjoyed your questions today! Thanks a lot! Visit the **Flower Garden Banks National Marine Sanctuary** for additional information.

Cathy/Gray's Reef NMS
Dear Web Chat Participants, Thank you so much for asking such terrific questions. They were well thought out and drew on your personal experiences. You all were well informed and that made my job more challenging and interesting. I hope you will join us again for another web chat. Please do check out the Web sites for the individual sanctuaries and for Sustainable Seas Expeditions. Until next time...Think Deep, Think Reefs!

Claire / Chat Host
Thank you everyone for participating. It sure appears that everyone did their homework and asked great questions surrounding the theme of today's Web chat. There were a few questions that we were not able to answer at this time, as I get answers I will update the transcript. So come back to the archives of this Web chat and we hopefully will have responded to all of your questions, even the trickier ones, such as what is the oldest part of the reef that is being studied in Belize.

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SUSTAINABLE SEAS EXPEDITIONS
LIVE EVENTS

WEB CHATS

SITE INDEX

June 26, 2001

2:00 pm to 3:00 pm Eastern Time (11:00 - 12:00 am Pacific Time)
Natural Reefs versus Artificial Reefs

Introduction

In recent years, scientists have been finding that many natural reefs cannot rebuild themselves fast enough to meet human demands. Long-lasting artificial reefs may be useful tools for restoring our reef systems to a natural and productive state. To create an artificial reef is to sink a man-made object in the sea (for example a ship), and then allow it to become part of the ocean ecosystem. Once the material is in place it acts in the same way that naturally occurring rock outcroppings do in providing hard substrate necessary in the basic formation of a live-bottom reef community. In most instances, marine life has been quick to adapt to artificial reefs.

An artificial reef teeming with life.

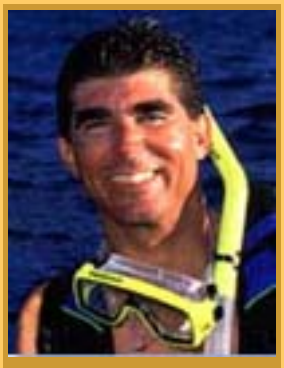
Since there is nothing artificial about the myriad of living organisms, which eventually colonize and inhabit almost every square inch of these man-made structures, the term artificial reef may really be somewhat misleading. When properly designed, located and constructed with an adequate quantity of stable and durable substrate, man-made reefs can be equally as productive in theory as naturally occurring hard- bottom habitats, limited only by the life-span of the materials utilized. Given the variety of materials currently in use on many artificial reefs, some reef structures in place now could remain productive for the next one to five hundred years.

Artificial reefs may sound like the perfect solution to helping rebuild reef communities throughout the marine environment, however, there are many questions that scientists have been studying regarding the complex issue of natural versus artificial reefs. There are biological, ecological, managerial, and toxicological issues and concerns associated with the use of artificial reefs. One of the more commonly asked questions is whether artificial reefs attract (aggregate) fish or do they increase fish population, which is known as the attraction-production issue. Some believe that artificial reefs support increased production, where others suggest that placement of artificial reefs largely determine whether attraction or production occurs.

A snorkeler enjoying a natural reef system.

If artificial reef communities do not mimic natural systems, but do attract life from natural reefs, then what are the potential ramifications to the natural balance of the ecosystem? Should resource managers consider the risks associated with materials remaining on the man-made object (e.g., Copper, asbestos, lead paint and anti-fouling paint fouling on a vessel) to be used as artificial reefs and how they will potentially affect the marine environment and the fish species? Resource managers rely on the answers to these types of questions to make the best possible management decisions in artificial reef development. Additionally, they must consider socioeconomic, political, logistical, and fishery management issues.

Panel of Experts



Laddie Akins

Laddie Akins is the Executive Director of the Reef Environmental Education Foundation (REEF), a nonprofit organization referred to as the underwater equivalent of the Audubon Society. A multi-agency scuba instructor and U.S. Coast Guard-licensed captain, Laddie has worked extensively in developing educational and fish survey programs for the Caribbean, Florida, Gulf of Mexico, California and Pacific Northwest. He has lectured extensively on marine life issues and field identification. His dive experience includes logging thousands of scuba dives over the past 17 years and serving as team leader on over 40 field survey expeditions.

Steven V. Baumgartner, Operations Officer of the Florida Keys National Marine Sanctuary, graduated from St. Petersburg College and San Jacinto College, receiving

degrees in both Physical Therapy and Pre-Medicine. He then attended the Texas College of Chiropractic Medicine. After completing an internship and residency in both Houston, TX and Tampa, FL he opened a private practice in Tampa, Florida. A career shift in 1986 led Steve to pursue a career in Marine Science. He taught Marine Science at the Tampa Marine institute until 1988. Steve relocated to Summerland Key, Florida and became a full-time charter boat captain, as well as a fishing and dive guide. During his time as guide, he observed a steady decline of the Florida Keys ecosystem and decided to take on the personal mission of protecting this fragile environment. He began this quest by volunteering for the Looe Key National Marine Sanctuary in 1993. Eventually he was hired as a part-time employee in 1994 in the education department. From there, he accepted a position as an Environmental Specialist, eventually becoming the Operations Officer, in the Key West office.

Steven V. Baumgartner

Preparation

To help you prepare for the live event on June 26, the SSE Education Team has provided a few challenge questions to get the juices flowing. We invite you to leave your own questions in the chat room before the event, or ask them during the live program.

Activities

Challenge Question 1: Do you feel that the benefits of artificial reefs outweigh any possible negative impacts they may have to the natural reef ecosystem?

Challenge Question 2: If you were a resource manager and were planning to introduce an artificial reef located offshore from a natural reef with a strong along-shore current, would you think that the artificial reef would increase production of fish species or simply attract fish? (Hint: think about fish larvae that would get caught in the current)

Challenge Question 3: Do artificial reefs decrease fishing pressure on natural reefs? Do artificial reefs decrease scuba diving pressure on natural reefs?

Email your responses to the challenge questions to SSEeducation@noaa.gov and your can receive a free Sustainable Seas Expeditions sticker!

Web Chat Transcript

Claire/ChatHost
Natural versus artificial reefs is an issue that resource managers often face when determining whether or not they should develop an artificial reef program. There are biological, ecological, managerial, and toxicological issues and concerns associated with the use of artificial reefs in any given area. Join us on June 26, 2001 as we talk to the panel of experts about this delicate issue. Feel free to leave your questions in the chat room in advance of the live event. We look forward to your participation!

Lad at REEF
Hi everyone and welcome to the chat! Lad Akins here, from the Reef Environmental Education Foundation (REEF). We're a marine conservation organization of divers and snorkelers that conduct fish surveys. We have also done quite a bit of work with the State of Florida, helping to train their county teams in fish identification and standardizing the methodology used to collect and report fish sightings on the State's artificial reefs. I'm looking forward to discussing ideas about these artificial habitats and maybe throwing out a few resources for you to look into. Best Fishes! Lad

Claire/ChatHost
Thank you for joining us for today's live Web chat. We have Laddie Akins and Steve Baumgartner on the line to answer all of your questions regarding the controversy between natural and artificial reefs. When you ask a question, please include where your are emailing from--enjoy!

Steve/Florida Keys National Marine Sanctuary (NMS)
RE: [Jean] Have you found differences in how artificial and natural reefs respond and recover from catastrophic situations (e.g., hurricanes, tidal waves).
I have personal experience with hurricane George several years back. We found immediately after the Hurricane, there was damage to some of the artificial reefs, but the fish population returned very quickly. Coral damage due to hurricanes return very slowly whether artificial or natural.

Lad at REEF
RE: [Rob] How can development of artificial reefs help ease some of the impact of higher water levels due to global warming?
Rob, Global warming is a huge issue right now (and of course in the future). Artificial reefs could be used as fisheries enhancement devices as well as juvenile recruitment habitat. As far as easing effects of higher water levels - I'm not too sure how they would have a direct effect.

Steve/Florida Keys NMS
RE: [Frank] The proper construction of a tire reef and proper placement of said reef has proven to be very beneficial in increasing habitat resulting in increasing resources in various parts of the worlds oceans. What are objections to the use of tires as artificial reefs?
I do not advocate the use of construction material or debris as artificial reefs. The ocean is not a dumping ground. With that said, I do feel that Shipwrecks and historical sites do assist in diminishing pressure on natural reefs.

Lad at REEF

RE: [Frank] The proper construction of a tire reef and proper placement of said reef has proven to be very beneficial in increasing habitat resulting in increasing resources in various parts of the worlds oceans. What are objections to the use of tires as artificial reefs?

Frank, Two of the key issues when using artificial reefs are stability (see Jean's earlier question) and pollution effects. Tires can be deployed as artificial reefs in a stable manner, but you've got to think about how a big storm could affect them. If they are broken up or moved around on the bottom, the potential for damage to the natural resource is great. There may also be a pollution issue with used tires. Chemicals used in their production could leak out as they slowly degrade.

Steve/Florida Keys NMS

RE: [AMR] Why do we have to use them at all?

Artificial reefs made out of ships can attract divers away from the natural reefs which tends to take some pressure off of the natural reef. In areas that lack natural habitat they tend provide protection for a variety of adult and juvenile fish.

Lad at REEF

RE: [Cathy] What are the long term benefits and/or deleterious effects of having artificial reefs in close proximity to natural reefs?

Cathy, This is a great question and gets to the heart of the "production/aggregation" argument. There is a lot of concern about whether an artificial structure placed near a natural reef will attract fish away from the natural reef or whether it is actually increasing production on its own. I don't think anyone has answered this completely yet, but there have been papers documenting reductions of fish on artificial reefs when they are open to fishing. (this is the scary part of the aggregating argument). Research on Gag grouper in Florida showed a 40% decrease in abundance after an artificial reef was opened to fishing. (Lindberg, 1998). If the artificial reefs do aggregate, then we could be decreasing our populations rather than helping them out.

Lad at REEF

RE: [Bobbi] Please tell me what reports show that tires cause a pollution issue, as I mentioned earlier I have been unable to find any documentation showing this.

Bobbi, An excellent resource for artificial reefs is the State of Florida's Fish and Wildlife Conservation Commission. You may want to drop an e-mail to them regarding the tire issue. I don't believe they allow tires in their program, which is one of the largest in the US. Try their Web site at www.state.fl.us/fwc/marine and follow the artificial reef links.

Steve/Florida Keys NMS

RE: [Mark] How much research into the use of artificial reefs has been carried out in temperate or cooler water environments? Any useful references for getting some details?

Over the past 5 or so years there has been research on the use of artificial reefs to relieve both diving and fishing pressures on natural reefs as well as on their use as fish aggregation devices and settlement substrate for juvenile fish. While I do not have citations on hand, you may find details in the proceedings from the most recent

International Coral Reef Symposium and the proceedings from the last meeting of the Society for Conservation Biology. If you have additional questions or need specific citations, you can email Ben Richards at the Florida Keys National Marine Sanctuary (ben.richards@noaa.gov)

Lad at REEF
Purposes of artificial reefs are probably the least addressed of the issues at hand. Many people think that you should be able to put out structure and it will serve many different functions - take pressure off natural habitat, increase fish populations, increase juvenile recruitment and survival, allow for more and better fishing opportunities, etc. However, each structure should be designed and implemented for a particular purpose and that purpose will define the structure. Shipwrecks may be great for diving, but do little for juvenile recruitment. Lindberg's 1998 report showed that more widely spaced, smaller structures were better for increasing Gag Grouper populations, but they certainly wouldn't be much fun to dive on. Nearshore structure would be better for many juvenile fish species, but not do much for fishing. They purpose needs to be thought out before the design is decided upon.

Steve/Florida Keys NMS
RE: [Cathy] What are the long term benefits and/or deleterious effects of having artificial reefs in close proximity to natural reefs?
The high profile of artificial reefs made out of shipwrecks tend to attract both pelagic species as well as those that recruit and grow on artificial reefs. As I stated earlier Shipwreck type artificial reefs tend to attract recreational divers from natural reefs. This in itself is a positive. By attracting divers from the natural reef you relieve the pressure of constant use on the natural reef. If you allow spearfishing or sportfishing you basically negate this positive effect. I would like see artificial reefs in the vicinity of natural reef a no take area.

Lad at REEF
RE: [Bobbi] Wasn't there a study recently completed off Florida where they built a man made reef in close proximity to a natural reef and during the study it showed no draw of fish from the natural reef to the man made and additionally the fish counts fluctuated similarly in both areas?
Bobbi, I'm not aware of that study, but it could very well be. two of the fear factors in deployment near natural reefs are that 1) artificial structures can move during storm events and they will congregate fish, making them easier to harvest. Bortone and Turpin (1997) documented movement of artificial structures in Florida after storms in 1995. Some of these artificial reefs moved more than 1,000 meters! If structures like this are near a natural reef, they could really do some severe damage. The aggregation argument can also be a little scary. If you place a structure near the natural reef and certain targeted species, like grouper, (which are normally dispersed on a natural habitat) congregate, they become easily harvested. If the study you are referring to said they don't move to artificial reefs from the nearby natural areas that wouldn't be a concern, but I would not guess that to be the case.

Steve/Florida Keys NMS
RE: [Bobbi] Please tell me what reports show that tires cause a pollution issue, as I mentioned earlier I have been unable to find any documentation showing this.

I do not know of any documentation that indicate tires cause toxic pollution, but we do know that tires do not have enough mass and when placed in mats. When used as artificial reef material, they tend to break apart and scatter with the current and tide. I must go back to an earlier statement in which I said we should not use any debris whether construction debit or any other debris for that matter as artificial reef. Our oceans are not a dumping ground. There is nothing more unattractive or unsightly than a tire or other debris laying on the bottom of the ocean. Scuttled ships are currently seen as a good material for the construction of artificial reefs due to their ability to withstand the physical demands of the ocean realm.

Lad at REEF

RE: [Bobbi] Please tell me what reports show that tires cause a pollution issue, as I mentioned earlier I have been unable to find any documentation showing this.

Bobbi, I was just looking through my file for more info on the tire issue. A report by Roberto Claro in Cuba (1999) mentions the use of tires as a potential artificial reef material. His negative positions revolve around the dispersal of the tires when the material used to hold them together (chain, wire, rope, etc) disintegrates and that "This material usually releases some toxic substances into the environment(grease, several solid particles, etc.)...". I know it's not much, but I'm seeing what I can dig up!

Steve/Florida Keys NMS

RE: [Bobbi] In regard to Frank's question, I have only been able to find one report published by EPA in 1974 titled "Scrap Tires as Artificial Reefs", and it states "..they provide an excellent surface for the attachment of encrusting organisms. Tires are durable; we found no evidence of toxic substances leaching from the tires, they do not decompose like metal, and there is no evidence of structural breakdown caused by boring organisms....".

While rubber tires do provide a good substrate for settlement and are resistant to physical and chemical breakdown, reefs created using tires do not possess the needed structural integrity to withstand the physical demands of the marine environment, especially when used in shallow water environments.

Bob

Divers will spend time exploring artificial reefs, especially interesting and historical sites which takes pressure off of natural reefs. Properly placed artificial reefs will produce various corals, sponges, tropical fish, and other interesting species. Non productive bottom can be transformed into productive habitat for all types of sea creatures which will attract curious divers.

Lad at REEF

RE: [Joanne/California] Is it big business for companies that focus on artificial reefs in the Florida Keys area?

Joanne, I'm not aware of any big business involved in artificial reefs here. The artificial reef program in Florida is funded through saltwater fish license fees that go through the State Fish and Wildlife Conservation Commission. There are a few non-profit groups that have been formed to help put down large shipwrecks for diving and fishing activities, but no large corporations that I know of. On the west coast of the US and potentially the Gulf of Mexico, there are pushes being made by the oil industry

to use old oil rigs as artificial reefs. The idea would be to cut the top structure off and leave the underwater portion in place as an artificial reef habitat. This would be cost effective for the oil companies that have to pay big bucks to remove the platforms once they are out of use.

Steve/Florida Keys NMS
RE: [Bobbi] Wasn't there a study recently completed off Florida where they built a man made reef in close proximity to a natural reef and during the study it showed no draw of fish from the natural reef to the man made and additionally the fish counts fluctuated similarly in both areas?
I am aware of that study, but do believe that artificial reefs attract the pelagic type fish (mackerel,jacks,cobia etc.) If there were no artificial reef in the area the pelagic species would probably migrate past the area, but with an artificial reef in the area they tend gather at the site. Fish like the grouper, snapper and tropical species tend to find these artificial reefs and grow up there.

Lad at REEF
RE: [Joanne/California] Lad, does REEF conduct fish counts on artificial reefs? If not, would you consider doing fish counts to compare the data collected on artificial versus natural reefs? I imagine the data would be quite helpful.
Joanne, Yes. REEF does do fish surveys on artificial reefs as well as natural ones. You can actually go explore some of the data yourself by going onto our publicly accessible Web site at www.reef.org/data If you know the names of the artificial reefs you would like to review, and where they are, you can pull up a complete list of fish species and their abundance right from the Web site. Try comparing a few and see what you come up with!

Lad at REEF
RE: [Bobbi] This question is for Laddie and Steve. Do you believe that man made artificial reefs benefit marine life? If not, why?
Bobbi, Big question! I do believe that artificial reefs CAN benefit the marine environment, but also that one structure cannot do everything and in fact may be detrimental to what you want to accomplish if it is not designed and deployed well. Want more detail?!

Steve/Florida Keys NMS
RE: [Joanne/California] Is it big business for companies that focus on artificial reefs in the Florida Keys area?
There are companies that specialize in establishing artificial reefs, but I would not say it is big business here in the Florida Keys. The process for establishing a Shipwreck here in the Florida Keys is very extensive and not many are permitted. For this reason not many companies have been established to do this type of work here. On the East coast of Florida their companies that specialize in this type of work.

Claire/ChatHost
Steve and Laddie are busy answering the remaining of your great questions. We will take a few more questions during the next five minutes, and then will let the expert panel continue to answer all of your questions that will be archived in the next week on NOAA's new Ocean Explorer Web site (http://oceanexplorer.noaa.gov/).

Bob
To Joanne. The state of Florida has large area artificial reef sites off of the panhandle of Florida where private individuals that are allowed to place artificial reefs constructed of minimum 1/8" steel and varying weights. In the past car bodies, tires, fiberglass boats and other materials have been used. These structures have proven to be long lasting and when properly placed have with stood severe marine storms. The sate of Florida does provide grants to local counties and other for placement of artificial reefs and they also allow private individuals to place their own materials.

Lad at REEF
RE: [Lex] In the development of an artificial reef that is being considered as both a research reef and an MPA, what parameters should be considered when determining the placement of the reef?
Lex, Sorry I missed your question at the top of the list! I hope you've been following some of the other discussions as I think the answers to your question are hidden in there. I think the big issue is what question do you want to answer in creating a research reef and/or an MPA with an artificial structure. If you want to determine whether the artificial structure works as a fisheries enhancement tool, then you need to have some structures that are fished and some not. You will also need to open some to fishing after they have been protected. Replication will be a big factor so you'll need more than one artificial reef to treat during your research. Proximity to nearby habitat as well as similarity of placement habitats should also be a concern. The biggest prerequisite though will be determining what questions do you want to answer.

Steve/Florida Keys NMS
RE: [Craig] Are artificial reefs completely supported by resource managers at the Florida Keys National Marine Sanctuary?
The Florida Keys National Marine Sanctuary supports the limited use of artificial reefs with an emphasis on continued research and monitoring. Artificial reefs are still in their infancy and existing research needs to be augmented to determine their use/efficacy for specific areas and environments. The FKNMS does not advocate random or non-targeted dumping of debris into the marine environment, nor do we support the creation of artificial reefs solely for the purpose of fish aggregation. Any artificial reef placement must have a specific purpose and procedures and plans need to be in place to monitor the effect of that artificial reef on the surrounding environment.

Joanne/California
Thanks to both of you, Laddie and Steve. Good luck with the Islands in the Stream mission!

Lad at REEF
RE: [Bobbi] Laddie, I certainly agree with you that one type structure can't do everything. (i.e. the reason for allowing numerous types of man made reefs), what do you feel are the detrimental things that will occur if not designed or deployed well? And, yes I don't want to take all of your time, but would like to hear more details.

No problem, that's why I'm here! I think some of the detriments include the degradation and/or movement of the structure during storms, harvesting of fish as they aggregate around the structure, tendency to view the overall concept of artificial reefs as a way to get rid of things we don't want on land (we could use old battleships as artificial forests for birds, but I doubt that would fly - no pun intended!), and the failure to remember that we need to protect the natural reefs not just keep putting out artificial structures as replacements.

Steve/Florida Keys NMS
RE: [Lex] In the development of an artificial reef that is being considered as both a research reef and an MPA, what parameters should be considered when determining the placement of the reef?
Lex, this is a very difficult and involved question. I will try to answer as briefly as possible given our time and space constraints. While many parameters for the creation of a research area and MPA will be the same, there are some differences. In both areas one is looking for an area devoid of existing highly topographic bottom characteristics. While artificial reefs do provide good refuge habitat for a variety of fish and other species, they will never be able to replace natural environments. Sites established as MPAs will need to be monitored for their continued efficacy in meeting established goals. The main difference in the establishment of a research area is in determination of specific questions and goals, which will be answered by the creation of an artificial reef. The use of appropriate control sites is essential in isolating the questions being asked. While MPA sites will need continued monitoring, research sites are generally sited to target specific questions.

Steve/Florida Keys NMS
RE: [Bob] It makes reasonable sense that if you have increased the amount of habitat (i.e. artificial reef) that you increase the area for the larvae to accumulate and to grow. This will, over time, be beneficial to the resource as it will give more opportunity to expand the fish population and give more area for future spawning because of the increase in habitat.
Bob - you make a good point. One consideration that must be made is to the protection of fish populations on artificial reefs. If these populations are under increased fishing pressure they may not contribute much to surrounding populations in the end.

Claire/ChatHost
RE: [Bobbi] Thanks for allowing me to be a part of this forum!
Bobbie, it was great to have you join us. It appears that you had a great interaction with our panel of experts, Laddie and Steve. Perhaps you will join us again for another Web chat in the near future.

Bobbi
Just for everyone's information artificial reefs have been deployed off of Alabama since the early 1950's and we have experienced great success with them.

Bob
Laddie. You jokingly state putting a ship as a forest for birds. Don't they create areas above power lines just for nesting ospreys? Isn't that something artificial for the birds it does a great thing by providing a place to nest and produce young? Isn't placing

artificial reefs similar?

Steve/Florida Keys NMS
RE: [Bob] Artificial reefs create an area that is publicly and also privately known. This allows fishermen an area to fish that he can locate and where he feels he will have better access to the fish. In the case of private artificial reefs, the fisherman will utilize his own artificial reefs because he feels they are only know to him and he knows how to effectively farm and nourish his own reef. This results in far less pressure on natural reefs while also giving the benefits of increasing habitat, which will result in increased resources. As no reef is surrounded by a fence, all the species which inhabit artificial reefs are free to roam and help to replenish the natural reefs. Artificial reefs help to reduce pressure on natural reefs and the fishing and diving public are willing to pay for the use of artificial reefs as per the publication "Economic Impact and Importance of Artificial Reefs in Northwest Florida" by Dr. Frederick W. Bell, Dr. Mark A. Bonn, and Dr. Vernon R. Leeworthy.
Bob - another good point. However, we have had problem in the Florida Keys with fishermen creating their own "private" reefs with little or no regard to existing bottom habitat. When the creation of artificial reefs results in the destruction of existing natural bottom habitat, there is a net loss to the ecosystem.

Steve/Florida Keys NMS
RE: [Bob] To Steve re. tires. You mention especially when placed in shallow water. Doesn't this suggest that if tires, or any other artificial reefs, are placed in proper depths and locations they are likely to work well in increasing habitat and increasing resources and also be able to with stand adverse weather as well as natural reefs?
Bob, yes this is the case. However, it has been determined that there are better materials than tires in the creation of artificial reefs.

Lad at REEF
RE: [Bob] Laddie. You jokingly state putting a ship as a forest for birds. Don't they create areas above power lines just for nesting ospreys? Isn't that something artificial for the birds it does a great thing by providing a place to nest and produce young? Isn't placing artificial reefs similar?
Bob, I was referring to putting a battleship on land for that purpose. Yes the power lines do provide nesting areas for Ospreys here, but I don't think anyone would consider replacing degraded forests with those metal monstrosities. Let's just protect the natural ones! Thanks, everyone for letting me take part in this web chat. You had some great questions. Keep asking them! Lad

Steve/Florida Keys NMS
RE: [Bobbi] Steve, we have to remember that what is aesthetically pleasing to our eyes is different to marine organisms. I have underwater video of reef materials that you might refer to as dumping, but the marine life around these materials is awesome. They are looking for substrate where none exists and if the materials are not doing anything harmful to the environment and marine life grows and flourishes around it what possible harm can be done other than some people may say it is not aesthetically pleasing?

While we acknowledge that our perception of aesthetics is quite different than that of marine organisms, we do not advocate the dumping of construction debris in the marine environment. In order to ensure that artificial reefs are of continued benefit, many factors must be considered including, but not limited to, the cleanliness of the material being used and its long-term resistance to the perturbations of the marine environment.

Steve/Florida Keys NMS
RE: [Bob] To Steve. You state that artificial reefs are still in there infancy. Artificial reefs have been deployed in the panhandle of Florida for over 30 years. Liberty ships have been deployed in this are for that long as well. How many years do you consider to be infancy?
Bob, while artificial reefs have been sued for many years, their overall effect on the marine environment still has not yet been determined. While we may never know their full effect, I would say that targeted research in this area is still relatively new.

Bob
Steve. I would agree with you on the lack of research and also suggest that the lack of research is no reason to dismiss long proven anecdotal information from people who have placed hundreds of artificial reefs and the areas they have been placed and the benefits derived form them. More info is definitely needed but doesn't throw out the baby with the bath water. Lets continue to research and then decide what is best.

Bobbi
Steve, I certainly agree with you about the cleanliness of material being used and advocate that myself. However, I am not opposed to taking materials that have outlived their purpose on land and re-engineering them to provide much needed habitat for our ocean environment. However, I am interested in what you mean by long term. By that I mean if organisms are allowed to complete a life cycle around an artificial reef, doesn't that benefit the resources?

Lundie
North Carolina used tires bound by cable about 20 years ago. The cables have broken and after storms, hundreds of tires litter the beaches. This has been a major marine debris problem and the fall NC Big Sweep has documented the number of tires. Check their Web site.

Bob
Thanks for the opportunity to participate. I look forward to continued debate on this critical issue and hopefully resolve concerns for the future.

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