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Expedition Report: EX-21-04 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV and Mapping)

Northwest Atlantic
Newport, Rhode Island, to Newport, Rhode Island
June 30, 2021-July 29, 2021

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Abstract

The *2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts* expedition (EX-21-04) was a combined mapping and remotely operated vehicle (ROV) expedition to the seamounts of the Northwest Atlantic that took place between June 30 and July 29, 2021. Operations during this 30-day at-sea expedition included a combination of ROV dives as well as exploratory mapping operations in support of NOAA Ocean Exploration and partner priorities targeting areas containing no or poor-quality modern data. The initial focus for the expedition was on the U.S. Northeast seamount and high seas areas; however, during the expedition, weather altered the planned transect to outside Bermudan waters, where three dives took place before rejoining the originally planned dive sites. Ultimately, the expedition resulted in the exploration of a total of 19 seamounts and one canyon (Hydrographer) for water column exploration. During the expedition, 20 ROV *Deep Discoverer* dives were conducted from 300 to 4,187 meters water depth for a total of 154 hours of bottom time, and 54,710 square kilometers of seafloor were surveyed using the EM 304 multibeam sonar on NOAA Ship *Okeanos Explorer*. This report contains summaries of the operations, including mapping operations, outreach activities, and expedition schedule. All data associated with this expedition have been archived and are publicly available through the NOAA Archives.

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1. Introduction

NOAA Ocean Exploration is the only federal program dedicated to exploring the deep ocean, closing prominent gaps in our basic understanding of U.S. deep waters and the seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation and the global oceans.

Using the latest tools and technology, NOAA Ocean Exploration explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, NOAA Ocean Exploration allows scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. To better understand our ocean, NOAA Ocean Exploration makes exploration data available to the public. This allows us, collectively, to more effectively maintain ocean health, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

1.1 Atlantic Seafloor Partnership for Integrated Research and Exploration

Data collected during expeditions on NOAA Ship *Okeanos Explorer* from 2018-2021 directly contribute to the Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE), a major multiyear, multinational collaborative field program focused on raising collective knowledge and understanding of the North Atlantic Ocean. ASPIRE builds on the momentum of past U.S. campaigns and international initiatives to support ecosystem-based management of marine resources. ASPIRE also provides information relevant to NOAA's emerging Blue Economy priorities, which, in addition to ocean exploration, are seafood production, tourism and recreation, marine transportation, and coastal resilience.

2. Expedition Overview

From June 30, 2021, to July 29, 2021, NOAA Ocean Exploration and partners conducted a telepresence-enabled ocean exploration expedition on *Okeanos Explorer* to collect critical baseline information and improve knowledge about unexplored and poorly understood deepwater areas (>200 meters) of the Northwest Atlantic. EX-21-04 was part of a series of expeditions contributing to ASPIRE. Previous expeditions in this region include Mountains in the Sea 2004, 2005 North Atlantic Stepping Stones Expedition, New England Seamount Chain Exploration (EX-13-04 Leg 2), and Our Deepwater Background: Exploring Canyons and

Seamounts 2014 (EX-14-04 Leg 3). As such, EX-21-04 was designed to provide timely, actionable information to support decision-making based on reliable and authoritative science including to support SeaBed 2030 and the National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone (NOMEC). Like other ASPIRE expeditions, it also served as an opportunity for NOAA to highlight the uniqueness and importance of deepwater environments.

2.1 Rationale for Exploration

The New England and Corner Rise Seamount chains comprise a line of seamounts that extend from near the Mid-Atlantic Ridge to the eastern continental margin of the United States. Together with the deep sides of the Azores platform, these features constitute a nearly continuous series of submerged volcanic features along the otherwise flat plain of abyssal mud extending across the North Atlantic Ocean. Relative to the U.S. East Coast, the New England Seamounts are some of the most prominent and closest submerged features.

As part of the planning for this expedition, NOAA Ocean Exploration collaborated with the science and management communities to assess the exploration needs and data gaps in unknown and poorly known areas of the New England and Corner Rise Seamounts. To define the operating area for this expedition, NOAA Ocean Exploration considered the 2018 Call for Input, results from the 2018 ASPIRE Workshop (NOAA, n.d.a), and priorities from marine resource managers and the science community.

Both the New England Seamounts and Corner Rise Seamounts may serve as biological stepping stones between the eastern and western Atlantic ecosystems and offer refuge to transient fish populations. These seamounts likely also provide habitat for other organisms and may be hotspots of genetic diversity for deep-sea corals that are known to exist in deep water throughout the Atlantic. As these features border the United States and its Northeast Canyons and Seamounts Marine National Monument, it is important to explore them in order to inform management decisions and better understand connectivity with the surrounding waters. Exploration of these seamounts also offers an opportunity to collect valuable mapping data, learn more about their volcanic origins, geomorphology, and ferromanganese crust accretion in an area where only sparse data currently exist. Data and information from this expedition will help improve our understanding of the deep-ocean habitats of the Northwest Atlantic and the connections of biological communities throughout the Atlantic basin. It will also inform deep-sea management plans for marine protected areas (MPAs); support local scientists and managers seeking to understand and manage deep-sea resources; and stimulate subsequent exploration, research, and management activities.

This expedition also contributed to the ongoing collaboration with the Sargasso Sea Commission, as well as management of Essential Fish Habitats (EFH) and MPAs, including the Northeast Canyons and Seamounts Marine National Monument.

2.2 Objectives

The expedition addressed scientific themes and priority areas put forward by NOAA scientists and resource managers, the Office of Naval Research (ONR), the U.S. Geological Survey (USGS), and the broader ocean science community. The primary objective of the expedition was to survey deepwater areas of the New England and Corner Rise Seamounts in U.S. waters and the high seas to provide baseline information to support science and management needs. Specifically, this expedition sought to:

- Improve knowledge of unexplored areas within the U.S. Exclusive Economic Zone (EEZ) and the high seas to inform management needs regarding sensitive habitats, geological features, and potential resources.
- Locate and characterize deep-sea coral and sponge communities.
- Enhance predictive capabilities for vulnerable marine habitats and marine minerals.
- Extend seafloor mapping coverage in the U.S. EEZ and the high seas in support of Seabed 2030 and NOMEC.
- Increase understanding of the role New England and Corner Rise Seamounts play in deep-sea ecosystem connectivity across the Atlantic basin.
- Improve international collaboration and contribute to the Galway Statement on Atlantic Ocean Cooperation and the Atlantic Ocean Research Alliance's deep-sea mapping and exploration efforts.
- Collect high-resolution bathymetry in areas with no or low-quality mapping data.
- Acquire a foundation of ROV, sonar, and oceanographic data to better understand the characteristics of the water column and fauna that live within it.
- Engage a broad spectrum of the scientific community and the general public in telepresence-enabled exploration.
- Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.

Additionally, the 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts expedition will contribute to ASPIRE.

3. Participants

EX-21-04 included onboard mission personnel as well as shore-based science personnel who participated remotely via telepresence. See **Table 1** for the onboard personnel who supported

EX-21-04. See **Table 2** for the onshore mission team personnel who supported EX-21-04. Appendix A **Table A1** contains the shore-based personnel.

Table 1. EX-21-04 onboard mission team personnel.

Name	Title	Affiliation
Kasey Cantwell	Expedition Coordinator	NOAA Ocean Exploration
Kimberly Galvez	Expedition Coordinator in Training	NOAA Ocean Exploration/Cherokee Federal
Rhian Waller	Science Lead	University of Maine
Shannon Hoy	Mapping Lead	NOAA Ocean Exploration/Cherokee Federal
Dan Freitas	Mapping Watch Lead	University Corporation for Atmospheric Research (UCAR)
Chris Ritter	Global Foundation for Ocean Exploration Operations Manager	Global Foundation for Ocean Exploration
Sean Kennison	Engineering Team	Global Foundation for Ocean Exploration
Jon Mefford	Engineering Team	Global Foundation for Ocean Exploration
Josh Carlson	Engineering Team	Global Foundation for Ocean Exploration
Lars Murphy	Engineering Team	Global Foundation for Ocean Exploration
Anya Jensen	Engineering Team	Global Foundation for Ocean Exploration
Levi Unema	Engineering Team	Global Foundation for Ocean Exploration
Chris Wright	Engineering Team	Global Foundation for Ocean Exploration
Jim Meyers	Engineering Team	Global Foundation for Ocean Exploration
Roland Brian	Video Engineering Team	Global Foundation for Ocean Exploration
Bob Knott	Video Engineering Team	Global Foundation for Ocean Exploration

Art Howard	Video Engineering Team	Global Foundation for Ocean Exploration
Emily Narrow	Video Engineering Team	Global Foundation for Ocean Exploration

Table 2. EX-21-04 shore-based mission team personnel.

Name	Title	Affiliation
Kira Mizell	Science Lead	United States Geological Survey (USGS)
Jason Chaytor	Science Lead	United States Geological Survey (USGS)
Emily Crum	Web Coordinator	NOAA Ocean Exploration/Cherokee Federal
Christa Rabenold	Communications Coordinator	NOAA Ocean Exploration/UCAR

4. Methodology

To accomplish the objectives, EX-21-04 used:

- NOAA Ocean Exploration's dual-bodied ROV system (*Deep Discoverer* and *Seirios*) to conduct daytime seafloor and water column surveys, and to collect a limited number of samples to help further characterize the deepwater fauna and geology of the region.
- Sonar systems (Kongsberg EM 304 multibeam sonar, Knudsen 3260 sub-bottom profiler, Simrad EK60/80 split-beam sonars, and Teledyne acoustic Doppler current profilers) to conduct mapping operations at night and when the ROVs were on deck.
- A high-bandwidth satellite connection to provide real-time ship-to-shore communications (telepresence).

All environmental data collected by NOAA must be covered by a data management plan to ensure the data are archived and publicly accessible. The data management plan for EX-21-04 is included in the "Project Instructions: EX-21-04, 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV and Mapping)" (Galvez and Cantwell, 2021).

4.1 ROV Seafloor Surveys

ROV dive operations supported the expedition objectives in Section 2.2 and included high-resolution visual surveys of seafloor and water column habitats as well as geological and biological sampling. During each benthic dive, the ROVs descended to the seafloor and then moved from waypoint to waypoint, documenting the geology and biology of the area. Each ROV dive was approximately 8-10 hours long, conditions and logistics permitting. Dives were primarily conducted during the day (operations described in detail by Quattrini et al., 2015 and Kennedy et al., 2019). Additional information about the general process of site selection,

collaborative dive planning, scientific equipment on the ROVs, and the approach to benthic exploration used on *Okeanos Explorer* can be found in Kennedy et al. (2019).

Onboard and shore-based scientists identified encountered organisms to the lowest taxon possible based on data available during real-time assessment. Additionally, they provided geological interpretations of the observed substrate throughout each ROV seafloor survey. These geological and biological observations were recorded using Ocean Networks Canada's SeaTube.

For water column exploration, a series of transects were conducted during a dedicated water column exploration dive. Transects primarily targeted the deep scattering layer and the waters directly above and below it. A standard set of deeper transects were also completed at 900, 700, 500, and 300 meters, and specific transect depths (1,200 and 630 meters), were decided through an evaluation of the Simrad EK60/EK80 data ; ROV conductivity, temperature, depth (CTD) data; and the acoustically determined position of the deep scattering layer. The length of time of the transects varied between 20 and 75 minutes at each depth, depending on the specific objectives for water column exploration, conditions, and seafloor depth. Specific transect depths and times are noted in each dive summary (see Section 7.1.1 for access information).

4.2 Sampling Operations

A limited number of geological and biological samples were collected on the seafloor and during water column exploration using ROV *Deep Discoverer*'s five-chamber suction sampler and two manipulator arms in conjunction with geological and biological collection boxes. The primary goal of the sampling operations was to collect voucher samples to be made publicly available for site characterization.

For each sample collected, the date, time, latitude, longitude, depth, salinity, temperature, and dissolved oxygen content were recorded at the time of collection. Geological samples were acquired for purposes of age dating, geochemical, and composition analyses. Biological collections targeted samples that represented potential new species, range extensions of organisms not previously known to occur in the region, dominant species at the site, and/or rare morphotypes. Samples intended to contribute to transatlantic connectivity studies were also collected.

After vehicle recovery, samples were examined for associated organisms, labeled, photographed, and entered into a database with all relevant metadata. Any associated organisms were separated from primary samples and processed separately as "associate" samples.

Geological samples were air dried and placed in rock bags or small containers depending on the size of the sample. These samples were shipped to the Marine and Geological Repository at Oregon State University (OSU) after the conclusion of the expedition aboard *Okeanos Explorer*. The samples will be photographed, and their data will be entered into the university's online database. Thin and polished sections will be made for some hard-rock samples. Descriptions and photos are included in the database.

Biological samples were subsampled for inclusion in the Smithsonian's National Museum of Natural History Biorepository for future barcoding and DNA extraction. For this purpose, a small subsample was removed from the original sample and placed in 95% analytical grade ethanol (EtOH).

For most of the biological samples, the remainder of each sample was also preserved in 70% or 95% EtOH. For select taxa, vouchers or subsamples were preserved in 10%, 5%, or 4% buffered formalin per recommendation from taxonomic experts and guidance provided by the Smithsonian's National Museum of Natural History. Full details of the preservation of each biological sample are in the associated metadata record. All voucher samples and subsamples were shipped to the Smithsonian's National Museum of Natural History for long-term archiving and public access.

4.3 Acoustic Operations

Acoustic operations included Kongsberg EM304 multibeam, Simrad EK60/EK80 split-beam, Knudsen 3260 sub-bottom profiler, and acoustic Doppler current profiler (ADCP) data collection. The schedule of mapping operations included overnight transits and whenever the ROVs were on deck. Tracklines were planned to maximize edge matching of existing data or filling of data gaps in areas with incomplete bathymetry coverage. In regions with no existing data, exploration transit lines were planned to optimize potential discoveries. Targeted mapping operations were conducted in the vicinity of the New England and Corner Rise Seamounts.

An associated "Mapping Data Acquisition and Processing Summary Report" provides a summary of mapping operations that occurred during this expedition and is archived in the NOAA Central Library (Hoy et al., 2021).

A detailed description of *Okeanos Explorer's* mapping equipment and capabilities is available in the "NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2021," which is archived in the NOAA Central Library (Candio et al., 2021).

For further information about general equipment calibration procedures, data acquisition, processing, reporting, and archiving, see the "NOAA Ocean Exploration Deepwater Exploration

Mapping Procedures Manual V1," which is archived in the NOAA Central Library and also available from the website (Hoy et al., 2020).

4.3.1 Multibeam Sonar (Kongsberg EM 304)

Multibeam seafloor mapping data were collected using the Kongsberg EM 304 MKII sonar, which operates at a nominal frequency of 26 kHz. Multibeam mapping operations were conducted during all overnight transits between ROV dive sites. Multibeam data quality was monitored in real time by acquisition watchstanders. Ship speed was adjusted to maintain data quality as necessary.

Whenever possible, transits were designed to maximize coverage over seafloor areas with no previous high-resolution mapping data. In these focus areas, line spacing was generally planned to ensure 25% overlap between lines at all times. Cutoff angles in the Seafloor Information System (SIS) software were generally adjusted on both the port and starboard sides to ensure the best balance between data quality and coverage. Overnight surveys were also completed in areas that were previously mapped with a lower-resolution multibeam sonar system.

Additionally, multibeam mapping operations were conducted directly over planned ROV dive sites to collect seafloor mapping data to refine dive plans and provide high-resolution maps for safe navigation of the vehicle. These operations collected seafloor depth (bathymetry), seafloor acoustic reflectivity (seafloor backscatter), and water column reflectivity (water column backscatter).

Background data used to guide exploratory multibeam mapping operations included mapping data collected during *Okeanos Explorer* expeditions, notably 2005 North Atlantic Stepping Stones Expedition, EX-13-03, EX-14-04 Legs 1 and 3; data collected by Research Vessel *Atlantis* within the New England Seamounts (AT07L35, AT08) and Corner Rise Seamounts (AT40-03, AT42-01, AT20); data collected by Research Vessel *Neil Armstrong* (AR23-01, AR23-02); and data collected by Research Vessel *Knorr* (KN188-01, KN18802, KN180L02). Some dive planning and mapping operations were conducted using bathymetric grids created using all available bathymetry archived at NOAA's National Centers for Environmental Information (NCEI). Sandwell and Smith satellite altimetry data were also used for regional planning. Additionally, in advance of each day's dive new bathymetry data was collected over the dive site to improve resolution and quality for safe vehicle operations. During many of the dives in the high seas, the bathymetry data revealed local topography in better detail, which ultimately changed the planned dive tracks.

4.3.2 Sub-Bottom Profiler (Knudsen Chirp 3260)

The purpose of the Knudsen Chirp 3260 (3.5 kHz) sonar is to image subseafloor sediment layers to a maximum depth of about 80 meters below the seafloor, depending on the specific sound speed of the substrate. The sub-bottom profiler was operated simultaneously with the multibeam sonar during mapping operations to provide supplemental information about subseafloor geological structure. The Atlantis II Seamount was targeted for a focused survey as part of an effort to support on-going Office of Naval Research Task Force Ocean and Ocean Acoustics basic research activities in the region.

4.3.3 Split-Beam Sonars (Simrad EK60/EK80)

Okeanos Explorer is equipped with five split-beam transducers, three Simrad EK60 general purpose transceivers (GPT) and two Simrad EK80 wideband transceivers (WBT). The frequencies of the GPTs are 18, 38, 120, and 200 kHz. The frequencies of the WBTs are 38 and 70 kHz. A detailed description of the calibration report onboard *Okeanos Explorer* is available in the "2021 NOAA Ship *Okeanos Explorer* EK60/80 Calibration Report," which is archived in the NOAA Central Library (Copeland et al., 2021).

These sonars were used continuously throughout EX-21-04 during both overnight mapping operations and daytime ROV operations. The sonars provided calibrated target strength measurements of water column features such as dense biological layers and schools of fish. EK60/EK80 data were also used during the midwater transect of ROV dives to detect the depth of the deep scattering layers, which are aggregations of biological organisms in the water column.

4.3.4 Acoustic Doppler Current Profiler (Teledyne Workhorse Mariner and Teledyne Ocean Surveyor ADCPs)

Okeanos Explorer is equipped with two ADCPs: a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz). The ADCPs provide information on the speed and direction of currents underneath the ship. The Teledyne Workhorse Mariner (300kHz) was used throughout ROV dives to support safe deployment and recovery of the vehicles. The Teledyne Ocean Surveyor (38kHz) ADCP was not functioning during this expedition. The ADCPs were not used during multibeam mapping due to sonar interference with the EM 304 multibeam sonar.

4.3.5 Expendable Bathythermograph (XBT) Systems

Sound speed profiles were conducted every four hours or more frequently as dictated by local oceanographic conditions (typically every two hours when operating near currents). Surface sound speed was obtained using a Reson SV-70 probe.

4.4 Conductivity, Temperature, and Depth

Conductivity, temperature, and depth measurements were collected during the expedition. The most frequent method was with the integrated ROV CTD system. This system records data from the CTD and associated sensors on every dive. Additional sensors installed on both of the CTDs include measured light scattering (LSS), dissolved oxygen (DO), and oxygen reduction potential (ORP).

4.5 Sun Photometer Measurements

NOAA Ocean Exploration gathers limited at-sea measurements aboard *Okeanos Explorer* to support a NASA-led, long-term research effort that assesses marine aerosols. As time allows on cloud-free days, onboard personnel collect georeferenced sun photometer measurements for the Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET). AERONET is a network of sun photometers that measure atmospheric aerosol properties around the world. MAN complements AERONET by conducting sun photometer measurements on ships of opportunity to monitor aerosol properties over the global ocean.

5. Clearances and Permits

Pursuant to the National Environmental Policy Act (NEPA), NOAA Ocean Exploration is required to include in its planning and decision-making processes appropriate and careful consideration of the potential environmental consequences of actions it proposes to fund, authorize, and/or conduct. The companion manual for NOAA Administrative Order 216-6A describes the agency's specific procedures for NEPA compliance.

An environmental review memorandum was completed for all *Okeanos Explorer* expeditions in 2021 in accordance with Section 4 of the companion manual in the form of a categorical exclusion worksheet (Appendix B1). Based on this review, a categorical exclusion was determined to be the appropriate level of NEPA analysis necessary, as no extraordinary circumstances existed that required the preparation of an environmental assessment or environmental impact statement. NOAA Ocean Exploration is preparing a programmatic environmental assessment to cover future expeditions.

NOAA Ocean Exploration conducted an analysis on the potential impacts to marine mammal species as a result of *Okeanos Explorer*'s oceanographic research and seafloor mapping under the Marine Mammal Protection Act (MMPA). It was determined that, due to the high-frequencies, narrow beamwidths, relatively low source levels of the onboard sonars, and transient nature of the expeditions, it is unlikely that activities aboard *Okeanos Explorer* would meet the definition of harassment under the MMPA.

As required under Section 7 of the Endangered Species Act (ESA), NOAA Ocean Exploration conducted an informal consultation with the National Marine Fisheries Service (NMFS) Office of Protected Resources to request their concurrence with NOAA Ocean Exploration's biological evaluation determining that *Okeanos Explorer* operations conducted as part of ASPIRE may affect, but are not likely to adversely affect, ESA-listed marine species. In a letter dated February 3, 2021 (Appendix B2), the chief of the ESA Interagency Cooperation Division in the NMFS Office of Protected Resources wrote that NMFS concurs with NOAA Ocean Exploration's determination that proposed ASPIRE expeditions are not likely to adversely affect ESA-listed marine species.

In addition, NOAA Ocean Exploration consulted with the NMFS Greater Atlantic Regional Fisheries Office (GARFO) on potential impacts of ASPIRE operations to essential fish habitat (EFH) in the Greater Atlantic Region between April 1, 2021, and September 31, 2021, under the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Ocean Exploration received a letter of acknowledgement from GARFO on March 10, 2021, that covers expedition activities through September 31, 2021 (Appendix B3).

No archaeological data was collected, and as such, no data from this expedition are restricted.

6. Schedule and Map

EX-21-04 consisted of a total of 30 days at sea, from June 30, 2021, to July 29, 2021. It started and ended in Newport, Rhode Island. See **Table 3** for a day-by-day breakdown of EX-21-04. There were 25 scheduled dives, and 20 dives were achieved (see **Tables 6 and 7** for details), with dives being lost due to significant weather and conditions that prevented safe operation of the ROV systems and at times deteriorated mapping data quality to a point where sonar operations were also secured. See **Figure 1** for a map of EX-21-04's track, dive sites, and bathymetry collected. Note that all named seamounts in quotation marks (e.g. "North Bermuda Triptop") are unofficial.

Table 3. EX-21-04 schedule.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6/27	**6/28** Move aboard day for new personnel Outreach: Inner Space Center Interns and National Ocean Sciences Bowl	**6/29** Alongside mobilization/ preparation	**6/30** Depart Newport, RI Transit mapping	**7/01** Transit mapping Outreach: Facebook Live event Sonar operations secured for troubleshooting	**7/02** Dive cancelled Transit mapping Sonar operations secured	**7/03** Dive 01: "North Bermuda Tritop" Seamount Overnight mapping operations
7/04 Transit mapping	**7/05** Dive 02: Congress "south" Seamount Overnight mapping operations	**7/06** Dive 03: "Hopscotch" Seamount Overnight mapping operations	**7/07** Dive 04: "Dumbbell" Guyot Overnight mapping operations Outreach: Institute for Journalism & Natural Resources Workshop	**7/08** Dive 05: Rockaway Seamount Overnight mapping operations Outreach: Knauss Fellow Q&A	**7/09** Dive 06: Castle Rock Seamount Overnight mapping operations Outreach: All-Atlantic Pledge event	**7/10** Dive 07: "Corner Rise 1" Seamount High flyer collected Overnight mapping operations
7/11 Dive 08: MacGregor Seamount Overnight mapping operations	**7/12** Dive 09: Yakutat "shallow" Seamount Overnight mapping operations	**7/13** Dive 10: Yakutat "deep" Seamount Overnight mapping operations	**7/14** Dive 11: Caloosahatchee Ridge Overnight mapping operations Outreach: NOAA Ocean Exploration public live event	**7/15** Dive cancelled Transit mapping	**7/16** Transit mapping Outreach: Sea Education Association classroom interaction	**7/17** Dive 12: "Y" Seamount Overnight mapping operations
7/18 Dive 13: "Next to Hodgsen" Seamount Overnight mapping operations	**7/19** Dive 14: "Seven" Seamount Overnight mapping operations	**7/20** Dive 15: Allegheny Seamount Overnight mapping operations	**7/21** Dive cancelled Transit mapping Sonar operations secured due to weather	**7/22** Dive cancelled Transit mapping Sonar operations secured due to weather	**7/23** Dive 16: Gosnold Seamount Focused seamount mapping and transit mapping	**7/24** Dive 17: Gosnold "shallow" Seamount Overnight mapping operations

Table 3 continued. EX-21-04 schedule.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
7/25 Dive 18: "Asterina" Seamount Overnight mapping operations	**7/26** Dive cancelled Transit mapping Sonar operations secured due to weather (subbottom continued recording)	**7/27** Dive 19: Retriever Seamount Overnight mapping operations Sonar operations secured due to weather Outreach: Panel discussion with USFWS and Mystic Aquarium	**7/28** Dive 20: Water column - Hydrographer Canyon	**7/29** Arrive Newport, RI	**7/30**	**7/31**

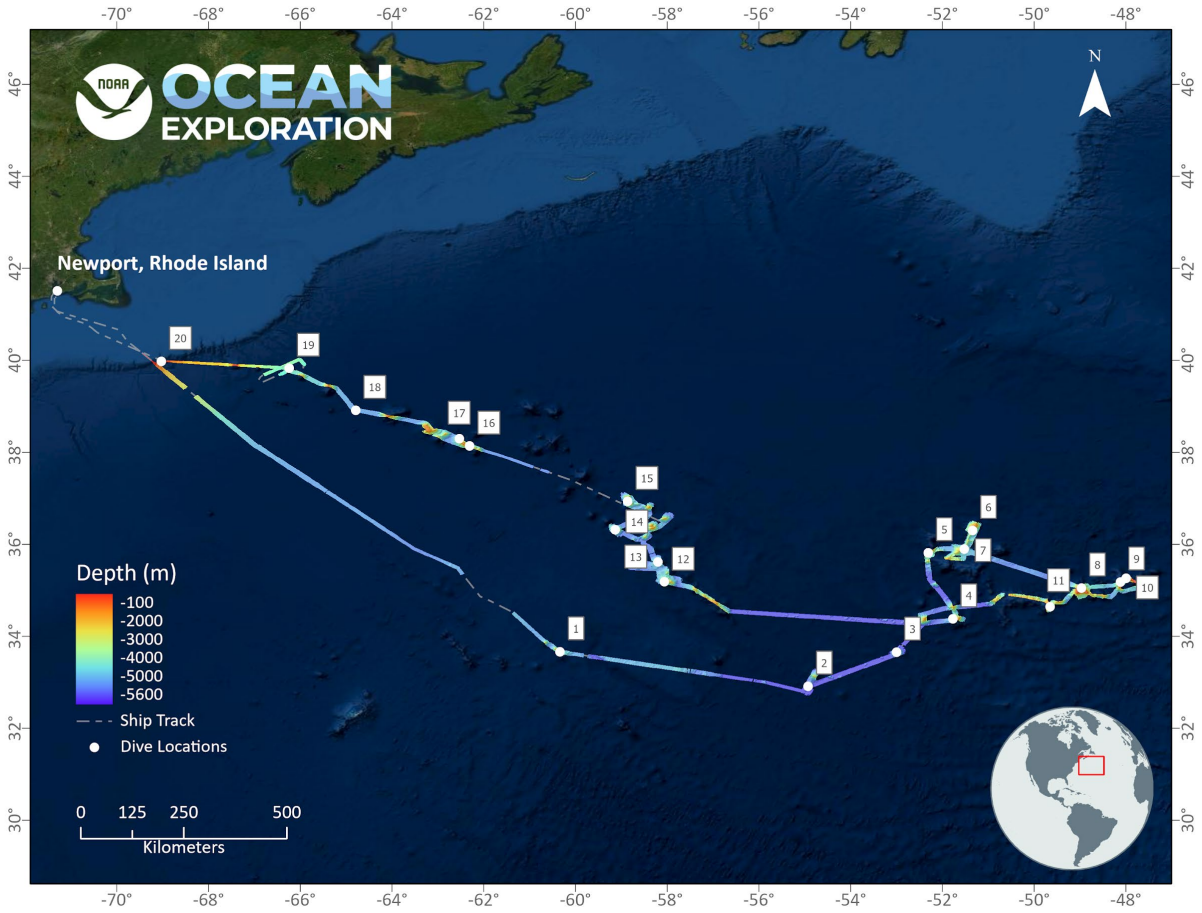

Figure 1. Map showing EX-21-04's track, 20 ROV dive sites, and bathymetry data collected. *Figure created using ArcGIS.*

7. Results

Metrics for EX-21-04's major exploration and scientific accomplishments are summarized in **Tables 4 and 5**. More detailed results are presented in the subsections that follow.

Table 4. Summary of exploration metrics for EX-21-04.

Exploration Metrics	Totals
Days at sea	30
Days at sea in U.S. waters	5
Linear km mapped by EM 304	7,025.8
Square km mapped by EM 304	54,709.7

Square km mapped by EM 304 in U.S. waters	4,109.5
Vessel CTD casts	0
XBT casts	133
ROV dives	20
ROV dives in U.S. waters	2
Maximum ROV seafloor depth (m)	4,187
Minimum ROV seafloor depth (m)	300
Total time on bottom (hh:mm:ss)	86:31:05
Water column survey time (hh:mm:ss)	6:43:41
Total ROV time (hh:mm:ss)	153:40:24

Table 5. Summary of scientific metrics for EX-21-04: The first five metrics are also included as scientific metrics in Table 6.

Scientific Metrics	Totals
Potential undescribed or novel species and new records observed*	24
Dives during which living corals and sponges were observed	19
Dives during which chemosynthetic communities were observed	0
Dives during which active seeps/vents were observed	0
Dives during which diverse benthic communities were observed	9
Total samples	123
Biological samples (primary)	45
Biological associate samples	24
Geological samples (primary)	48
Geological associate samples	6
Actively participating scientists, students, and resource managers	90

* Organisms unknown to science or an extension of their known range of geolocation or depth.

7.1 ROV Survey Results

Depth ranges explored during the 20 ROV surveys were between 300 and 4,187 meters. During the 20 dives, the ROVs spent a total of 86.5 hours on the bottom and 6.75 hours conducting water column exploration. See **Tables 6 and 7** for dive-specific information.

Table 6. Summary information for the 20 ROV dives conducted during EX-21-04.

Dive #	Site Name	Date (yyyymmdd)	On Bottom Latitude (dd)	On Bottom Longitude (dd)	Max Depth (m)	Dive Duration (hh:mm:ss)	Bottom Time (hh:mm:ss)	Water Column Exploration Time (hh:mm:ss)
1	"North Bermuda Tritop"	7/3/21	33.66116°	-060.33575°	2592	7:32:00	4:28:28	0:00:00
2	Congress Seamount “South Peak”	7/5/21	32.92230°	-054.91399°	2815	8:14:20	4:54:05	0:00:00
3	"Hopscotch"	7/6/21	33.67644°	-052.99544°	2640	7:56:51	4:49:36	0:00:00
4	"Dumbbell"	7/7/21	34.39158°	-051.77518°	2412	8:15:54	5:15:39	0:00:00
5	Rockaway Seamount	7/8/21	35.81691°	-052.30754°	4187	8:09:08	3:11:28	0:00:00
6	Castle Rock	7/9/21	36.30087°	-051.34720°	2331	8:16:06	5:36:50	0:00:00
7	“Corner Rise 1”	7/10/21	35.88766°	-051.52234°	2594	7:37:52	4:36:14	0:00:00
8	MacGregor Seamount	7/11/21	35.05256°	-048.97057°	1272	7:49:52	4:49:57	0:00:00
9	Yakutat Seamount “Shallow”	7/12/21	35.18092°	-048.11720°	1366	8:06:40	5:53:22	0:00:00
10	Yakutat Seamount “Deep”	7/13/21	35.26536°	-048.00233°	1983	8:15:54	5:36:23	0:00:00
11	Caloosahatchee Seamount	7/14/21	34.65030°	-049.65092°	1247	5:24:53	3:44:21	0:00:00
12	"Y" Seamount	7/17/21	35.22067°	-058.03379°	2807	8:13:51	4:58:18	0:00:00
13	“Next to Hodgsen”	7/18/21	35.61283°	-058.20342°	2531	8:30:41	5:14:11	0:00:00
14	"Seven" Seamount	7/19/21	36.34806°	-059.11858°	2144	8:17:42	5:36:08	0:00:00
15	Allegheny Seamount	7/20/21	36.93040°	-058.85859°	3447	7:37:00	3:34:13	0:00:00
16	Gosnold	7/23/21	38.13459°	-062.30428°	3238	8:00:15	3:55:01	0:00:00
17	Gosnold "Shallow"	7/24/21	38.29397°	-062.53314°	1783	7:06:17	4:48:04	0:00:00
18	"Asterina" Seamount	7/25/21	38.92694°	-064.82043°	3792	5:07:03	0:39:32	0:00:00
19	Retriever Seamount	7/27/21	39.83891°	-066.22864°	1936	8:24:24	4:49:15	0:00:00
20	Hydrographer Canyon (water column)	7/28/21	39.98367°	-069.00966°	1195	6:43:41	0:00:00	6:43:41

Table 7. Summary of scientific metrics for the 20 ROV dives conducted during EX-21-04: Potential undescribed or novel species and new records observed, dives during which living corals and sponges were observed, dives during which chemosynthetic communities were observed, dives during which active seeps/vents were observed, dives during which diverse benthic communities were observed, and samples collected.

Dive #	Site Name	Undescribed Species	Corals & Sponges	Chemo-synthetic Community	Active Seeps & Vents	Diverse Benthic Community	Primary Biological Samples	Associate Biological Samples	Primary Geological Samples	Associate Geological Samples
1	"North Bermuda Tritop"	yes	yes	no	no	yes	4	0	3	0
2	Congress Seamount "South Peak"	yes	yes	no	no	no	2	0	2	0
3	"Hopscotch"	no	yes	no	no	yes	2	0	2	0
4	"Dumbbell"	yes	yes	no	no	yes	3	0	2	0
5	Rockaway Seamount	yes	yes	no	no	no	2	0	3	0
6	Castle Rock	yes	yes	no	no	yes	2	2	3	0
7	"Corner Rise 1"	yes	yes	no	no	no	1	0	3	1
8	MacGregor Seamount	yes	no	no	no	yes	2	5	2	0
9	Yakutat Seamount "Shallow"	yes	yes	no	no	no	4	2	2	0
10	Yakutat Seamount "Deep"	yes	yes	no	no	no	1	1	3	2
11	Caloosahatchee Seamount	no	yes	no	no	yes	1	1	3	0
12	"Y" Seamount	yes	yes	no	no	no	2	0	2	1
13	"Next to Hodgsen"	no	yes	no	no	no	0	0	2	0
14	"Seven" Seamount	yes	yes	no	no	no	3	1	2	0
15	Allegheny Seamount	yes	yes	no	no	yes	3	0	3	0
16	Gosnold	yes	yes	no	no	no	2	5	4	1
17	Gosnold "Shallow"	no	yes	no	no	yes	1	4	3	0

18	"Asterina" Seamount	no	yes	no	no	no	1	0	2	1
19	Retriever Seamount	yes	yes	no	no	yes	1	3	2	0
20	Hydrographer Canyon (water column)	yes	no	no	no	no	5	0	0	0

7.1.1 Accessing ROV Data

NOAA Ocean Exploration Digital Atlas

ROV data from EX-21-04 are archived at NCEI and available through NOAA Ocean Exploration's Digital Atlas. To access these data, click on the Search tab, enter "EX2104" in the Enter Search Text field, and click Search. Click on the point that represents EX-21-04 to access data options. In the pop-up window, select the ROV Data Access tab for links to the ROV dive data, which is organized by dive.

NCEI Archival Dataset

The EX-21-04 NCEI Archival dataset is an alternate resource for the ship and ROV data collected during the expedition. This dataset contains data collected from shipboard sensors including navigational data, meteorological data (wind), and oceanographic data (bathythermograph, sound velocity probe, thermosalinograph). Additional data include profile data (ASVP, CTD, and XBT), event logs, images, ROV ancillary data, and sample data.

ROV Dive Summaries

Individual ROV dive summaries and associated ROV dive data are archived at NCEI and available on the EX-21-04 pages of the Okeanos Explorer ROV Expeditions website.

ROV Dive Video

To search, preview, and download dive video for *Okeanos Explorer*, go to the NOAA Ocean Exploration Video Portal.

SeaTube

NOAA Ocean Exploration works closely with Ocean Networks Canada to implement SeaTube, a web-based annotation interface for ROV operations on expeditions aboard *Okeanos Explorer*. SeaTube is the digital equivalent to a scientist's logbook. It is used by onboard and shore-based scientists to log real-time observations on a variety of topics. To watch a video of a dive and search and export annotations, click on the "Expeditions" tree and select "NOAA," "2021," and "NOAA OER EX2104 (Jun 2021)". To play an individual dive, hover the mouse over the desired dive and press the play icon (triangle). To search, click the magnifying glass icon in the top right

corner of the list pane, or hover the mouse over the desired dive and press the magnifying glass icon.

7.2 Sampling Operations Results

A total of 123 samples were collected during EX-21-04: 54 geological primary samples, 45 biological primary samples, and 30 associate samples (see **Table 7** for more cumulative results).

The geological samples included carbonate rocks, ferromanganese crusted rocks, and ferromanganese nodules. See **Table 8** for full details of the geological samples collected.

There were 45 biological samples that were purposely collected (primary samples), as well as 24 samples that were incidentally collected (associate samples). In total, these samples amounted to 69 individuals. The biological samples included corals, sponges, echinoderms, jellyfish, and siphonophores. See **Table 9** for full details of the biological samples collected.

Table 8. Inventory of geological samples collected during EX-21-04.

Dive #	Site Name	Sample #	Sample Field ID	Preservation	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
1	"North Bermuda Tritop"	EX2104_D01_01G	FeMn crusted rock	Rinsed and Dried	Characteristic of Site	20210703	151856	33.66095	-60.33573	2570.42	1.30
1	"North Bermuda Tritop"	EX2104_D01_05G	Rock	Rinsed and Dried	Characteristic of Site	20210703	175412	33.65900	-60.33490	2436.28	3.11
1	"North Bermuda Tritop"	EX2104_D01_06G	Manganese Crust	Rinsed and Dried	Characteristic of Site	20210703	175608	33.65907	-60.33475	2435.50	8.05
2	Congress Seamount	EX2104_D02_01G	FeMn encrusted rock	Rinsed and Dried	Characteristic of Site	20210705	143423	32.92215	-54.91394	2815.61	1.30
2	Congress Seamount	EX2104_D02_03G	Angular Rock	Rinsed and Dried	Characteristic of Site	20210705	164114	32.92159	-54.91491	2730.15	2.05
3	"Hopscotch" Seamount	EX2104_D03_01G	Rock with FeMn crust	Rinsed and Dried	Characteristic of Site	20210706	150548	33.67620	-52.99456	2618.91	0.43
3	"Hopscotch" Seamount	EX2104_D03_03G	Basalt sample	Rinsed and Dried	Characteristic of Site	20210706	180821	33.67641	-52.99289	2485.61	2.81
4	"Dumbbell" Seamount	EX2104_D04_03G	Rock encrusted in FeMn	Rinsed and Dried	Characteristic of Site	20210707	175205	34.39127	-51.77323	2330.28	0.16
4	"Dumbbell" Seamount	EX2104_D04_04G	Loose rock: Potential Ice Raft Debris	Rinsed and Dried	Characteristic of Site	20210707	180242	34.39129	-51.77286	2326.29	6.00
5	Rockaway Seamount	EX2104_D05_01G	Deep Rock Sample	Rinsed and Dried	Characteristic of Site	20210708	151948	35.81690	-52.30753	4171.04	0.70
5	Rockaway Seamount	EX2104_D05_04G	Rock sample with FeMn crust	Rinsed and Dried	Characteristic of Site	20210708	172220	35.81802	-52.30635	4165.71	0.67
5	Rockaway Seamount	EX2104_D05_05G	Rock Landslide	Rinsed and Dried	Characteristic of Site	20210708	180727	35.81894	-52.30563	4114.13	2.51
6	Castle Rock Seamount	EX2104_D06_01G	Angular rock	Rinsed and Dried	Characteristic of Site	20210709	140219	36.30094	-51.34750	2325.07	1.44
6	Castle Rock Seamount	EX2104_D06_03G	Coral Rubble and Sediment	Rinsed and Dried	Characteristic of Site	20210709	165649	36.30089	-51.34941	2182.82	-

Dive #	Site Name	Sample #	Sample Field ID	Preservation	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
6	Castle Rock Seamount	EX2104_D06_05G	Rock with FeMn crust	Rinsed and Dried	Characteristic of Site	20210709	182010	36.30082	-51.35053	2126.31	2.40
7	"Corner Rise 1" Seamount	EX2104_D07_01G	Carbonate Sample	Rinsed and Dried	Characteristic of Site	20210710	152035	35.88789	-51.52142	2586.73	3.90
7	"Corner Rise 1" Seamount	EX2104_D07_02G	Basalt Rock	Rinsed and Dried	Characteristic of Site	20210710	163620	35.88830	-51.52076	2569.22	32.80
7	"Corner Rise 1" Seamount	EX2104_D07_03G	Fossil Desmophyllum dianthus	Rinsed and Dried	Characteristic of Site	20210710	181131	35.88862	-51.52038	2475.10	0.20
7	"Corner Rise 1" Seamount	EX2104_D07_03G_A01	Biogenic Sediment	Rinsed and Dried	Not Applicable	20210710	181131	35.88862	-51.52038	2475.10	-
8	MacGregor Seamount	EX2104_D08_01G	Carbonate Conglomerate Rock	Rinsed and Dried	Characteristic of Site	20210711	155808	35.05280	-48.97148	1269.37	1.49
8	MacGregor Seamount	EX2104_D08_04G	Basalt Rock	Rinsed and Dried	Characteristic of Site	20210711	190105	35.05493	-48.97666	947.94	7.68
9	Yakutat Seamount "shallow"	EX2104_D09_01G	Carbonate sample	Rinsed and Dried	Characteristic of Site	20210712	142443	35.18092	-48.11673	1364.86	2.11
9	Yakutat Seamount "shallow"	EX2104_D09_04G	Carbonate rock slab	Rinsed and Dried	Characteristic of Site	20210712	180813	35.17869	-48.11702	1233.39	3.36
10	Yakutat Seamount "deep"	EX2104_D10_01B_A01	fossilized coral	Rinsed and Dried	Not Applicable	20210713	162611	35.26386	-48.00228	1893.04	0.01
10	Yakutat Seamount "deep"	EX2104_D10_01B_A02	shell pieces	Rinsed and Dried	Not Applicable	20210713	162611	35.26386	-48.00228	1893.04	0.00
10	Yakutat Seamount "deep"	EX2104_D10_02G	FeMn Covered Rock	Rinsed and Dried	Characteristic of Site	20210713	170618	35.26377	-48.00227	1867.24	4.10
10	Yakutat Seamount "deep"	EX2104_D10_03G	Coral rubble	Rinsed and Dried	Characteristic of Site	20210713	190648	35.26225	-48.00171	1723.52	0.00
10	Yakutat Seamount "deep"	EX2104_D10_04G	rounded dropstone	Rinsed and Dried	Characteristic of Site	20210713	192958	35.26203	-48.00108	1699.12	3.90

Dive #	Site Name	Sample #	Sample Field ID	Preservation	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
11	Caloosahatchee Seamount	EX2104_D11_02G	Carbonate Conglomerate	Rinsed and Dried	Characteristic of Site	20210714	172404	34.65069	-49.65183	1233.68	0.47
11	Caloosahatchee Seamount	EX2104_D11_03G	Rock with carnivorous tunicate	Rinsed and Dried	New or Unusual Morphotype	20210714	172948	34.65076	-49.65186	1231.52	0.37
11	Caloosahatchee Seamount	EX2104_D11_04G	FeMn Crust	Rinsed and Dried	Characteristic of Site	20210714	185004	34.65144	-49.65344	1210.61	0.05
12	"Y" Seamount	EX2104_D12_02G	Rock FeMn Crust	Rinsed and Dried	Characteristic of Site	20210717	142906	35.22059	-58.03368	2808.88	1.70
12	"Y" Seamount	EX2104_D12_03G	Rock from wasting area FeMn crust	Rinsed and Dried	Characteristic of Site	20210717	152731	35.22072	-58.03422	2777.63	3.61
12	"Y" Seamount	EX2104_D12_03G_A01	FeMn Crust	Rinsed and Dried	Not Applicable	20210717	152731	35.22072	-58.03422	2777.63	0.95
13	"Next to Hodgsen" Seamount	EX2104_D13_01G	Large FeMn coated rock	Rinsed and Dried	Characteristic of Site	20210718	141940	35.61132	-58.20641	2533.67	0.30
13	"Next to Hodgsen" Seamount	EX2104_D13_02G	Botryoidal FeMn	Rinsed and Dried	Characteristic of Site	20210718	170744	35.61302	-58.20668	2422.98	3.05
14	"Seven" Seamount	EX2104_D14_01G	FeMn Covered Rock	Rinsed and Dried	Characteristic of Site	20210719	141450	36.34801	-59.11863	2143.21	0.85
14	"Seven" Seamount	EX2104_D14_03G	Fossil Desmophyllum dianthus	Rinsed and Dried	Characteristic of Site	20210719	150826	36.34784	-59.11881	2126.88	0.05
15	Allegheny Seamount	EX2104_D15_01G	Large rock FeMn Coated	Rinsed and Dried	Characteristic of Site	20210720	151654	36.93014	-58.85800	3448.58	2.08
15	Allegheny Seamount	EX2104_D15_02G	Flatter FeMn coated Rock	Rinsed and Dried	Characteristic of Site	20210720	151738	36.93047	-58.85829	3447.37	1.96
15	Allegheny Seamount	EX2104_D15_05G	Rounded FeMn rock	Rinsed and Dried	Characteristic of Site	20210720	171830	36.92963	-58.85764	3388.39	2.25

Dive #	Site Name	Sample #	Sample Field ID	Preservation	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
16	Gosnold Seamount	EX2104_D16_01G	V Large FeMn Nodule	Rinsed and Dried	Characteristic of Site	20210723	145612	38.13457	-62.30433	3228.96	1.74
16	Gosnold Seamount	EX2104_D16_02G	Small nodules	Rinsed and Dried	Characteristic of Site	20210723	145942	38.13453	-62.30418	3229.00	0.13
16	Gosnold Seamount	EX2104_D16_03G	Rock FeMn debris	Rinsed and Dried	Characteristic of Site	20210723	161835	38.13361	-62.30424	3218.64	
16	Gosnold Seamount	EX2104_D16_05G	Large rock nodule FeMn	Rinsed and Dried	Characteristic of Site	20210723	170002	38.13314	-62.30431	3210.03	4.09
16	Gosnold Seamount	EX2104_D16_06B_A01	rock	Rinsed and Dried	Not Applicable	20210723	170545	38.13328	-62.30412	3210.17	1.13
17	Gosnold "Shallow" Seamount	EX2104_D17_01G	Rock with Crinoid and Coral Associate	Rinsed and Dried	Characteristic of Site	20210724	145624	38.29391	-62.53318	1784.66	1.30
17	Gosnold "Shallow" Seamount	EX2104_D17_02G	FeMn Nodules	95% EtOH	Characteristic of Site	20210724	150801	38.29386	-62.53344	1785.29	2.00
17	Gosnold "Shallow" Seamount	EX2104_D17_04G	Large Nodule with Biota	Rinsed and Dried	Characteristic of Site	20210724	173856	38.29165	-62.53273	1732.09	1.41
18	“Asterina” Seamount	EX2104_D18_01G	Rock	Rinsed and Dried	Characteristic of Site	20210725	174509	38.92691	-64.82038	3793.01	0.66
18	“Asterina” Seamount	EX2104_D18_02G	Rock	Rinsed and Dried	Characteristic of Site	20210725	181210	38.92724	-64.82101	3788.84	0.66
18	“Asterina” Seamount	EX2104_D18_03B_A01	mud	Dried	Not Applicable	20210725	181638	38.92728	-64.82101	3785.63	
19	Retriever Seamount	EX2104_D19_01G	Angular Rock	Rinsed and Dried	Characteristic of Site	20210727	144316	39.83893	-66.22883	1937.10	1.20
19	Retriever Seamount	EX2104_D19_02G	Partially Rounded Rock	Rinsed and Dried	Characteristic of Site	20210727	165136	39.83752	-66.23006	1895.50	1.30

Table 9. Inventory of biological samples collected during EX-21-04.

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
00**	2.2 miles from Dive 7	EX2104_D00_03B	Polychaeta	70% EtOH	Unintentional Sample	20210710	130000	N/A	N/A	N/A	N/A	N/A	N/A
00**	2.2 miles from Dive 7	EX2104_D00_02B	Crab	70% EtOH	Unintentional Sample	20210710	130000	N/A	N/A	N/A	N/A	N/A	N/A
00**	2.2 miles from Dive 7	EX2104_D00_01B	Barnacles	70% EtOH	Unintentional Sample	20210710	130000	N/A	N/A	N/A	N/A	N/A	N/A
1	"North Bermuda Tritop"	EX2104_D01_02B	Anthomastus	95% EtOH	Connectivity Study	20210703	160138	33.66068	-60.33535	2535.33	34.954	3.225	6.835
1	"North Bermuda Tritop"	EX2104_D01_03B	Keratoisis	95% EtOH	Potential Undescribed Species	20210703	163840	33.66024	-60.33503	2500.34	34.943	3.416	7.240
1	"North Bermuda Tritop"	EX2104_D01_03B	Keratoisis	95% EtOH	Potential Undescribed Species	20210703	163840	33.66024	-60.33503	2500.34	34.943	3.416	7.240
1	"North Bermuda Tritop"	EX2104_D01_04B	Geodia megastrella	95% EtOH	Connectivity Study	20210703	170519	33.65990	-60.33483	2467.87	34.958	3.393	6.743
1	"North Bermuda Tritop"	EX2104_D01_04B	Geodia megastrella	95% EtOH	Connectivity Study	20210703	170519	33.65990	-60.33483	2467.87	34.958	3.393	6.743
1	"North Bermuda Tritop"	EX2104_D01_07B	Rossellidae	95% EtOH	Potential Undescribed Species	20210703	180313	33.65900	-60.33510	2439.28	34.951	3.407	6.371
1	"North Bermuda Tritop"	EX2104_D01_07B	Rossellidae	95% EtOH	Potential Undescribed Species	20210703	180313	33.65900	-60.33510	2439.28	34.951	3.407	6.371

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
2	Congress Seamount "South Peak"	EX2104_D02_02B	Cerianthidae	95% EtOH	Potential Undescribed Species	20210705	155307	32.92205	-54.91444	2780.44	34.936	3.074	6.494
2	Congress Seamount "South Peak"	EX2104_D02_04B	Jasonisis	70% EtOH	New or Unusual Morphotype	20210705	181405	32.91824	-54.91609	2594.65	34.971	3.209	6.378
2	Congress Seamount "South Peak"	EX2104_D02_04B	Jasonisis	70% EtOH	New or Unusual Morphotype	20210705	181405	32.91824	-54.91609	2594.65	34.971	3.209	6.378
3	"Hopscotch" Seamount	EX2104_D03_02B	Bolosominae	95% EtOH	New or Unusual Morphotype	20210706	173553	33.67630	-52.99315	2494.33	34.963	3.276	8.070
3	"Hopscotch" Seamount	EX2104_D03_04B	Chonelasma	95% EtOH	New or Unusual Morphotype	20210706	182721	33.67638	-52.99260	2474.99	34.964	3.291	8.063
4	"Dumbbell" Seamount	EX2104_D04_01B	Euplectellidae	95% EtOH	Potential Undescribed Species	20210707	164802	34.39135	-51.77375	2356.56	34.965	3.385	8.107
4	"Dumbbell" Seamount	EX2104_D04_02B	Keratoisis	70% EtOH	New or Unusual Morphotype	20210707	170520	34.39130	-51.77379	2355.23	34.965	3.371	8.163
4	"Dumbbell" Seamount	EX2104_D04_05B	Bathycrinidae	95% EtOH	Potential Undescribed Species	20210707	190358	34.39042	-51.77142	2259.55	34.978	3.578	8.115
5	Rockaway Seamount	EX2104_D05_02B	Bathygorgia	95% EtOH	Potential Undescribed Species	20210708	154224	35.81673	-52.30762	4167.82	34.883	2.251	8.015

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
5	Rockaway Seamount	EX2104_D05_02B	Bathygorgia	95% EtOH	Potential Undescribed Species	20210708	154224	35.81673	-52.30762	4167.82	34.883	2.251	8.015
5	Rockaway Seamount	EX2104_D05_03B	Demospongiae	95% EtOH	Potential Undescribed Species	20210708	161738	35.81703	-52.30758	4182.41	34.884	2.257	7.668
6	Castle Rock Seamount	EX2104_D06_02B	Hexactinella	95% EtOH	Potential Undescribed Species	20210709	150211	36.30070	-51.34791	2265.04	34.966	3.613	8.196
6	Castle Rock Seamount	EX2104_D06_02B	Hexactinella	95% EtOH	Potential Undescribed Species	20210709	150211	36.30070	-51.34791	2265.04	34.966	3.613	8.196
6	Castle Rock Seamount	EX2104_D06_02B	Hexactinella	95% EtOH	Potential Undescribed Species	20210709	150211	36.30070	-51.34791	2265.04	34.966	3.613	8.196
6	Castle Rock Seamount	EX2104_D06_02B	Hexactinella	95% EtOH	Potential Undescribed Species	20210709	150211	36.30070	-51.34791	2265.04	34.966	3.613	8.196
6	Castle Rock Seamount	EX2104_D06_02B_A01	Crinoidea	95% EtOH	Not Applicable	20210709	150211	36.30070	-51.34791	2265.04	34.966	3.613	8.196
6	Castle Rock Seamount	EX2104_D06_02B_A02	Crinoidea	95% EtOH	Not Applicable	20210709	150211	36.30070	-51.34791	2265.04	34.966	3.613	8.196
6	Castle Rock Seamount	EX2104_D06_04B	Crinoidea	95% EtOH	Characteristic of Site	20210709	180553	36.30096	-51.35020	2137.67	34.975	3.765	8.138
7	"Corner Rise 1" Seamount	EX2104_D07_04B	Demospongiae	95% EtOH	Potential Undescribed Species	20210710	181437	35.88870	-51.52038	2474.97	34.963	3.459	8.117

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
8	MacGregor Seamount	EX2104_D08_01G_A01	Crinoidea	95% EtOH	Not Applicable	20210711	155808	35.05280	-48.97148	1269.37	35.007	4.490	8.275
8	MacGregor Seamount	EX2104_D08_02B	Plexauridae	95% EtOH	Potential Undescribed Species	20210711	171451	35.05252	-48.97143	851.28	35.048	5.237	7.758
8	MacGregor Seamount	EX2104_D08_02B	Plexauridae	95% EtOH	Potential Undescribed Species	20210711	171451	35.05252	-48.97143	851.28	35.048	5.237	7.758
8	MacGregor Seamount	EX2104_D08_03B	Plexauridae	95% EtOH	Potential Undescribed Species	20210711	185309	35.05496	-48.97658	947.90	35.053	5.093	7.854
8	MacGregor Seamount	EX2104_D08_03B	Plexauridae	95% EtOH	Potential Undescribed Species	20210711	185309	35.05496	-48.97658	947.90	35.053	5.093	7.854
8	MacGregor Seamount	EX2104_D08_04G_A01	Yellow Porifera	95% EtOH	Not Applicable	20210711	190105	35.05493	-48.97666	947.94	35.049	5.084	7.860
8	MacGregor Seamount	EX2104_D08_04G_A02	Pink Porifera	95% EtOH	Not Applicable	20210711	190105	35.05493	-48.97666	947.94	35.049	5.084	7.860
8	MacGregor Seamount	EX2104_D08_04G_A03	Brown Porifera	95% EtOH	Not Applicable	20210711	190105	35.05493	-48.97666	947.94	35.049	5.084	7.860
8	MacGregor Seamount	EX2104_D08_04G_A04	Hydrozoa	95% EtOH	Not Applicable	20210711	190105	35.05493	-48.97666	947.94	35.049	5.084	7.860
9	Yakutat Seamount "shallow"	EX2104_D09_02B	Plexauridae	95% EtOH	Potential Undescribed Species	20210712	165726	35.17882	-48.11700	1254.44	35.010	4.311	8.274

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
9	Yakutat Seamount "shallow"	EX2104_D09_02B	Plexauridae	95% EtOH	Potential Undescribed Species	20210712	165726	35.17882	-48.11700	1254.44	35.010	4.311	8.274
9	Yakutat Seamount "shallow"	EX2104_D09_02B_A01	Crinoidea	95% EtOH	Not Applicable	20210712	165726	35.17882	-48.11700	1254.44	35.010	4.311	8.274
9	Yakutat Seamount "shallow"	EX2104_D09_03B	Demospongiae	95% EtOH	Potential Undescribed Species	20210712	172417	35.17876	-48.11707	1242.22	35.011	4.302	8.298
9	Yakutat Seamount "shallow"	EX2104_D09_03B_A01	Ophiurida	95% EtOH	Not Applicable	20210712	172417	35.17876	-48.11707	1242.22	35.011	4.302	8.298
9	Yakutat Seamount "shallow"	EX2104_D09_05B	Chondraster	95% EtOH	New or Unusual Morphotype	20210712	185358	35.17854	-48.11698	1224.61	35.014	4.275	8.263
9	Yakutat Seamount "shallow"	EX2104_D09_06B	Polychaeta	95% EtOH	Unintentional Sample	20210712	195100	35.17830	-48.11753	1192.80	N/A	N/A	N/A
10	Yakutat Seamount "deep"	EX2104_D10_01B	Lophaster	95% EtOH	Potential Undescribed Species	20210713	162611	35.26386	-48.00228	1893.04	34.996	3.903	8.165
10	Yakutat Seamount "deep"	EX2104_D10_03G_A01	Ophiuroidea	95% EtOH	Not Applicable	20210713	190648	35.26225	-48.00171	1723.52	34.998	3.933	8.171
11	Caloosahatchee Seamount	EX2104_D11_01B	Scleractinia	95% EtOH	Connectivity Study	20210714	165452	34.65039	-49.65135	1242.64	35.044	4.680	8.107
11	Caloosahatchee Seamount	EX2104_D11_03G_A01	Tunicata	5% Formalin	Not Applicable	20210714	172948	34.65076	-49.65186	1231.52	35.048	4.716	8.077

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
12	"Y" Seamount	EX2104_D12_01B	Hexactinellida	95% EtOH	Potential Undescribed Species	20210717	142321	35.22055	-58.03374	2810.55	34.948	3.127	8.132
12	"Y" Seamount	EX2104_D12_04B	Zeidora	70% EtOH	Potential Undescribed Species	20210717	174035	35.22118	-58.03524	2635.60	34.952	3.219	8.054
14	"Seven" Seamount	EX2104_D14_02B	Urchin	95% EtOH	New or Unusual Morphotype	20210719	150211	36.34782	-59.11880	2127.18	34.953	3.464	8.318
14	"Seven" Seamount	EX2104_D14_04B	Isididae	70% EtOH	New or Unusual Morphotype	20210719	154758	36.34775	-59.11886	2120.85	34.955	3.544	8.255
14	"Seven" Seamount	EX2104_D14_04B	Isididae	70% EtOH	New or Unusual Morphotype	20210719	154758	36.34775	-59.11886	2120.85	34.955	3.544	8.255
14	"Seven" Seamount	EX2104_D14_05B	Euretidae	95% EtOH	Characteristic of Site	20210719	173513	36.34718	-59.11824	2043.49	34.957	3.501	8.270
14	"Seven" Seamount	EX2104_D14_05B_A01	Hexactinella	95% EtOH	Not Applicable	20210719	173513	36.34718	-59.11824	2043.49	34.957	3.501	8.270
15	Allegheny Seamount	EX2104_D15_03B	Cerianthidae	70% EtOH	Potential Undescribed Species	20210720	153355	36.93034	-58.85850	3443.72	34.920	2.512	8.098
15	Allegheny Seamount	EX2104_D15_03B	Cerianthidae	70% EtOH	Potential Undescribed Species	20210720	153355	36.93034	-58.85850	3443.72	34.920	2.512	8.098

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
15	Allegheny Seamount	EX2104_D15_04B	Jasonisis	70% EtOH	New or Unusual Morphotype	20210720	162210	36.93021	-58.85760	3419.86	34.910	2.584	8.132
15	Allegheny Seamount	EX2104_D15_04B	Jasonisis	70% EtOH	New or Unusual Morphotype	20210720	162210	36.93021	-58.85760	3419.86	34.910	2.584	8.132
15	Allegheny Seamount	EX2104_D15_06B	Hexactinellidae	95% EtOH	Characteristic of Site	20210720	174202	36.92930	-58.85768	3370.70	34.915	2.639	8.009
16	Gosnold Seamount	EX2104_D16_04B	Primnoidae	70% EtOH	Characteristic of Site	20210723	164120	38.13341	-62.30435	3214.25	34.923	2.785	7.538
16	Gosnold Seamount	EX2104_D16_05G_A01	Foraminifera	95% EtOH	Not Applicable	20210723	170002	38.13314	-62.30431	3210.03	34.924	2.795	6.160
16	Gosnold Seamount	EX2104_D16_05G_A02	Barnacle	95% EtOH	Not Applicable	20210723	170002	38.13314	-62.30431	3210.03	34.924	2.795	6.160
16	Gosnold Seamount	EX2104_D16_05G_A03	Bryozoan colony	95% EtOH	Not Applicable	20210723	170002	38.13314	-62.30431	3210.03	34.924	2.795	6.160
16	Gosnold Seamount	EX2104_D16_05G_A04	Hexactinellidae	95% EtOH	Not Applicable	20210723	170002	38.13314	-62.30431	3210.03	34.924	2.795	6.160
16	Gosnold Seamount	EX2104_D16_06B	Eknomisis	70% EtOH	Potential Undescribed Species	20210723	170545	38.13328	-62.30412	3210.17	34.924	2.805	7.857
16	Gosnold Seamount	EX2104_D16_06B	Eknomisis	70% EtOH	Potential Undescribed Species	20210723	170545	38.13328	-62.30412	3210.17	34.924	2.805	7.857

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
16	Gosnold Seamount	EX2104_D16_06B_A02	Polychaeta	95% EtOH	Not Applicable	20210723	170545	38.13328	-62.30412	3210.17	34.924	2.805	7.857
17	Gosnold "Shallow" Seamount	EX2104_D17_01G_A01	Crinoidea	95% EtOH	Not Applicable	20210724	145624	38.29391	-62.53318	1784.66	34.970	4.044	8.120
17	Gosnold "Shallow" Seamount	EX2104_D17_01G_A02	Stolonifera	95% EtOH	Not Applicable	20210724	145624	38.29391	-62.53318	1784.66	34.970	4.044	8.120
17	Gosnold "Shallow" Seamount	EX2104_D17_03B	Goniaster	95% EtOH	Characteristic of Site	20210724	164846	38.29247	-62.53285	1751.50	34.969	4.074	8.042
17	Gosnold "Shallow" Seamount	EX2104_D17_04G_A01	Stolonifera	70% EtOH	Not Applicable	20210724	173856	38.29165	-62.53273	1732.09	34.967	3.995	8.069
17	Gosnold "Shallow" Seamount	EX2104_D17_04G_A02	Ophiuroidea	95% EtOH	Not Applicable	20210724	173856	38.29165	-62.53273	1732.09	34.967	3.995	8.069
18	"Asterina" Seamount	EX2104_D18_03B	Pennatulacea	70% EtOH	Characteristic of Site	20210725	181638	38.92728	-64.82101	3785.63	34.887	2.231	8.037
18	"Asterina" Seamount	EX2104_D18_03B	Pennatulacea	70% EtOH	Characteristic of Site	20210725	181638	38.92728	-64.82101	3785.63	34.887	2.231	8.037
19	Retriever Seamount	EX2104_D19_02G_A01	Brachiopoda	95% EtOH	Not Applicable	20210727	165136	39.83752	-66.23006	1895.50	34.946	3.716	5.749
19	Retriever Seamount	EX2104_D19_02G_A02	Hydroida	95% EtOH	Not Applicable	20210727	165136	39.83752	-66.23006	1895.50	34.946	3.716	5.749
19	Retriever Seamount	EX2104_D19_03B	Plexaurid	70% EtOH	Potential Undescribed Species	20210727	175250	39.83721	-66.23025	1868.65	34.976	3.678	6.002

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
19	Retriever Seamount	EX2104_D19_03B	Plexaurid	70% EtOH	Potential Undescribed Species	20210727	175250	39.83721	-66.23025	1868.65	34.976	3.678	6.002
19	Retriever Seamount	EX2104_D19_03B_A01	Asteroschema (Ophiocreas)	95% EtOH	Not Applicable	20210727	175250	39.83721	-66.23025	1868.65	34.976	3.678	6.002
20	Hydrographer Canyon	EX2104_D20_01B	Physonect Siphonophore	5% Formalin	Characteristic of Site	20210728	154141	39.98272	-69.01176	894.16	34.986	4.610	6.221
20	Hydrographer Canyon	EX2104_D20_01B	Physonect Siphonophore	5% Formalin	Characteristic of Site	20210728	154141	39.98272	-69.01176	894.16	34.986	4.610	6.221
20	Hydrographer Canyon	EX2104_D20_02B	Bathocyroe fosteri		Characteristic of Site	20210728	154932	39.98280	-69.01147	900.41	34.996	4.605	5.946
20	Hydrographer Canyon	EX2104_D20_03B	Solmissus	5% Formalin	Potential Undescribed Species	20210728	155210	39.98272	-69.01144	903.11	35.004	4.599	6.018
20	Hydrographer Canyon	EX2104_D20_03B	Solmissus	5% Formalin	Potential Undescribed Species	20210728	155210	39.98272	-69.01144	903.11	35.004	4.599	6.018
20	Hydrographer Canyon	EX2104_D20_03B	Solmissus	5% Formalin	Potential Undescribed Species	20210728	155210	39.98272	-69.01144	903.11	35.004	4.599	6.018
20	Hydrographer Canyon	EX2104_D20_03B	Solmissus	5% Formalin	Potential Undescribed Species	20210728	155210	39.98272	-69.01144	903.11	35.004	4.599	6.018
20	Hydrographer Canyon	EX2104_D20_04B	Botrynema brucei	95% EtOH	New or Unusual Morphotype	20210728	163448	39.98317	-69.01123	1201.62	34.976	4.439	6.937

Dive #	Site Name	Sample #*	Sample Field ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temper-ature (C)	Dissolved Oxygen (mg/l)
20	Hydrographer Canyon	EX2104_D20_05B	Unknown Jelly	5% Formalin	New or Unusual Morphotype	20210728	171244	39.98418	-69.01076	1200.84	34.978	4.441	5.990
20	Hydrographer Canyon	EX2104_D20_05B	Unknown Jelly	5% Formalin	New or Unusual Morphotype	20210728	171244	39.98418	-69.01076	1200.84	34.978	4.441	5.990
20	Hydrographer Canyon	EX2104_D20_05B	Unknown Jelly	5% Formalin	New or Unusual Morphotype	20210728	171244	39.98418	-69.01076	1200.84	34.978	4.441	5.990
20	Hydrographer Canyon	EX2104_D20_05B	Unknown Jelly	5% Formalin	New or Unusual Morphotype	20210728	171244	39.98418	-69.01076	1200.84	34.978	4.441	5.990

*Biological sample numbers with "_A##" indicate associate samples.

**Dive 00 indicates samples taken from collected drifting high flyer buoy that was picked up during small boat operations, not a ROV dive. Metadata recorded for these samples were generated as similarly as possible to normal operations given the unusual collection method.

7.2.1 Sample Repositories

The following repositories archive samples collected during NOAA Ocean Exploration expeditions on *Okeanos Explorer*.

Biological Samples

Invertebrate Zoology Collections
National Museum of Natural History
Smithsonian Institution, Museum Support Center
MRC 534, 4210 Silver Hill Road, Suitland, MD 20746
Contact: Abigail Reft, ReftAJ@si.edu

DNA Samples

Biorepository
National Museum of Natural History
Smithsonian Institution, Museum Support Center
4210 Silver Hill Road, Suitland, MD 20746
Contact: Chris Huddleston, huddlestonc@si.edu

Geological Samples

Marine and Geology Repository
Oregon State University
Burt 346, Corvallis, OR 97331-5503
Contact: Maziet Cheseby, maziet.cheseby@oregonstate.edu

7.3 Acoustic Operations Results

During EX-21-04, multibeam mapping operations results included 7,025.8 linear kilometers mapped and 54,709.7 square kilometers covered (4,109.5 square kilometers of these in U.S. waters).

Additional information about the mapping conducted during EX-21-04, including data quality assessments, is in the EX-21-04 mapping data report (Hoy et al., 2021).

7.3.1 Acoustic Operations Data Access

Multibeam Sonar (Kongsberg EM 304)

The multibeam dataset for the expedition is archived at NCEI and accessible through their Bathymetric Data Viewer. To access these data, click on the Search Bathymetric Surveys button, select “NOAA Ship Okeanos Explorer” from the Platform Name dropdown menu, and “EX2104”

from the Survey ID dropdown menu. Click OK, and the ship track will appear on the map. Click the ship track for options to download data.

Sub-Bottom Profiler (Knudsen Chirp 3260)

The sub-bottom profiler was not run during any of EX-21-04's ROV dive operations, but generally was operated during multibeam mapping operations. These data are archived at NCEI and accessible through the Trackline Geophysical Data Viewer. To access these data, select "Subbottom Profile" under Marine Surveys and click on Search Marine Surveys. In the pop-up window, select "EX2104" in the Filter by Survey IDs dropdown menu. Click OK, and the ship track will appear on the map. Click the ship track for options to download data.

Split-Beam Sonars (Simrad EK60 and EK80)

EK60/EK80 water column data for EX-21-04 are archived at NCEI and available through the Water Column Sonar Data Viewer. To access these data, click on the Additional Filters button, deselect "All" next to Survey ID, and select "EX2104" from the Survey ID list. Click OK, and the ship track will appear on the map. Click on the ship track for options to download data.

Acoustic Doppler Current Profilers (Teledyne Marine Workhorse Mariner and Teledyne Ocean Surveyor ADCPs)

Please contact ncei.info@noaa.gov for information on the ADCP data collected onboard *Okeanos Explorer*.

7.4 Conductivity, Temperature, and Depth Measurements

CTD profile data from EX-21-04 are archived at NCEI and available through OER's Digital Atlas. To access these data, click on the Search tab, enter "EX2104" in the Enter Search Text field, and click Search. Click on the point that represents EX-21-04 to access data options. In the pop-up window, select the Data Access tab for a link to download the CTD profile data.

ROV CTD data can be found on the EX-21-04 pages of the Okeanos Explorer ROV Expeditions website.

7.5 Sun Photometer Measurements

No Sun Photometer measurements were taken during this expedition. However, data for this region can still be accessed through NASA's Marine Aerosol Network. Access these data by searching the table for "2014" and "Okeanos Explorer," and "North Atlantic Ocean." Click on the links to download the data. (Note: There may be more than one entry for *Okeanos Explorer* in a region in a given year.)

7.6 Engagement

EX-21-04 engaged with audiences around the world, opening a window of understanding into the deep sea. Highlights are listed below:

- Engaged over 100 scientists, resource managers, and students, with participation from 9 international countries including Canada, Russia, Japan, Kenya, Trinidad and Tobago, Spain, New Zealand, United Kingdom, Australia, and Bermuda.
- Engaged with audiences around the world through live interactions, livestreamed video, expedition web content, and media/web stories, including:
    - 10 live interactions and a Facebook lunch hour Q&A that engaged over 600 people.
    - More than 350 news/web stories sharing expedition news, including the stories about the "real life SpongeBob and Patrick Star" and the undescribed red jellyfish, which received the most coverage both domestically and internationally. Stories were picked up by NPR, HuffingtonPost, IFL Science, Smithsonian Magazine, Fox News, People Magazine, USA Today, the Hill, and many others.
    - More than 191,000 views to the live video feeds during the expedition.
    - More than 14,000 views to expedition-specific web content during the expedition, with more than 7,400 additional views coming in the month immediately following the expedition, largely due to exposure on social media and subsequent media interest.

8. Summary

Achieving ASPIRE Goals

Each ASPIRE expedition has its own objectives that support the goals of the larger campaign. Some of these goals are highlighted here, with relevant accomplishments from the 2021 North Atlantic Stepping Stones expedition.

Goal: Improve knowledge of unexplored areas within the U.S. EEZ and high seas to inform management needs for sensitive habitats, geological features, and potential resources.

- Conducted 20 ROV dives ranging in depth from 300 to 4,187 meters). Data collected can be used to increase understanding of deep-sea ecosystem connectivity across the Atlantic basin.
- Collected 69 biological (45 primary and 44 associates) and 54 geological specimens.
    - Biological specimens were representatives of new records, potential new species, or dominant fauna. Six biological samples were collected to support

trans-Atlantic connectivity studies, including *Geodia megastrella, Anthomastus sp.*, and *Desmophyllum dianthus*.
    - Geological samples will be used to better understand the geologic history of the region, as well as to characterize habitat substrate.
- Conducted ROV dives and mapping operations in the Northeast Canyons and Seamounts Marine National Monument managed by NOAA and the U.S. Fish and Wildlife Service, collecting valuable data of deep-sea habitats and geological features.
- Discovered areas of high diversities of deep-sea corals and sponges on seamounts in the New England and Corner Rise Seamounts in areas with no previous exploration.
- Explored an area on Yakutat Seamount that was observed to have remnant scars of anthropogenic impacts from trawling or dredging (Dive 10).
- Observed ubiquitous ferromanganese crust coverage on outcropping basalt and other rocks in both seamount chains, especially on edifices further offshore, at a variety of depths and with some crusts appearing quite thick based on lobed morphologies.
- Collected the first visual confirmation of seamount-hosted ferromanganese nodule fields in the New England Seamount Chain region (at Gosnold Seamount, Dives 16 and 17).
- Collected visual and geologic sample evidence of "carbonate caps" (calcium carbonate-rich rocks deposited in layers on the seamount summits), supporting hypotheses on the early history of the seamounts and subsequent subsidence, including the only known sample from the region formed largely from Nummulite fossils (Dive 09).
- Observed extensive coverage and took several samples of fossil coral rubble on seamounts in both seamount chains that was often identified to be *Desmophyllum dianthus* and typically coated with a thin patina of black ferromanganese mineral precipitation. This rubble serves as evidence of substantial ancient coral gardens before subsidence of these massive seamounts, ridges, and plateaus.
- Observed evidence of both constructional and destructional processes associated with seafloor features that make up these two volcanic chains. This included documenting a relatively high-velocity current regime enhanced by the Gulf Stream and evidenced by sediment ripples of numerous sizes and distributions. Other observed features included lava flows, mixed seafloor pavement lithologies, rock debris, and sediment slope failures marked by chutes and slides and even tabular failures.

Goal: Locate and characterize deep-sea coral, sponge, and chemosynthetic communities.

- Documented nine dive sites with high biological diversity.
- Observed deep-sea corals and sponges on every dive except one, which was a dedicated water column exploration dive.

- Observed several potential new species and/or undescribed species, including an unknown “finger sponge” in high-density patches throughout exploration of Yakutat Seamount during Dive 09.
- Recorded significant depth and geographic range extensions for several fish and coral species, including the deepest known record of rock pens in the Atlantic and potential deepest records of two species of *Synaphobranchid* fish (seen on Gosnold Seamount).
- Observed rare Rhodaliid dandelion siphonophores during Dive 13.
- Discovered an unexpectedly high diversity of organisms while exploring Alleghany Seamount (Dive 15) at depths of 3,447 meters.
- Documented several rarely observed predation events and other biological highlights, including:
    - A sea star (*Sthenaster emmae)* feeding on a coral stalk (Dive 11), which also happened to be the deepest known record of the sea star species at 1,219 meters.
    - Video footage of a yellow sponge (genus *Hertwigia*) and pink sea star (genus *Chondraster*) that resembled the cartoon characters SpongeBob SquarePants and Patrick Star, collected during Dive 19 within the Northeast Canyons and Seamounts Marine National Monument.
    - A sea urchin (genus *Echinus*) observed during Dive 19 to have seemingly eaten more than half of a bamboo whip coral.
    - A pink seastar consuming sunken sargassum (Dive 16).
    - A slit limpet actively eating away the encrusting material on the surface of a rock, leaving a visible, darkly colored feeding track in its wake (Dive 12).
    - Rare Rhodaliid dandelion siphonophores observed during Dive 13.
    - Observations of bentho-pelagic jellyfish, *Ptychogastria* (Dive 20).
    - Observation of a snipe eel eating a shrimp species previously thought not to be a food item for this species (Dive 20).
    - Large coral colonies observed shallow on Retriever Seamount (Dive 19), some estimated to be approximately 1,600 years old based on growth data from other areas.
- Increased understanding of deep-sea ecosystem connectivity across the Atlantic basin with observations including:
    - Possible species extension of Roselliid sponges collected from “North Bermuda Tritop” and Congress Seamounts (Dives 01 and 02).
    - Range extensions of rock pens in the Western Atlantic (Dive 19).

Goal: Characterize water column habitats using acoustics, visual observations, and emerging technologies.

- Conducted midwater exploration at depths ranging from 300 to 1,200 meters during a dive to investigate the diversity and abundance of the largely unknown pelagic fauna at the mouth of Hydrographer Canyon (Dive 20).
- Discovered a potentially undescribed species of red jellyfish (*Poralia* sp.) in the water column at a depth of 700 meters.

Goal: Extend bathymetric mapping coverage in the U.S. EEZ and international waters in support of Seabed 2030.

- Mapped more than 54,000 square kilometers of seafloor.
- Made new insights into this region, including the discovery of previously unknown seamounts south of the New England Seamount Chain and within the Corner Rise Seamounts, filling in gaps of data in the region.
- Conducted a record of 14 “map and dives,” where higher-resolution mapping data were collected within hours of a dive when previously there was no or poor data at the dive site.
- Mapped 40 seamounts, 20 of which had never been bathymetrically mapped before.
- Collected new bathymetric and sub-bottom data over the extensive sediment deposits of the north part of the Bermuda Rise.

Goal: Collect mapping data and conduct ROV dives to support enhanced predictive capabilities for vulnerable marine habitats and geologic ages of the New England and Corner Rise Seamounts.

- Discovered numerous areas of deep-sea coral and sponge habitat, which has not only improved our understanding of this region, but has habitat modeling implications that may apply to many other places in the world.
- Collected mapping, image and video footage, and physical samples of geological material that may contribute to the understanding of how and when the New England and Corner Seamounts formed and developed through time.

Goal: Engage the Scientific Community and the Public.

- Engaged over 100 scientists, resource managers, and students, with participation from 9 international countries including Russia, Japan, Kenya, Trinidad and Tobago, Spain, New Zealand, the United Kingdom, Australia, and Bermuda.
- Engaged with audiences around the world, opening a window of understanding into the deep sea through live interactions, live-streamed video, expedition web content, and media/web stories, including:
    - 10 live interactions and a Facebook lunch hour Q&A that engaged over 600 people.
    - More than 350 news/web stories sharing expedition news, including the stories about the "real life" SpongeBob and Patrick Star and the undescribed red

jellyfish, which received the most coverage both domestically and internationally. Stories were picked up by NPR, the Huffington Post, IFL Science, Smithsonian Magazine, Fox News, People Magazine, USA Today, the Hill, and many others.

- More than 191,000 views to the live video feeds during the expedition.
- More than 14,000 views to expedition-specific web content during the expedition, with more than 7,400 additional views coming in the month immediately following the expedition, largely due to exposure on social media and subsequent media interest.

Data collected during this expedition are intended to inform initial characterization of the areas visited and include multibeam, split-beam, sub-bottom, ADCP, XBT, CTD, and dissolved oxygen profiles; surface oceanographic and meteorological sensors; video and imagery; and physical specimens. All data from this expedition will be publicly available through national archives. Oceanexplorer.noaa.gov will provide a direct link to the expedition data archive once available.

9. Referencing Data

To reference oceanographic data associated with this expedition please use the following citation:

Cantwell, Kasey; Galvez, Kimberly; Hoy, Shannon; Chaytor, Jason; Mizell, Kira; Waller, Rhian (2021). Oceanographic data collected during the EX2104: 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV and Mapping) expedition on NOAA Ship OKEANOS EXPLORER in the North Atlantic Ocean from 2021-06-30 to 2021-07-29 (NCEI Accession 0240591). [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. https://doi.org/10.25921/pbs1-ad27. Accessed [date].

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Appendix A: EX-21-04 Shore-Based Science Team Members

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Appendix B: EX-21-04 Permits and Clearances

Appendix B1. (Categorical Exclusion)

Categorical Exclusion (CE) Evaluation Worksheet

Project Identifier: EX2104

Date Review Completed: 5/10/2021

Completed by: Amanda Maxon, Environmental Compliance Specialist, Contractor

OAR Functional Area: OER

Worksheet File Name: 2021-05-OER-E3-EX2104

Step 1. CE applicability

1. **Is this federal financial assistance, including via grants, cooperative agreements, loans, loan guarantees, interest subsidies, insurance, food commodities, direct appropriations, and transfers of property in place of money?**

   no

2. **What is the proposed federal action?**
   The proposed action is the NOAA's Office of Exploration and Research (OER) to complete a ROV and Mapping expedition focused on exploring deep waters (greater than 250 m for ROV operations and greater than 200 m for mapping operations) in U.S. waters off the Northern U.S. East Coast and the high seas focusing within the New England and Corner Rise Seamounts region. Operations will be conducted 24 hours per day and consist of remotely operated vehicle (ROV) dives, mapping operations (primarily overnight), and full shore-based participation via telepresence. Expedition operations will include using NOAA Ship Okeanos Explorer's deepwater mapping systems (Kongsberg EM 304 multibeam, EK60/EK80 split-beam sonars, Knudsen 3260 Chirp sub-bottom profiler, and Teledyne acoustic Doppler current profiler), expendable bathythermograph (XBTs) in support of multibeam sonar mapping operations, conductivity, temperature, depth profiler (CTD) casts, OER's two-body ROV system (Deep Discoverer and Seirios), and a high-bandwidth satellite connection for continuous ship-to-shore communications. The EX-21-04, 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV and Mapping) will commence operations on June 30, 2021 in Newport, Rhode Island and will conclude on July 29, 2021 in Newport, Rhode Island. The exact start and end dates may vary by a few days or weeks depending on weather and other logistical considerations.

EX-21-04 will focus operations in U.S. waters off the Northern U.S. East Coast and the high seas focusing within the New England and Corner Rise Seamounts region. Mapping and ROV operations will be conducted at depths between 250 and 6,000 m. With actions demonstrating independent utility and is not connected to any other federal action.

3. **Which class of CE in Appendix E of the NAO 216-6A Companion Manual is applicable to this action and why?**
    a. E3: Activities to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner.
    b. The scope of this action is consistent with Categorical Exclusion E3 in Appendix E of the Companion Manual to NOAA Administrative Order (NAO) 216-6A to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner. The expedition will use remote sensing, video, images, and a limited number of physical samples to collect baseline information on unexplored deep-water (>250m) areas off the Northern U.S. East Coast and the high seas focusing within the New England and Corner Rise Seamounts region. The use of conductivity, temperature, and depth instruments or a moving vessel profiler from a platform, including the use of drop cameras during this expedition will occur. During EX-21-04 operations deployment, operation, and retrieval of a limited number of ROVs, ASVs, AUVs, buoys, moorings, or similar instrumentation to conduct non-destructive sampling and collection of data from those instruments once installed, including physical, chemical, and biological measurements, and visual data will take place.

Step 2. Extraordinary Circumstances Consideration

4. **Would the action result in adverse effects on human health or safety that are not negligible?**

    No, the actions of the NOAA Ship Okeanos Explorer operating in remote deep-sea (>200m) areas located off the Northern U.S. East Coast and the high seas focusing within the New England and Corner Rise Seamounts region starting and ending in Newport, Rhode Island. All operations are underwater and, therefore, have no human presence. The vessel will transit through different depths as it moves from the ports of call to the areas of operations in deeper waters. These actions do not involve any procedures or outcomes known to result in impacts on human health and safety.

5. **Would the action result in adverse effects on an area with unique environmental characteristics that are not negligible?**

Data collection will primarily focus offshore in deep waters (greater than 200 meters), including areas offshore the Northern U.S. East Coast and the high seas near and within the New England and Corner Rise Seamounts region. The effects will be negligible, as acoustic mapping and ROV operations are transient and will not cause any permanent impact on the seabed or water column since OER's operations are well-documented following accepted best management practices. The expedition is being planned to meet readiness objectives of scientific systems, in particular the ROV systems, onboard the Okeanos Explorer.

6. **Would the action result in adverse effects on species or habitats protected by the ESA, MMPA, MSA, NMSA, or MBTA that are not negligible?**

OER has taken measures to ensure that any effects on species or habitats protected by the ESA, MMPA, MSA or NMSA meet the definition of negligible. In 2018, an informal consultation was initiated under Section 7 of the Endangered Species Act (ESA), requesting NOAA Fisheries' Protected Resources Division concurrence with our Biological Evaluation determining that NOAA Ship Okeanos Explorer operations conducted during the 2018-2019 field seasons are not likely to adversely affect ESA-listed marine species. The informal consultation was completed on August 8, 2018 when OER received a signed letter from the Chief ESA Interagency Cooperation Division in the NOAA Office of Protected Species, stating that NMFS concurs with OER's determination that operations conducted during NOAA Ship Okeanos Explorer 2018-2019 field seasons are not likely to adversely affect ESA-listed marine species. A Re-initiation of ESA Section 7 Letter of Concurrence was completed for the FY20 cruise season. ESA Section 7 Letter of Concurrence was received for the Okeanos Explorer's FY21 field season on February 4, 2021 which incorporated the usage of new technologies and regions of interest. The ESA Section 7 Letter of Concurrence will be provided in the FY21 Field Season Instructions.

Given the offshore focus of most of our proposed work, it is improbable that we will encounter marine mammals protected under the MMPA, or sea birds protected under the MBTA. If we did encounter any such protected animals, our impacts would be negligible because of the best management practices to which we adhere to avoid or minimize environmental impacts. These best management practices are all outlined in the Field Season Instructions. OER also initiated a request for an abbreviated Essential Fish Habitat (EFH) consultation for expeditions by NOAA Ship Okeanos Explorer in 2021 to the Greater Atlantic Region. OER is currently in the process of requesting a Letter of Acknowledgement from the Assistant Regional Administrator for the NOAA Office of Habitat Conservation stating that these expeditions will not adversely impact EFH. This letter will be provided in appendices of the EX FY21 Project Instructions.

7. **Would the action result in the potential to generate, use, store, transport, or dispose of hazardous or toxic substances, in a manner that may have a significant effect on the environment?**

The operations of the expedition will be in compliance with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or the OMAO procedure that supersedes it) to ensure generation, use, storage, transport, and disposal of such substances will not result in significant impacts.

8. **Would the action result in adverse effects on properties listed or eligible for listing on the National Register of Historic Places authorized by the National Historic Preservation Act of 1966, National Historic Landmarks designated by the Secretary of the Interior, or National Monuments designated through the Antiquities Act of 1906; Federally recognized Tribal and Native Alaskan lands, cultural or natural resources, or religious or cultural sites that cannot be resolved through applicable regulatory processes?**

   The proposed action will not result in adverse effects that cannot be resolved through applicable regulatory processes since we will not be operating within listed or eligible properties, lands, resources or sites coming under the umbrella of protection referenced above.

9. **Would the action result in a disproportionately high and adverse effect on the health or the environment of minority or low-income communities, compared to the impacts on other communities (EO 12898)?**

   NOAA Ship Okeanos Explorer will be operating in remote and offshore areas off the northern U.S. East Coast and the high seas within the New England and Corner Rise Seamounts region. There are no communities within or near the geographic scope of the expedition, and the mission does not involve actions known or likely to result in adverse impacts on human health.

10. **Would the action contribute to the introduction, continued existence, or spread of noxious weeds or nonnative invasive species known to occur in the area or actions that may promote the introduction, growth, or expansion of the range of the species?**

    During EX-21-04, NOAA Ship Okeanos Explorer will not make landfall in areas other than commercial ports in Newport, Rhode Island. The ship and OER mission team will comply with all applicable local and federal regulations regarding the prevention or spread of invasive species. At the completion of every ROV dive or CTD cast, the equipment will be thoroughly rinsed with fresh water and completely dried to prevent spreading organisms from one site to another. Also the Engineering Department aboard the NOAA Ship Okeanos Explorer attends yearly Ballas Management Training in accordance with NOAA Form 57-07-13 NPDES VGP Annual Inspection and Report to prevent the introduction of invasive species.

11. Would the action result in a potential violation of Federal, State, or local law or requirements imposed for protection of the environment?

The proposed actions will not result in any Federal, State, or local law violations or requirements imposed for protection of the environment. OER engaged in the requisite consultations on ESA Section-7 EFH, and MMPA for this expedition as outlined in questions 4-6 above.

12. Would the action result in highly controversial environmental effects?

No, the exploration activities will be localized and of short duration in any particular area at any given time with no notable or lasting changes to the environment. Given the project's scope and breath, no notable or lasting changes or highly controversial effects to the environment will result.

13. Does the action have the potential to establish a precedent for future action or an action that represents a decision in principle about future actions with potentially significant environmental effects?

While each cruise contributes to the overarching goal of exploring, mapping, and sampling the ocean, every cruise is independently useful and not connected to subsequent federal actions.

14. Would the action result in environmental effects that are uncertain, unique, or unknown?

The techniques and equipment used are standard for this type of field study, and the effects are well known.

15. Does the action have the potential for significant cumulative impacts when the proposed action is combined with other past, present and reasonably foreseeable future actions, even though the impacts of the proposed action may not be significant by themselves?

By definition, actions that a federal agency classifies as a categorical exclusion have no potential, individually or cumulatively, to significantly affect the environment. This cruise is consistent with a class of CE established by NOAA and there are no extraordinary circumstances for this action that may otherwise result in potentially significant impacts.

CE Determination

☒I have determined that a Categorical Exclusion is the appropriate level of NEPA analysis for this action and that no extraordinary circumstances exist that would require preparation of an environmental assessment or environmental impact statement.

☐I have determined that an environmental assessment or environmental impact statement is required for this action.

Signature: SOSSA.GENENE.FISHER.1403930306 Digitally signed by SOSSA.GENENE.FISHER.1403930306 Date: 2021.05.19 16:47:10 -04'00'

Signed by: Genene Fisher, Deputy Director, OER

Date Signed: 5/19/2021

Appendix B2. (Letter of Concurrence)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

February 3, 2021
Refer to NMFS No: OPR-2021-00095

Dr. Alan Leonardi
Director
Office of Ocean Exploration and Research
1315 East West Highway
Silver Spring, Maryland 20910

RE: Concurrence Letter for the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean Exploration and Research's Section 7 Consultation Pursuant to the Endangered Species Act for Marine Operation Activities on the NOAA Ship *Okeanos Explorer* for the 2021 Field Season

Dear Dr. Leonardi:

On January 14, 2021, the National Marine Fisheries Service (NMFS) received your request for a written concurrence that the NOAA Office of Ocean Exploration and Research's (OER) marine operation activities on the NOAA ship *Okeanos Explorer* for the 2021 field season under the Endangered Species Act (ESA) of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) is not likely to adversely affect species listed as threatened or endangered or critical habitats designated under the ESA. This response was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at (50 C.F.R. §402), and agency guidance for preparation of letters of concurrence.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with agency guidelines issued under section 515 of the Treasury and General Government Appropriations Act of 2001 (Data Quality Act; 44 U.S.C. 3504(d)(1) and 3516). A complete record of this informal consultation is on file at NMFS Office of Protected Resources in Silver Spring, Maryland.

Background and Consultation History

Previous consultations for NOAA's Office of Ocean Exploration and Research's marine operation activities on the NOAA Ship *Okeanos Explorer* were concluded in 2020, 2019, and 2018 (NMFS 2018a; NMFS 2018b; NMFS 2019; NMFS 2020). Each of these consultations assessed NOAA OER's bathymetric mapping activities in the North Atlantic Ocean. Although similar in scope, these activities differed slightly by geographic location and/or consisted of new sonar technologies added to the NOAA Ship *Okeanos Explorer*. Critical habitats for the following species were proposed since the conclusion of these consultations and may be in the action area of the 2021 survey: lobed star coral (*Orbicella annularis*), boulder star coral (*Orbicella franksi*), mountainous star coral (*Orbicella faveolata*), pillar coral (*Dendrogyra cylindrus*), and rough cactus coral (*Mycetophyllia ferox*), see 85 FR 76302, November 27, 2020.

Action Agency's Effect Determinations

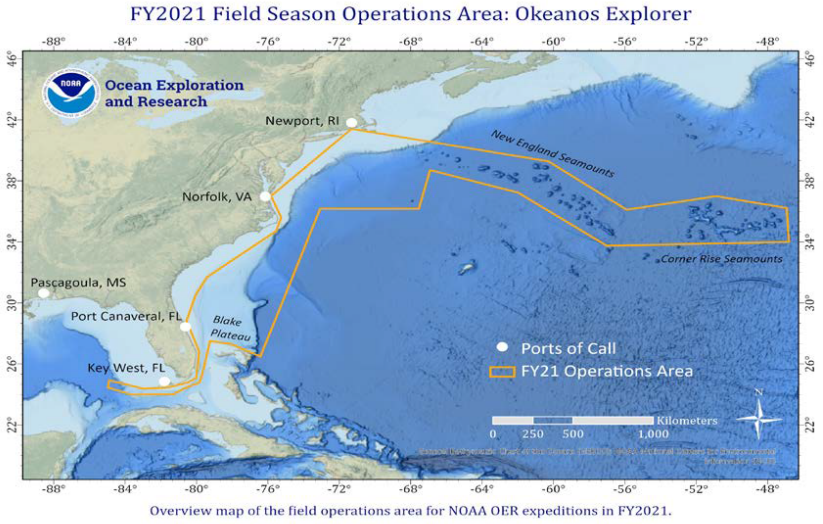
The 2018 to 2019 NOAA OER Biological Evaluation (BE) contained information regarding species and DPSs that may also be affected by the proposed marine operation activities on the NOAA ship *Okeanos Explorer* during the 2021 field season. Your staff provided an analysis and effects determinations for newly proposed ESA-listed coral critical habitat via email for the 2021 request for consultation on January 27, 2021. In the 2018 BE and the 2021 consultation initiation request, you concluded that the marine operation activities on the NOAA ship *Okeanos Explorer* were not likely to adversely affect ESA-listed species or their proposed or designated critical habitat within the action area.

Proposed Action and Action Area

Although still within the Gulf of Mexico and North Atlantic Ocean, the proposed action area is not the same as that for the 2020 consultation. The 2021 survey area includes additional marine environments within the U.S. exclusive economic zone (EEZ) off the coast of South Carolina extending north to New Jersey and along the New England Seamounts. Other proposed survey areas off the coast of Florida, Georgia and New England were included in the marine operation activities consulted on in 2020 and are contained in the 2021 survey area as well.

In addition to new survey areas, NOAA's Office of Ocean Exploration and Research plans to use additional sonar technology, the Teledyne Blueview Sonar, which was not used in the 2020 survey.

Figure 1. NOAA OER FY 2021 Field Season Action Area



Affected ESA-listed Species and Designated/Proposed Critical Habitat

Based on the information submitted by your office for the 2021 survey, although new areas will be surveyed, we determined that all ESA-listed species consulted on during the 2018, 2019 and 2020 field season would be the same for the 2021 field season. Furthermore, the additional information you provided related to the frequency and source levels of the Teledyne Blueview Sonar system indicated that it will operate at a frequency range (900 kHz to 2,250 kHz), which is outside of the hearing range for ESA-listed species in the action area. Therefore, the addition of this sonar technology to the cruise will not result in additional effects to ESA-listed species.

For this reason, this consultation considers only the potential effects to the proposed coral critical habitats from the 2021 survey.

Effects of the Action

"Effects of the action" has been recently revised to mean all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 C.F.R. § 402.02; see also 50 C.F.R. § 402.17).

The applicable standard to find that a proposed action is not likely to adversely affect ESA-listed species or designated critical habitat is that all of the effects of the action are expected to be extremely unlikely to occur, insignificant, or wholly beneficial. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. For an effect to be extremely unlikely to occur, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did affect a listed species), but it is very unlikely to occur.

Based on the information submitted by your office, we determined that all newly proposed coral critical habitat would experience the same impacts from the survey as critical habitat that is currently designated for elkhorn and staghorn coral in the action area. This is due to the survey depths of the cruise, which are planned to occur at depths greater than 250 meters, well below the depth distributions for all of the ESA-listed corals that have proposed critical habitat in the action area (See Figure 2). For this reason, we believe the effects of the cruise such as potential stressors associated with vessel transit and operation will be extremely unlikely to occur as previously determined for elkhorn and staghorn coral designated critical habitat. Therefore, the proposed 2021 surveys may affect, but are unlikely to adversely affect proposed coral critical habitat.

Figure 2. Depth distributions for ESA-listed corals with proposed critical habitat in the action area (85 FR 76302).

Species	Reef Environment	Depth Distribution	US Geographic Distribution
Dendrogyra cylindrus	most reef environments	1 to 25 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; Puerto Rico; USVI; Navassa
Mycetophyllia ferox	most reef environments	5 to 90 m	Southeast Florida from Broward County to the Dry Tortugas; Puerto Rico; USVI; Navassa
Orbicella annularis	most reef environments	0.5 to 20 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa
Orbicella faveolata	most reef environments	0.5 to 90 m	Southeast Florida from St. Lucie Inlet in Martin County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa
Orbicella franksi	most reef environments	5 to 90 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa

Conclusion

Based on this analysis, NMFS concurs with NOAA OER that the effects of the proposed action may affect, but are not likely to adversely affect proposed coral critical habitat.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by the NOAA Office of Ocean Exploration and Research or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) take occurs; (b) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this consultation; (c) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not previously considered in this consultation; or (d) if a new species is listed or critical habitat designated that may be affected by the action (50 C.F.R. §402.16). In the case of this consultation, because the effects of the proposed action on proposed critical habitat for ESA-listed Atlantic/Caribbean corals have been considered in this consultation, we do not anticipate the need for reinitiation should the designation be finalized.

We look forward to further cooperation with you on other projects to ensure the conservation of our threatened and endangered marine species and designated critical habitat. If you have any questions on this consultation, please contact me at (301) 427-8495 or by email at cathy.totorici@noaa.gov or Jonathan Molineaux at (301) 427-8440 or by email at jonathan.molineaux@noaa.gov.

Sincerely,

TORTORICI.CATHRYN.ELISA.1365826850
Digitally signed by TORTORICI.CATHRYN.ELISA.1365826850
Date: 2021.02.03 14:54:44 -05'00'

Cathryn E. Tortorici
Chief, ESA Interagency Cooperation Division
Office of Protected Resources

cc: Amanda Maxon
Environmental Compliance Contractor
Office of Ocean Exploration and Research

Literature Cited

NMFS. 2018a. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Marine Operation Activities on the National Oceanic and Atmospheric Administration Ship Okeanos Explorer for the 2018 through 2019 Field Seasons. Reference Number: FPR-2018-9276. National Marine Fisheries Service Office of Protected Resources, Silver Spring.

NMFS. 2018b. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Reinitiation of Section 7 Consultation for Marine Operation Activities on the National Oceanic and Atmospheric Administration Ship Okeanos Explorer for the 2018 through 2019 Field Seasons. Reference Number: FPR-2018-9284.

NMFS. 2019. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Reinitiation of Section 7 Consultation Pursuant to the Endangered Species Act for Marine Operation Activities on the National Oceanic and Atmospheric Administration Ship Okeanos Explorer for the 2018 through 2019 Field Seasons. Reference Number: OPR-2019-01058.

NMFS. 2020. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Reinitiation of Section 7 Consultation Pursuant to the Endangered Species Act for Marine Operation Activities on the Ship Okeanos Explorer for the 2020 Field Season. Reference Number: OPR-2020-00374.

Appendix B3. (Scientific Research Letter of Acknowledgement)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

SCIENTIFIC RESEARCH LETTER OF ACKNOWLEDGMENT **21007**

Principal Investigator:

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Operations Chief, Expeditions and Exploration Division
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Issuance Date: March 10, 2021

Acknowledged Study Period: April 1, 2021 – September 31, 2021

Vessel Owner or Operator	Vessel Name	IMO Number
NOAA	R/V *Okeanos Explorer*	8835114

This letter acknowledges that the R/V *Okeanos Explorer* is acting as a scientific research vessel, and is exempt from the Atlantic Coastal Fisheries Cooperative Management Act, the Magnuson-Stevens Fishery Conservation and Management Act, and fishery regulations published in 50 CFR parts 648 and 697. The acknowledgement applies while the vessel is participating in research activities described in the Scientific Research Plan, within the specified study period, and while under the control of NOAA. The regulations authorizing these exemptions are described in 50 CFR 600.745.

NOAA is using the *Okeanos Explorer* to conduct an exploration and mapping expedition in the North Atlantic Ocean. The research activity will use remote operated vehicles (ROV) and sonar technology to explore and map the ocean floor.

The expedition consists of 7 cruises and a combined 134 days-at-sea. Mapping and exploration activities will be conducted 24 hours a day. ROVs will be operated during the day, and sonar

mapping will be conducted at night. OER staff will be on board all trips conducted under this LOA to direct research activities. No fishing gear will be deployed during the research cruises.

This letter does not acknowledge any other activities conducted outside the scope of the Scientific Research Plan; including those which may not be considered scientific research activities and may require a separate permit. This letter is not intended to inhibit or prevent any scientific research activity conducted by the research vessel. In addition, this letter does not exempt the above vessel from requirements imposed by any state.

This letter is separate and distinct from any permit or consultation required under the Marine Mammal Protection Act, the Endangered Species Act, or any other applicable law. To determine if such a permit is required, please contact the Greater Atlantic Region's Protected Resources Division at (978) 281-9174. All necessary permits should be obtained prior to embarking on any research activity.

Please submit a copy of any cruise report or other publication created as a result of the project, including the amount, composition, and disposition of the catch, be submitted to: Ryan Silva, at ryan.silva@noaa.gov.

Please carry copies of the Scientific Research Plan and the Letter of Acknowledgment (LOA) on board the vessel while conducting this research. If the vessel is subject to vessel monitoring system reporting requirements, the vessel will need to declare out of fishery (DOF-SCI) while operating as the research platform. In addition, it is recommended that any fish or fish parts retained for research be accompanied by a copy of this LOA.

Acknowledged by:

Sarah Bland
Assistant Regional Administrator
for Sustainable Fisheries