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National Coral Reef Monitoring Program

Biological Monitoring Summary

Flower Garden Banks National Marine Sanctuary: East and West Flower Garden Banks 2024

NOAA | NOS Coral Reef Conservation Program
NOAA | NOS National Centers for Coastal Ocean Science
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NOAA Technical Memorandum NOS CRCP 55

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Flower Garden Banks National Marine Sanctuary: East and West Flower Garden Banks 2024

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2025

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Cover photos by Nicole Krampitz and infographic photos by Nicole Krampitz (left), Adam Glahn (top right), and Bethany Williams (bottom right).

Disclaimer

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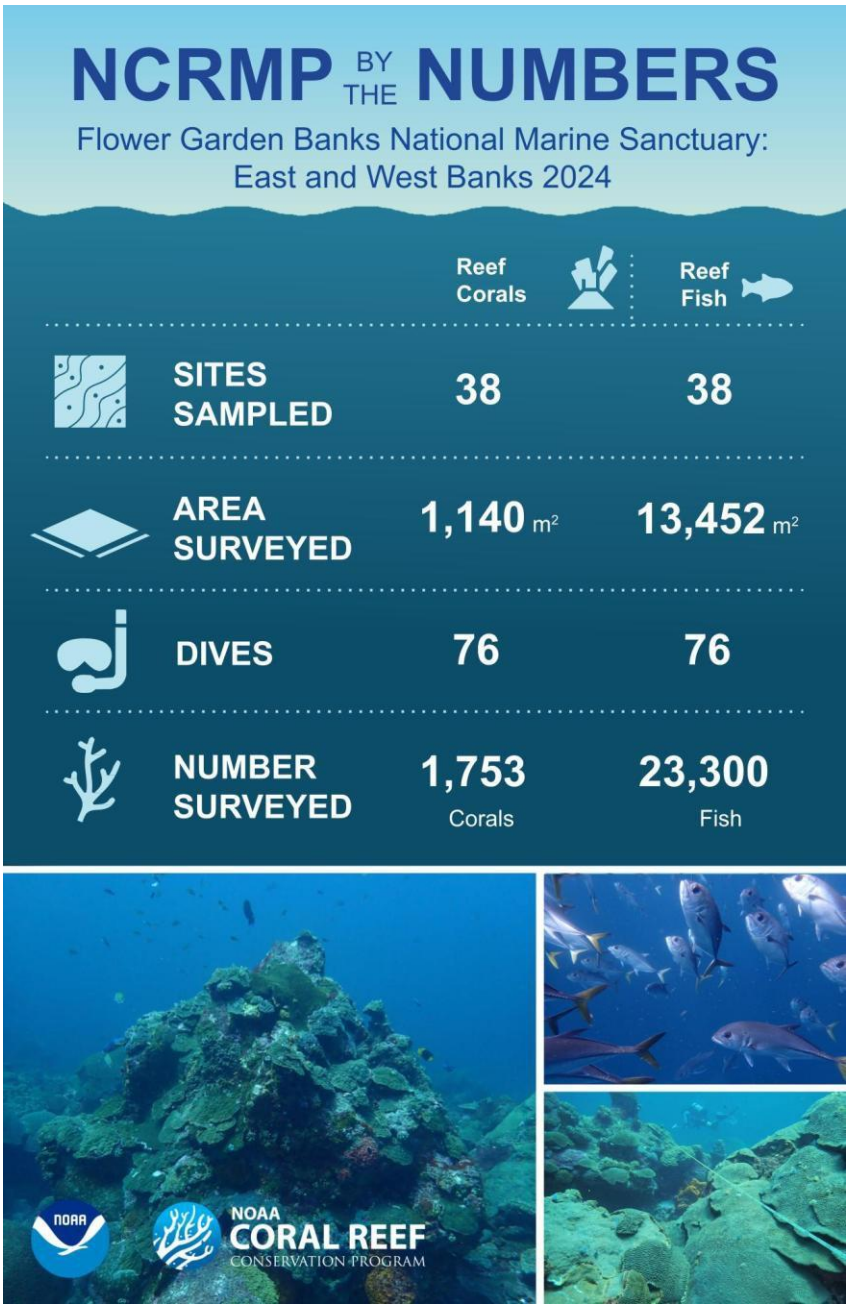
Acronyms

APT	All Purpose Tool
CRCP	NOAA Coral Reef Conservation Program
CV	Coefficient of Variation
ESA	Endangered Species Act
EFGB	East Flower Garden Bank
FGBNMS	NOAA Flower Garden Banks National Marine Sanctuary
GAM	Generalized Additive Models
LAI	Large Area Imagery
NCCOS	NOAA National Centers for Coastal Ocean Science
NCEI	NOAA National Centers for Environmental Information
NCRMP	National Coral Reef Monitoring Program
NMFS	NOAA Fisheries
NOAA	National Oceanic and Atmospheric Administration
NOS	NOAA National Ocean Service
OCM	NOAA Office for Coastal Management
RVC	Reef fish Visual Census
SCTLD	Stony Coral Tissue Loss Disease
SE	Standard Error
SEFSC	NOAA Fisheries, Southeast Fisheries Science Center
USVI	United States Virgin Islands
WFGB	West Flower Garden Bank

Executive Summary

NOAA's National Coral Reef Monitoring Program (NCRMP) conducted biological sampling for fish populations and communities, and for coral populations and benthic communities at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB). NCRMP surveys at EFGB and WFGB, part of Flower Garden Banks National Marine Sanctuary (FGBNMS), began in 2013, and in recent years, have been conducted in even-numbered years. In 2024, NCRMP dive surveys on EFGB and WFGB's shallow-water (18–30 m) coral reefs occurred during a single field mission from late July to early August. NCRMP data complement local monitoring, inform coral and fish population management strategies, and document the occurrence of endangered species and coral disease. Information about NCRMP's methods, data, and data products is available on the project website: https://www.coralreef.noaa.gov/topics/national-coral-reef-monitoring-program/biological.



Report Overview

NCRMP provides large-scale, stratified-random monitoring data to detect the status and trends of coral reef communities. The NCRMP biological sampling effort consists of surveys of: 1) Fish Communities and Populations, and 2) Benthic Communities and Coral Populations. This report provides a broad overview of NCRMP's accomplishments and regional results by summarizing the 2024 biological data collected by NOAA and regional partners in the shallow water coral reef ecosystems of East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB).

Sampling Overview

In 2024, the cruise collected surveys from July 29 to August 1 aboard the M/V *Fling*. Partners involved in these efforts included:

- Channel Islands National Marine Sanctuary
- Flower Garden Banks National Marine Sanctuary
- Louisiana State University
- NOAA Diving Program
- NOAA Fisheries - Southeast Regional Office
- Nova Southeastern University
- Texas A&M University-Corpus Christi
- U.S. Environmental Protection Agency

Key Report Points

Corals and Benthic Community

- Coral cover at EFGB and WFGB has remained consistently high (> 50%) since 2013, and in 2024, estimated coral cover was 65.0% ± 4.1. This is by far the highest coral cover of all the U.S. Atlantic coral reef jurisdictions (Florida, FGBNMS, Puerto Rico, U.S. Virgin Islands).
- High coral cover and density are driven by the persistence of large, on average > 1 m, colonies of massive species like *Orbicella franksi, O. faveolata, and Siderastrea siderea,* as well as sites dominated by large fields of branching *Madracis auretenra.*
- Evidence of recent or old mortality on coral colonies continues to be low, despite observations of coral bleaching in 2023 and ongoing coral disease since 2022 surveys.

Fish Community

- Reefs were dominated by a mix of smaller demersal and pelagic fishes, including creole wrasse (*Clepticus parrae*), brown chromis (*Chromis multilineata*), Atlantic creolefish (*Cephalopholis furcifer*), bluehead wrasse (*Thalassoma bifasciatum*), and bicolor damselfish (*Stegastes partitus*).
- A strong recruitment year for yellowmouth grouper (*Mycteroperca interstitialis*), first noted in the 2022 survey, was evident again at EFGB and WFGB reefs in 2024, with many individuals now nearing documented length at reproductive maturity.
- NCRMP fish data showed greater variability in density estimates compared to previous survey years, largely due to fewer sites sampled in 2024.

Introduction

Coral reefs are valuable ecosystems that provide people with goods and services, including food, coastal protection, and recreational opportunities. Despite their importance, coral reef ecosystems are in decline from numerous human-made threats that directly degrade resources and exacerbate natural stressors (Hughes and Tanner, 2000; Knowlton, 2001). In response to these threats, National Oceanic and Atmospheric Administration (NOAA)'s Coral Reef Conservation Program (CRCP) established a National Coral Reef Monitoring Program (NCRMP) with partners across the United States (U.S.). This program is a strategic framework for conducting long-term, quantitative surveys of biological, environmental, and socioeconomic indicators in U.S. coral reef states and territories. The resulting data present a robust picture of the U.S. coral reef ecosystem condition and the communities connected to them.

NCRMP biological monitoring provides an assessment of the coral reef communities over a broad spatial scale in U.S. jurisdictions. The goal is to generate robust, quantitative data that document the status and trends of coral reef fishes, corals, and benthic communities at a regional (or jurisdictional) scale (NOAA CRCP, 2021; Towle et al., 2022). NCRMP produces large-scale, regional status and trend information of U.S. shallow-water (≤ 30 m) coral reef ecosystems. These data provide critical context and perspective for understanding ecosystem condition and informing coral reef management. Biological sampling occurs on a two-year cycle in the U.S. Virgin Islands (USVI; including St. Thomas, St. John, and St. Croix), Puerto Rico, Florida, and Flower Garden Banks National Marine Sanctuary (FGBNMS; Figure 1).

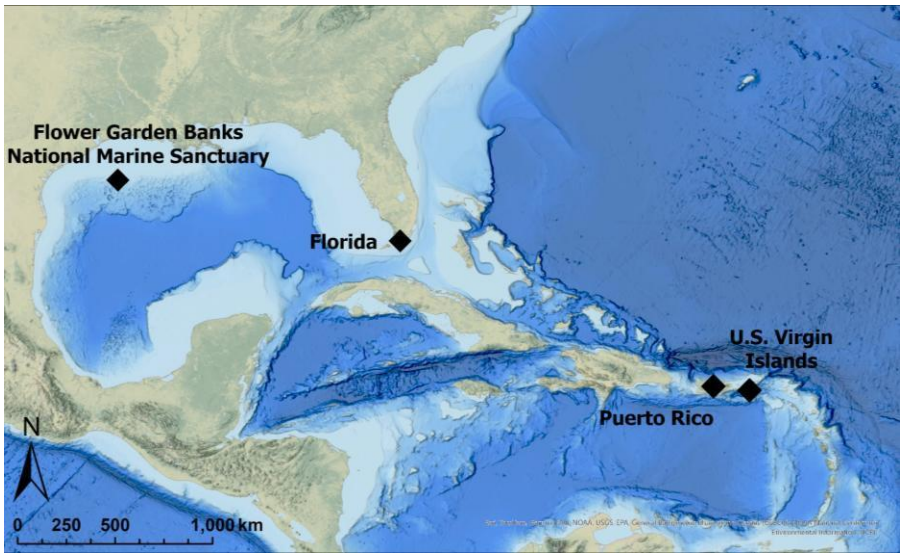


Figure 1. Map of U.S. Atlantic jurisdictions sampled within the National Coral Reef Monitoring Program (NCRMP).

This report summarizes NCRMP biological sampling data in 2024 from the coral reef caps (18–30 m) at EFGB and WFGB. Data summaries for ecologically important metrics are provided for the most recent sampling year, and trends are reported from the onset of NCRMP. The full datasets for 2024 and prior can be obtained from the NCRMP data webpage (https://www.coralreef.noaa.gov/topics/national-coral-reef-monitoring-program/data) and the NOAA's National Centers for Environmental Information (NCEI) database (see Appendix for additional reference and archive information).

NCRMP has surveyed EFGB and WFGB since 2013, and this report shows trend data for fish and benthic communities between 2013 and 2024. NCRMP surveys complement Flower Garden Banks National Marine Sanctuary (FGBNMS) long-term monitoring efforts, which have been conducted annually at fixed sites since 1988 (Eisenbach et al., 2025).

Methods

Sample Design

NCRMP biological monitoring of fishes, corals, and benthic communities uses a grid-based stratified random design. This strategic approach is optimized to efficiently sample for ecologically and commercially important species while also collecting representative community data. Details of the sample frame protocol, methods, and definitions of the specific habitat types can be found in the Spatial Framework Protocols (NOAA NCCOS, 2018). The survey design ensures that survey sites for fish and corals are proportionally allocated in the sampling domain by geography (East and West Flower Garden Banks) to a maximum depth of 30 m in FGBNMS.

Each year, NCRMP strives to sample a target number of sites in each jurisdiction to ensure that data are statistically robust and able to detect status and trends. The actual number of sites sampled varies due to weather conditions, ship time, and other resource constraints. Fish and benthic sites are co-located within the same grid cell, but may not be sampled during the same dive. As additional NCRMP data are gathered in future years, the program's ability to detect long-term trends and variability will increase.

Sample Protocols

Field Surveys

Corals and benthic communities were monitored using the Benthic Community Assessment survey and the Coral Demographics survey (NOAA CRCP, 2024a; 2024b; Figure 2). Together, these surveys provide complementary measures of benthic community cover and coral population structure and condition.

The Benthic Community Assessment survey includes: 1) benthic cover (%) estimates using a line point intercept (LPI) approach along a 15 m transect, 2) presence/absence of Endangered Species Act (ESA)–listed coral species (in transect area; at site), 3) abundance of key macroinvertebrates, and 4) reef rugosity measurements within a 15 m × 2 m belt-transect area (NOAA CRCP, 2024a). At the same site, Coral Demographics surveys are conducted within a 10 m × 1 m belt-transect area (NOAA CRCP, 2024b). Within this transect, all live coral colonies ≥ 4 cm were counted, identified to species level, and measured to the nearest centimeter (length, width, and height). Partial mortality was estimated as the percentage of the colony surface area showing old mortality, recent mortality, or both. Relative condition factors such as disease (present, with lesion progression classified as slow or fast) and bleaching (total, partial, or paling) were also recorded when present per colony. Only live coral colonies were included in the surveys; dead colonies with 100% mortality were not surveyed due to the unreliability of species-level identification of dead coral skeletons. In a first for NCRMP EFGB and WFGB Coral Demographics surveys, counts of a subset of species of small corals (< 4 cm) were included in 2024 (NOAA CRCP, 2024b) to provide information on coral recruitment and species dynamics. Other species of small corals were reported for species richness only and were not included in counts, size measurements, or estimates of condition.

NCRMP Coral Demographics surveys provide information on disease occurrence on individual coral colonies; however, disease identification is not included (NOAA CRCP, 2024b). Disease progression rate estimates (i.e., slow or fast rates determined by lesion width greater or less than 1 cm) were added at the request of

partners as a rapid, general approach to identify potential stony coral tissue loss disease (SCTLD). However, further information has shown that the rate is not a reliable indicator of SCTLD; therefore, NCRMP will revisit the inclusion of this classification approach in subsequent survey years. Additional information on how NCRMP can inform SCTLD response is provided in Towle (2021).

NCRMP surveys consistently include evaluations of coral bleaching (total, partial, paling, or none) per coral colony (NOAA CRCP, 2024b). Because NCRMP field sampling dates do not always coincide with bleaching events, peak bleaching may not fully be captured in the NCRMP data.

In a first for NCRMP EFGB and WFGB surveys, photogrammetry was collected at a subset of sites in 2024. A dedicated imagery diver collected high-resolution photos of approximately a 15 x 3 m survey area. Given the limitations of diver time at depth, large coral colonies, and high coral cover, this field method may have advantages over in situ surveys. In addition, photogrammetry provides a permanent record of the survey site. In a future comparison study, NCRMP benthic metrics will be extracted from orthophotomosaics (Edwards et al., 2023) and calibrated to diver-collected NCRMP benthic data to identify efficiencies and trade-offs related to a potential methods change for a long-term monitoring program.

The Reef Fish Visual Census (RVC) is a stationary point count sampling protocol (NOAA CRCP, 2024c) modified from Bohnsack and Bannerot (1986). A two-diver RVC team surveyed all fish within adjacent 15 m diameter cylinders centered on each diver and extending vertically from the substrate to the sea surface. Within each cylinder, fishes were identified to the species level, counted, and fork length was estimated to the nearest centimeter (Figure 2). Fish sizes were verified using an All Purpose Tool (APT), a one meter measuring stick with a perpendicular 30 cm top marked with cm measurements. Data collected by the diver survey pair were averaged at the site level.

Figure 2. Examples of a diver collecting benthic community data (left) and Reef Visual Census (RVC) fish survey data (right) at East Flower Garden Bank. Photo credits: NOAA NCCOS.

Data Quality Assurance

NCRMP data quality standards were met using five primary approaches:

1) NCRMP surveyors demonstrated expertise in field identification prior to field surveys. Surveyors were trained in NCRMP methods through a) detailed training for new surveyors and b) annual refresher

training for repeat surveyors;

2) NCRMP fish surveyors initially calibrated their fork length measurements using an APT during training dives and, to ensure consistency, continued to use an APT during field surveys;
3) Reciprocal data checks followed data collection at each site. Upon surveyors' return to the survey vessel after each dive, surveyors traded datasheets with their dive buddy and reviewed them to ensure all data were collected consistently and completely;
4) Divers entered their data into the online database and then compared their original datasheets with the database entries; and
5) Data from the database underwent quality checks that included basic statistical analyses (e.g., by species and diver). After vetting, the data were archived at NCEI and made publicly available (Appendix).

Analytical Methods

Corals and Benthic Communities

The condition of coral populations and benthic communities is summarized here using standard metrics, including benthic cover (% cover of corals and macroalgae), coral species occurrence, coral density, and relative size composition for select individual species, to allow for temporal and cross-jurisdictional comparisons. Computational formulas of standard metrics for single-stage stratified random sampling design are provided in detail in Smith et al. (2011a), Viehman, Groves, et al. (2024), and Groves et al. (2025). Species size distributions for each year were generated from measurements of the maximum skeletal diameter of colonies ≥ 4 cm, which included areas of partial mortality (Bak and Meesters 1998, Meesters et al., 2001), and weighted. Generalized Additive Models (GAM) with the tweedie distribution were used to model how partial mortality of a coral colony varied by colony size for coral species each year of NCRMP's surveys at EFGB and WFGB. Mean colony density was calculated by year and coral species. For temporal comparisons, a pairwise two-tailed t-test was performed to evaluate differences between years (see Results section) per species. Site-level coral bleaching and disease prevalence were calculated by species as the number of colonies with any bleaching or disease divided by the total number of corals at each site. Domain-level prevalence was then calculated as the percentage of affected colonies for each species across all sites and strata.

NCRMP analysis scripts for corals and benthic communities are open source and available through the NCRMP **Benthic R package** (Groves et al., 2025).

Fish Communities

Standard fish metrics, including density, occurrence, and relative length composition, are reported herein. Computational formulas of standard metrics for a single-stage stratified random sampling design are modified from Smith et al. (2011b) and provided in detail in Grove et al. (2021) and Bryan et al. (2016). Additionally, a two-tailed t-test was performed to evaluate density differences between years (see Results section).

Of note, fish surveys in 2013 and 2015 were collected using the belt-transect methodology, and from 2018 to 2024 using the RVC stationary-point-count methodology described above. A calibration study allowed for the belt-transect results to be statistically calibrated to RVC estimates and the full time series to be analyzed.

Fish analysis scripts are open source and available through the NCRMP **Fish R package** (Ganz and Blondeau 2015).

Results

In 2024, NCRMP surveyed 38 sites at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB), combined (Table 1, Figure 3). Fewer sites were surveyed in 2024 than in previous NCRMP years due to challenging sea conditions that resulted in slower dive operations. Of note, no surveys were conducted in 2020 due to the global COVID-19 pandemic. Additionally, off-cycle 'bonus' fish surveys, collected in 2023 as part of a separate calibration effort, were included in analyses for this report.

Table 1. National Coral Reef Monitoring Program fish and benthic surveys completed by year at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB).

Year	Flower Garden Banks National Marine Sanctuary					
	EFGB		WFGB		Total	
	Fish	*Benthic*	*Fish*	*Benthic*	*Fish*	*Benthic*
2024	25	25	13	13	38	38
2023	39	-	35	-	74	-
2022	30	29	23	20	53	49
2018	17	17	20	20	37	37
2015	37	37	26	26	63	63
2013	39	39	30	30	69	69

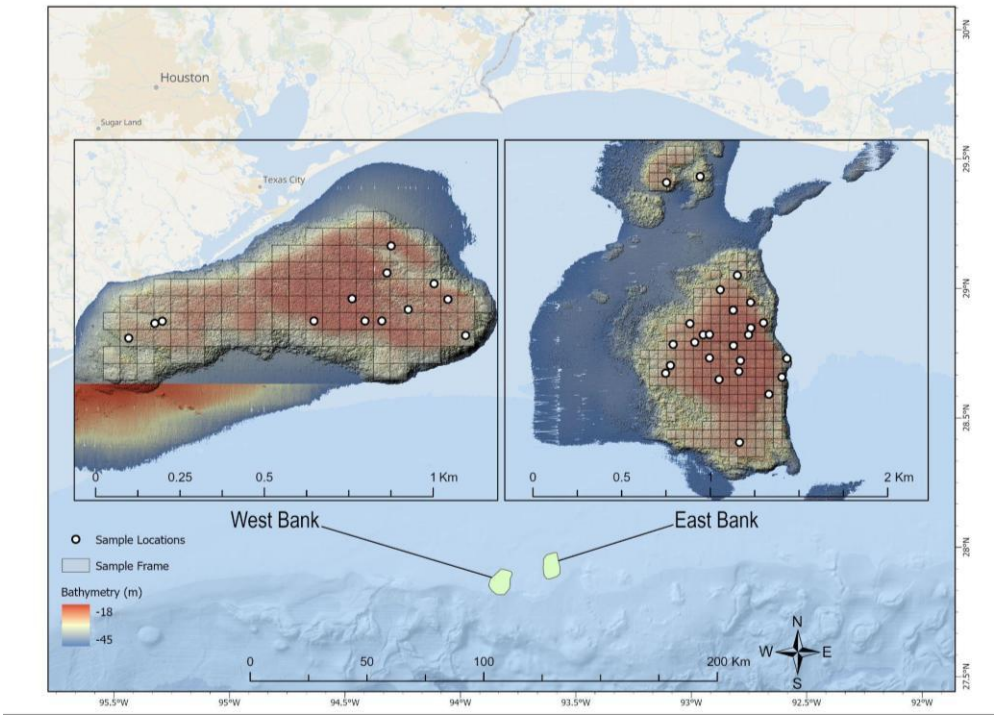


Figure 3. NCRMP survey sites sampled at West Flower Garden Bank (left) and East Flower Garden Bank (right).

Benthic Community Results

Coral and Macroalgae Cover

Mean coral cover on EFGB and WFGB remains consistently high (Figure 4; Eisenbach et al., 2025; Viehman and Groves, et al., 2023). In 2024, mean coral cover was 65.0% ± 4.1, which is significantly higher than 56.7% (± 2.0) in 2013. In contrast, macroalgae cover has declined significantly from 29.4% (± 1.7) in 2013 to 12.7% ± 2.0 (Figure 4) in 2024. However, macroalgae cover can be strongly influenced by the timing of the sampling season and the habitat type surveyed.

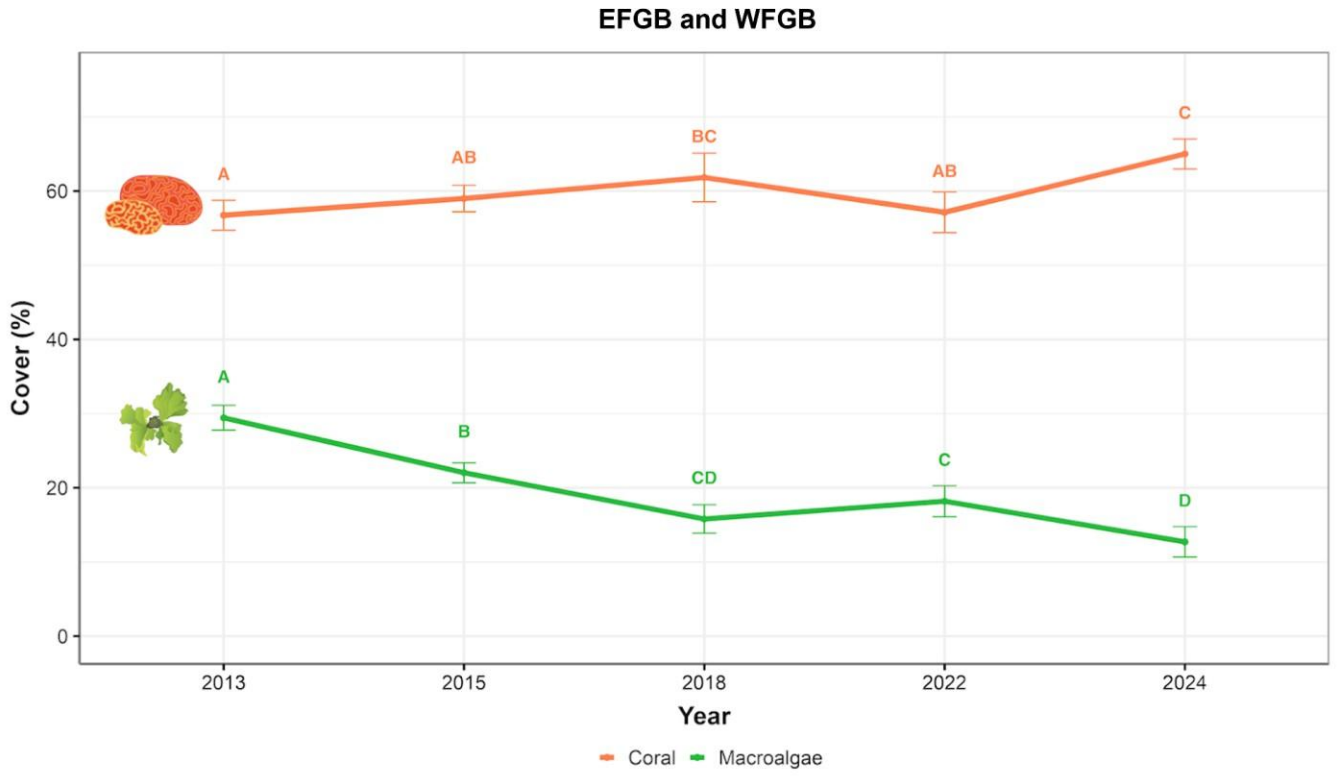


Figure 4. Mean cover (%) ± standard error (SE) for corals and macroalgae at EFGB and WFGB. Statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., A, B, C, D) denote a difference between survey years.

Coral Species Occurrence

In 2024 NCRMP coral demographic surveys, seven coral species had CVs of 20% or lower: *Porites astreoides*, *Pseudodiploria strigosa*, *Orbicella franksi*, *Montastraea cavernosa, Agaricia agaricites, Colpophyllia natans,* and *Orbicella faveolata* (Figure 5). A 20% CV of density allows for statistically detecting a 40% change; thus, a lower CV increases the ability to detect differences. This emphasizes the importance of surveying additional sites in future assessments to reduce variability and improve precision, particularly for less common coral species, thereby strengthening the ability to detect ecologically meaningful changes.

Coral species listed as threatened under the U.S. Endangered Species Act (Federal Register 2014) were highly prevalent on EFGB and WFGB and present at 95% of the NCRMP benthic survey sites. The most prevalent ESA-listed species were *O. franksi* and *O. faveolata* (present at 36 of the 38 sites), and *O. annularis* was occasionally present (present at 4 of the 38 sites; Figure 5).

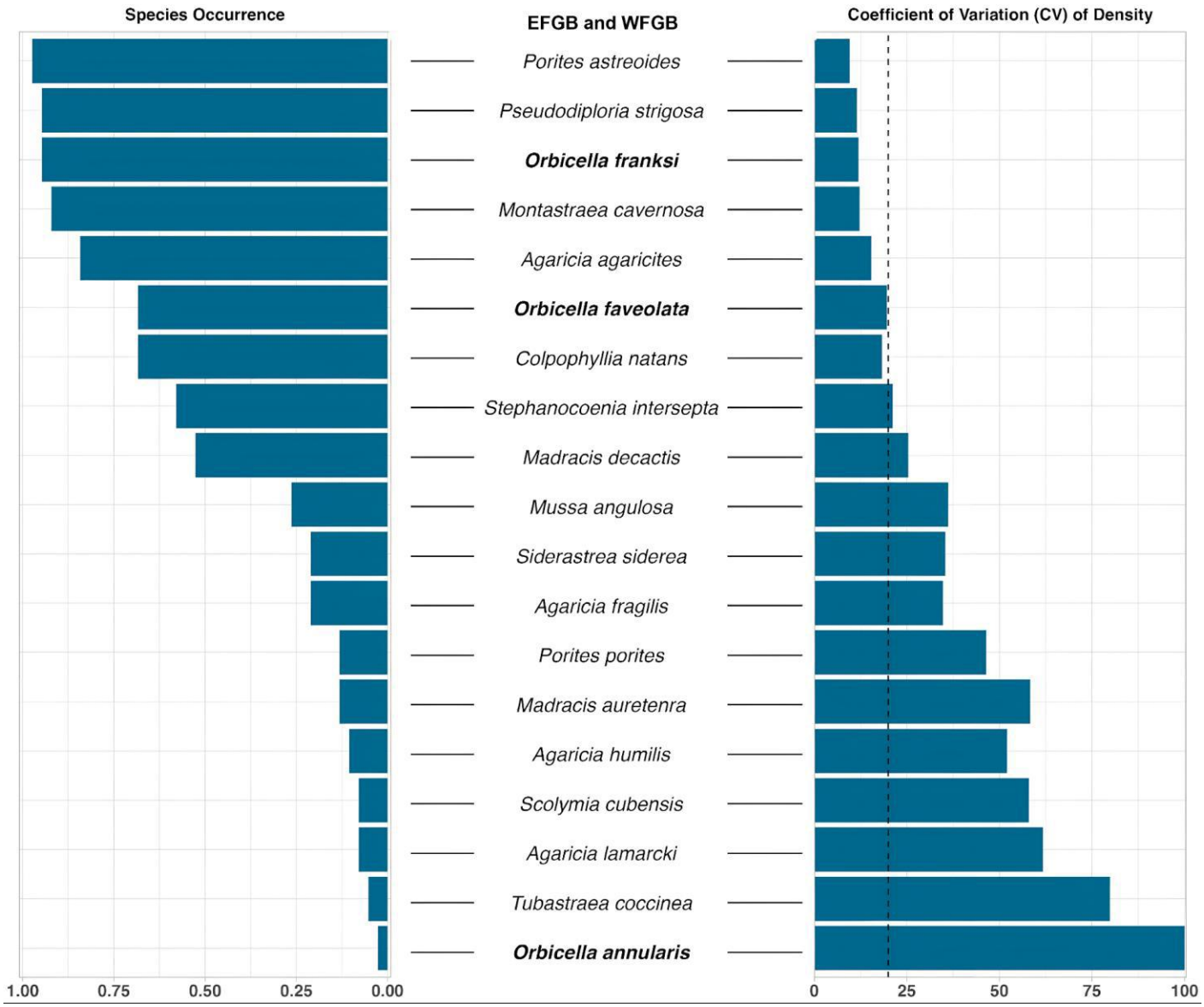


Figure 5. Coral species occurrence and coefficient of variation (CV) of density from NCRMP 2024 coral demographics surveys at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB). Species with an occurrence less than 0.01 are not shown. Dashed vertical line on the CV plot indicates the target CV of 20%. Bold font indicates the species is listed as threatened under the U.S. Endangered Species Act.

Coral Density and Size Distribution

Density estimates reflect only surviving corals. This highlights the importance of also tracking size and partial mortality, which provide information on the health of coral populations beyond density alone. In 2024, the coral species with the highest densities were *P. astreoides*, *O. franksi, P. strigosa,* and *A. agaricites* (Figure 6). *Madracis auretenra* had the largest mean colony size (maximum skeletal dimension), a result skewed by a few low-relief sites that were largely dominated by large *Madracis* colonies. What sets EFGB and WFGB apart from other coral reefs in the U.S. Atlantic is the continued persistence of large, massive species with coral colonies > 1 m in diameter with low partial mortality. In 2024, *O. faveolata, O. franksi,* and *S. siderea* were the next largest species, with average maximum diameters ranging from 123–134 cm (Figure 6). Overall mortality in 2024 was low (mean overall old mortality = 7.5 ± 0.8% and mean overall recent mortality = 0.3 ± 0.07%). The *Madracis* species had the highest average percentage of old mortality (*M. decactis*: 21.0 ± 5.8%, *M. auretenra*: 16.2 ± 8.5%). Overall, recent mortality was low, at less than 2.5% by species (Figure 6).

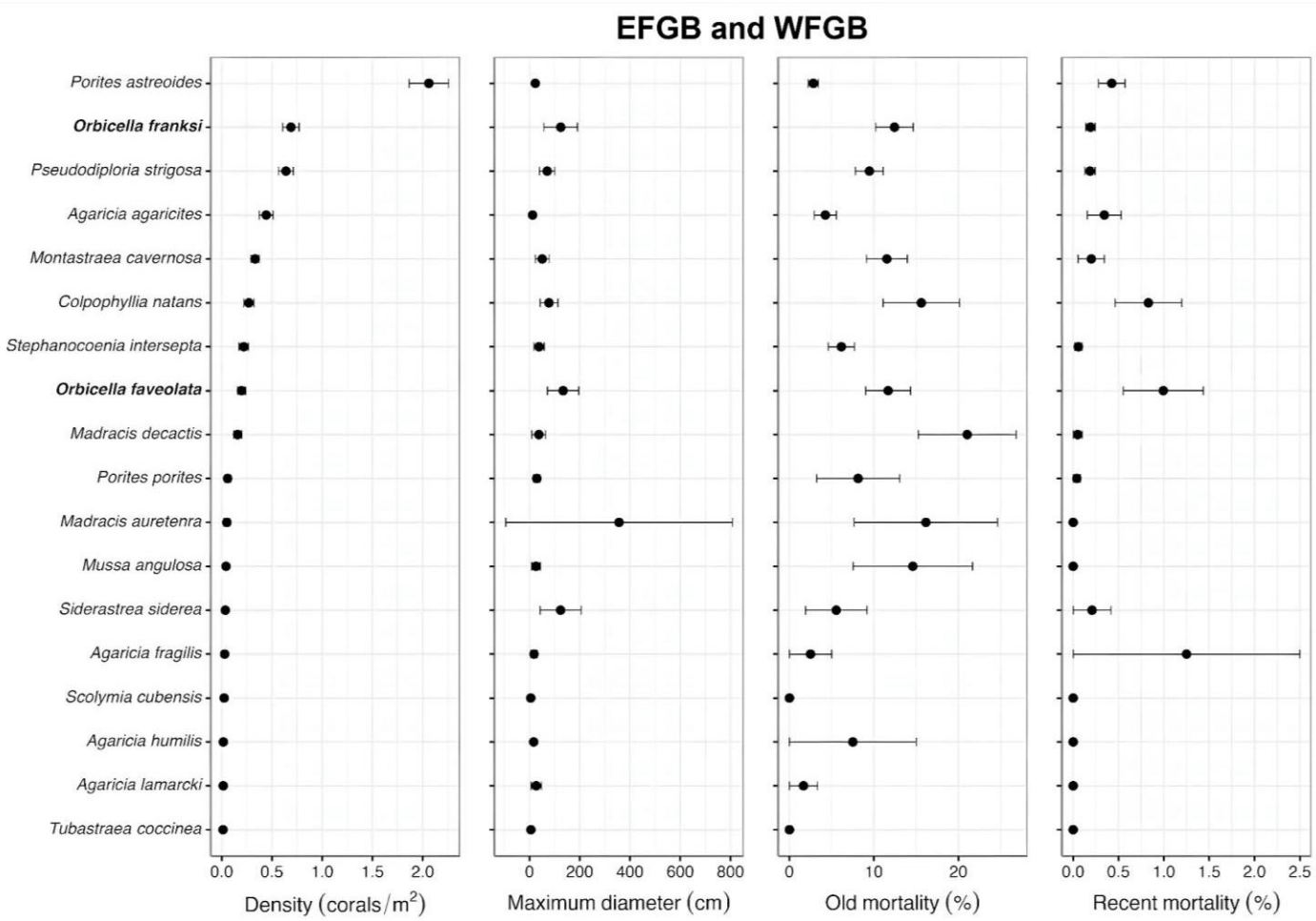
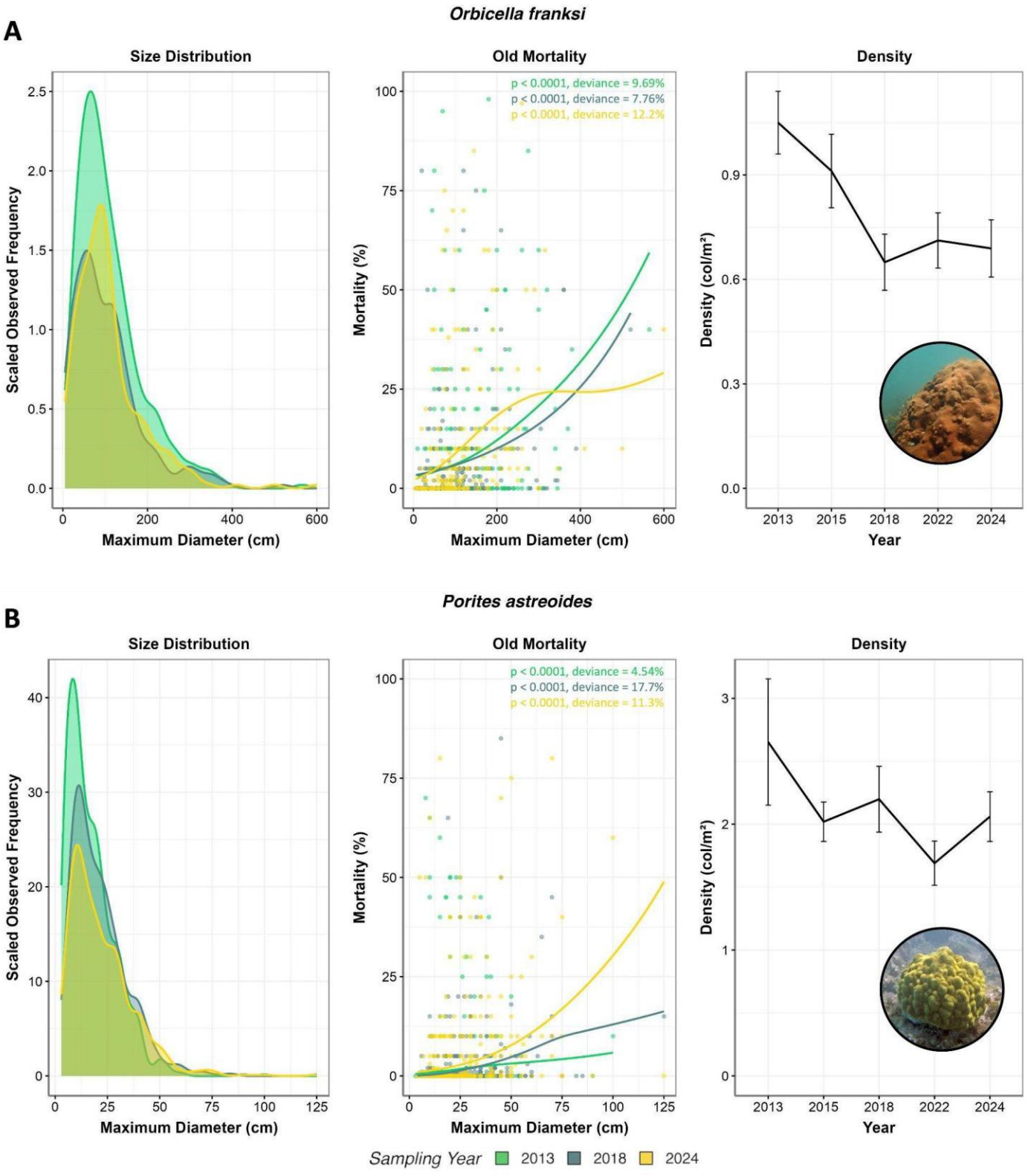


Figure 6. Mean density of corals (colonies/m^2), maximum diameter (cm), percentage of old mortality (%), and percentage of recent mortality (%) by coral species from NCRMP 2024 surveys at East and West Flower Garden Banks. Species are ordered in terms of decreasing density, and only species with densities above 0.01 are included. Error bars indicate standard error (SE). Bold font indicates that the species is listed as threatened under the U.S. Endangered Species Act.


A
Orbicella franksi
Size Distribution
Scaled Observed Frequency
Maximum Diameter (cm)
Old Mortality
p < 0.0001, deviance = 9.69%
p < 0.0001, deviance = 7.76%
p < 0.0001, deviance = 12.2%
Mortality (%)
Maximum Diameter (cm)
Density
Density (col/m²)
Year
B
Porites astreoides
Size Distribution
Scaled Observed Frequency
Maximum Diameter (cm)
Old Mortality
p < 0.0001, deviance = 4.54%
p < 0.0001, deviance = 17.7%
p < 0.0001, deviance = 11.3%
Mortality (%)
Maximum Diameter (cm)
Density
Density (col/m²)
Year
Sampling Year 2013 2018 2024

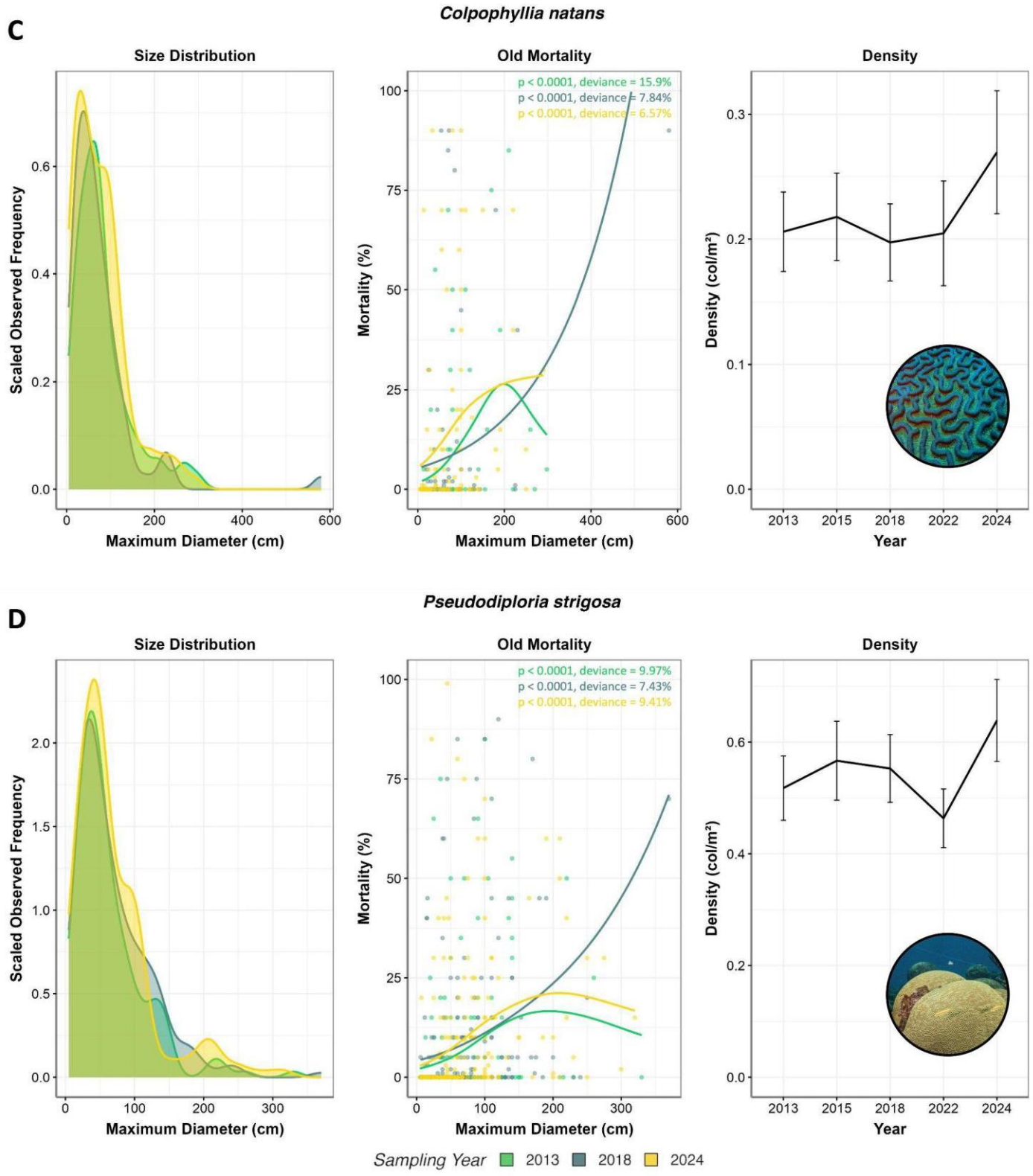


Figure 7. Summary of NCRMP East Flower Garden Bank and West Flower Garden Bank survey results for A) *Orbicella franksi*, B) *Porites astreoides*, C) *Colpophyllia natans,* and D) *Pseudodiploria strigosa.* Left panel is size distribution scaled by observed frequency of maximum diameter; Middle panel is relationship between maximum diameter and old mortality across years, with fitted GAM (Generalized Additive Model) and associated p-values and percent deviance explained; Right panel is mean colony density (colonies per m^2) across survey years with standard error.

Relative size frequencies (using maximum diameter) and coral densities for select coral species in FGBNMS indicate relatively stable populations of *Colpophyllia natans*, *O. franksi*, *P. astreoides*, *P. strigosa* over time on EFGB and WFGB from 2013 to 2024 (Figure 7). GAM models of old colony mortality (%) by size distribution (maximum diameter) show that mortality generally increases with coral colony size (Figure 7). The subset of species shown in Figure 7 was selected based on CV, ESA status, SCTLD susceptibility, and ecological value (e.g., reef-building capability).

Divers observed partial bleaching, paling, and disease on multiple coral species in 2024 surveys (Figure 8), although no total bleaching was observed, and the percentage of recent mortality on colonies was low (Figure 6). *Orbicella faveolata* had the highest prevalence of both bleaching and disease (Figure 8). Coral disease was observed on *O. faveolata*, *C. natans*, *O. franksi*, *P. strigosa*, *P. astreoides,* and *A. agaricites* (Figure 8). A disease outbreak was observed in FGBNMS starting in 2022, but this disease has not been definitively characterized; the long-term disease dynamics and histopathological signs do not suggest it is SCTLD (Johnston et al., 2023; Rossin 2024).

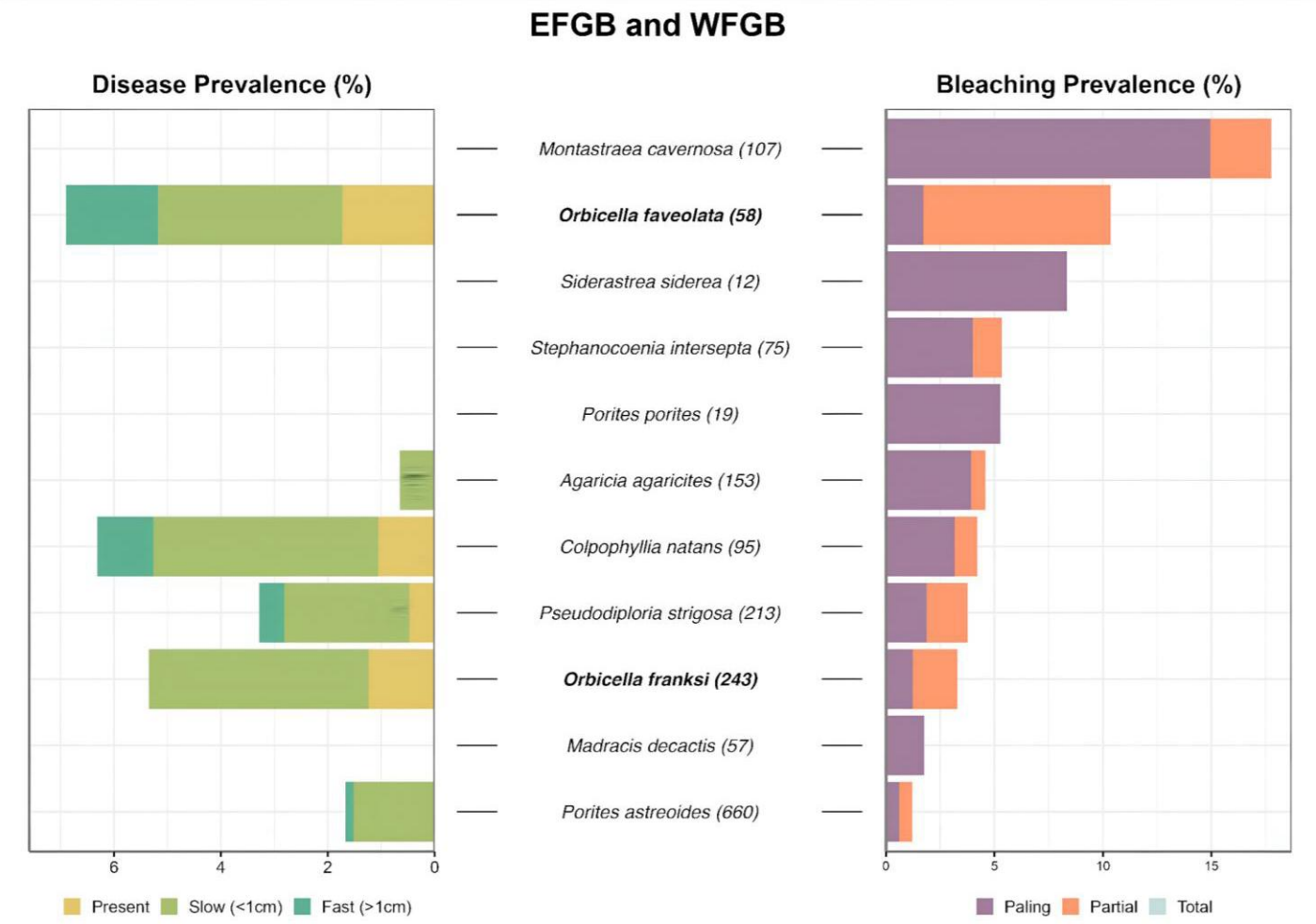


Figure 8. Disease prevalence (left) and bleaching prevalence (right) by coral species from NCRMP 2024 surveys at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB). Only species with disease or bleaching observed in the NCRMP coral demographics surveys are included. Bolded species are ESA-listed.

Large Area Imagery

Results presented in this document are from diver-collected data. Large area imagery (LAI) was collected at 19 NCRMP EFGB and WFGB sites in 2024 (Figure 4). LAI analysis and data archival at NCEI is in progress.

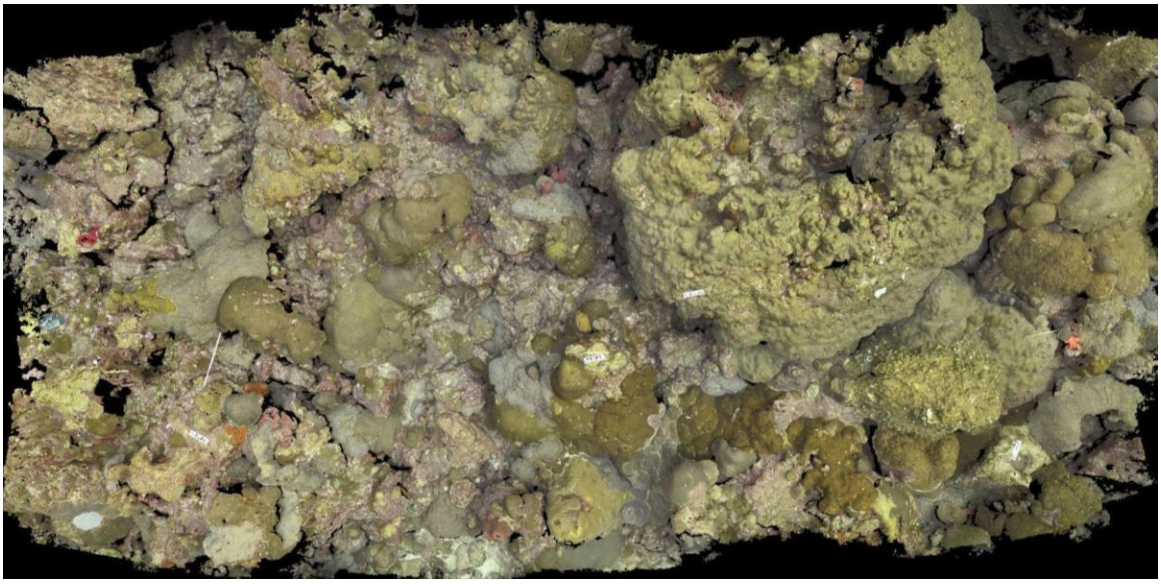


Figure 9. Large area imagery (LAI) of a NCRMP benthic transect at East Flower Garden Bank in 2024. Survey area is approximately 15 x 3 m. Scale bars are visible in the image.

Fish Community Results

Fish Species Occurrence

Statistically robust data are needed to effectively assess the health of fish populations and inform fisheries and ecosystem management efforts. NCRMP fish surveys observed 101 unique fish species with 19 individual species having CVs of density less than 20% at EFGB and WFGB (Figure 10). A 20% CV of density allows for statistically detecting a 40% change; thus, a lower CV increases the ability to detect differences. For example, the NCRMP data shows that three species of parrotfish, including stoplight (*Sparisoma viride*), queen (*Scarus vetula*), and redband (*Sparisoma aurofrenatum*) parrotfish, were regularly observed and had CVs of density that were less than 20%. Two species, bluehead wrasse (*Thalassoma bifasciatum*) and brown chromis (*Chromis multilineata*) were observed at every survey site, resulting in CVs of density below 12% (Figure 10). In 2024, the smaller sample size (n = 38 sites) resulted in fewer species having CVs of density that were 20% or less compared to previous survey years (e.g., 19 species in 2024 versus 31 species in 2022).

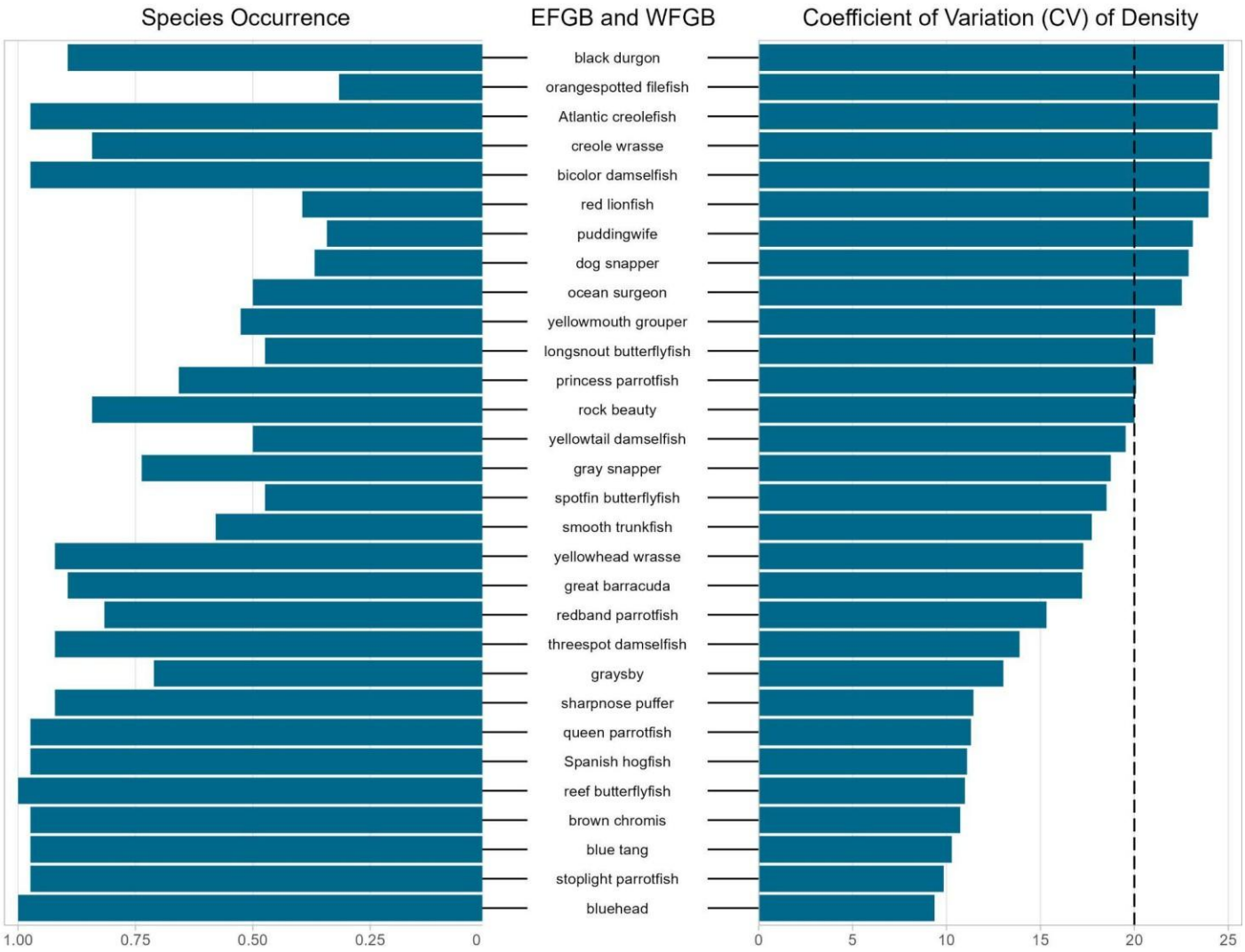


Figure 10. Reef fish species occurrence with a CV of density < 25% from NCRMP 2024 surveys. Species are sorted by increasing CV of density at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB). Dashed vertical line on the CV plot indicates the target CV of 20%.

Fish Density

Marine ecosystems are diverse. A common practice used to simplify complex datasets and improve communication to stakeholders in large-scale reports is to group fishes together (e.g., guilds, trophic, genera) and present results as a single analysis metric (e.g., density, occurrence, biomass). When species are grouped, it obscures species-specific trends that can slow the implementation of management actions and, in some cases, the detection of ecosystem stress. Fish groups are often dominated by a single or a few species. When all species are combined, it can result in a misinterpretation of the data as it is often assumed that each species equally contributes to the total. At EFGB and WFGB, five species of herbivores make up 73% of the total herbivore density, highlighting the importance of analyzing and reporting species-specific information. Dominant herbivore trophic group species have remained similar over time and, in 2024, include bicolor damselfish (*Stegastes partitus*), black durgon (*Melichthys niger*), queen parrotfish, Bermuda chub (*Kyphosus sectatrix*), and blue tang (*Acanthurus coeruleus*; Figure 11).

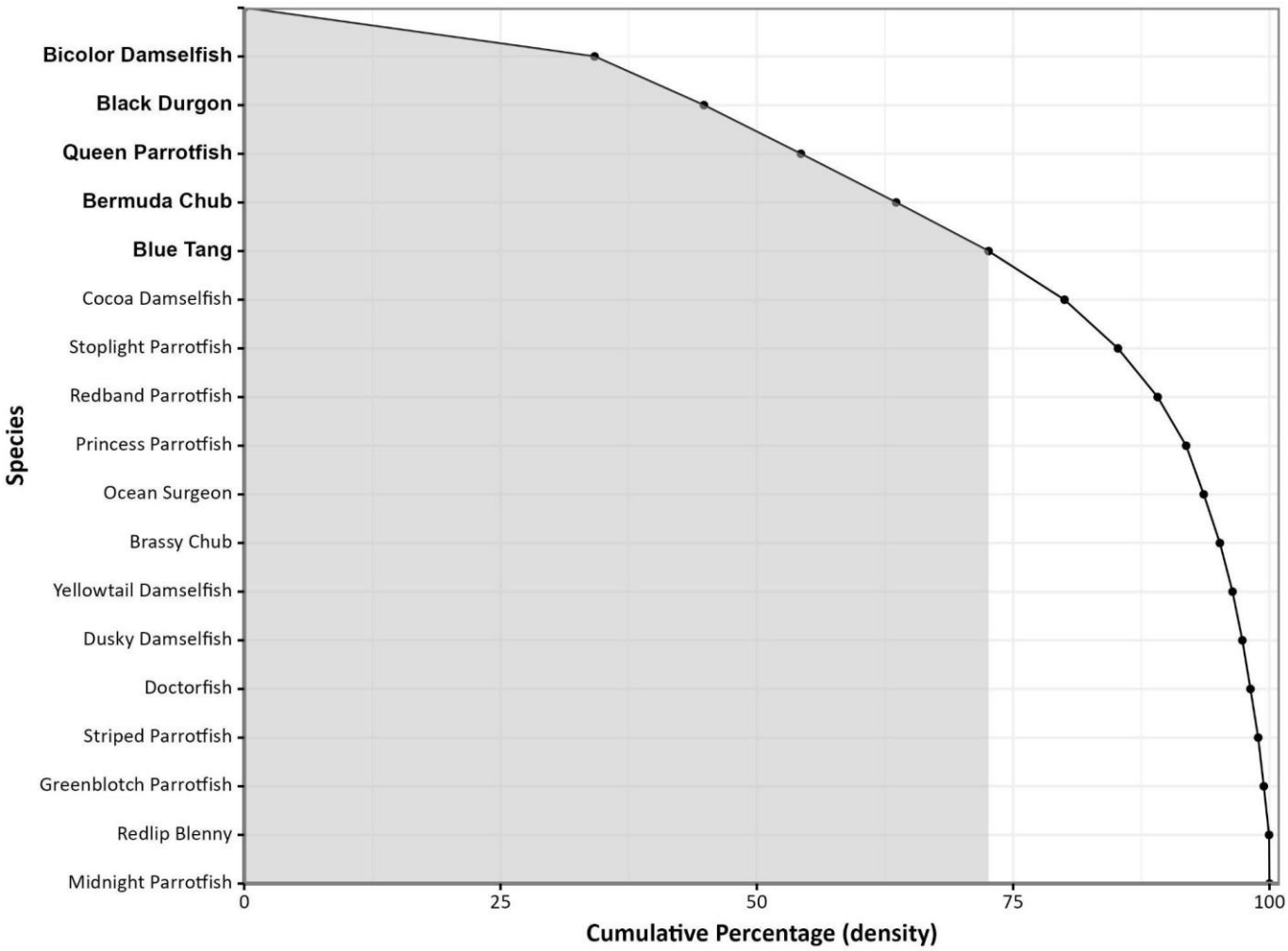


Figure 11. Cumulative density for herbivores from NCRMP 2024 surveys at East and West Flower Garden Banks. The five dominant species of herbivores are in bold, and the shaded area represents their contribution (%) to the total herbivore density.

NCRMP's comprehensive sampling design strategy provides a broad, population-level perspective on the reef fish community that is essential for effective and sustainable fisheries and ecosystem management. This community is composed of fishery target and non-target species ranging from small, cryptic (e.g., gobies [Gobiidae], jawfish [Opistognathidae]) to larger, mobile fishes (e.g., barracuda [*Sphyraena barracuda*]), and spans all trophic levels. In 2024, similar to previous NCRMP survey years, the reef caps of EFGB and WFGB are dominated by creole wrasse (*Clepticus parrae*), brown chromis, Atlantic creolefish (*Cephalopholis furcifer*), bluehead wrasse, and bicolor damselfish (Figure 12).

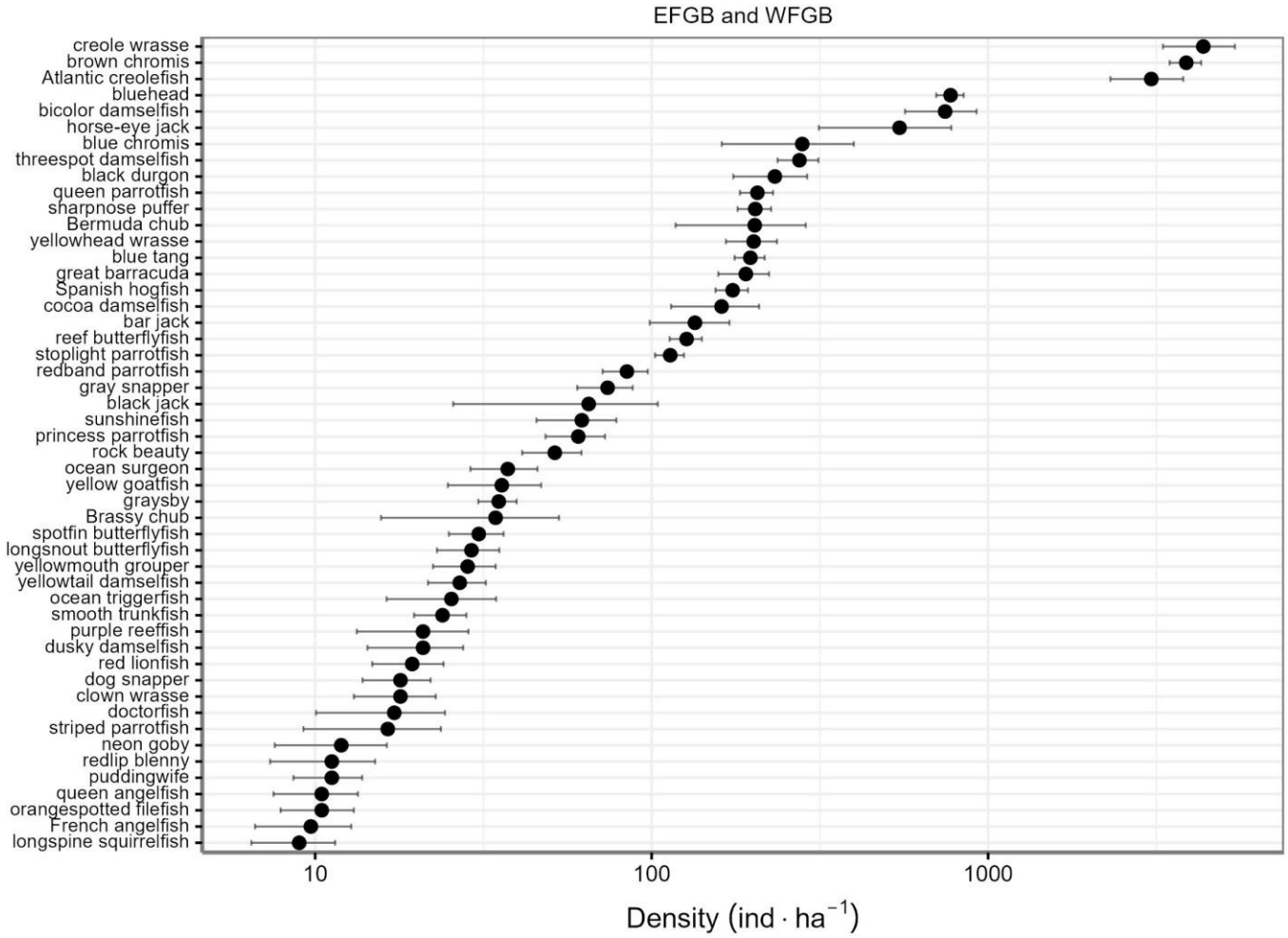


Figure 12. Mean density of the top 50 reef fish species (by occurrence) from NCRMP 2024 surveys at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB). Fish densities are presented on a log scale and show the number of fish per hectare (ha). ind = individuals.

NCRMP surveys capture a snapshot of coral reef fish populations. Reporting trends over time provides a more comprehensive perspective of changes in reef fish populations. While a single survey year's data may capture a temporary increase or decrease, evaluating a longer time series helps to contextualize normal survey year 'noise' versus a consistent, long-term trend. It is common for fish populations to fluctuate annually due to a number of factors including, but not limited to, recruitment success, predator-prey dynamics, fishing pressure, and natural events (e.g., hurricanes, marine heat waves). Importantly, for fisheries and resource managers, trend data can provide insight into whether management actions are needed and how fishery target species respond to management actions, including fishing regulations (e.g., minimum size at capture, bag limits, and gear limitations).

We show fish densities for a diverse and representative group of species from different families, ecological roles, and fishery importance, including gray snapper (*Lutjanus griseus*), great barracuda (*Sphyraena barracuda*), stoplight parrotfish (*Sparisoma viride*), and yellowmouth grouper (*Mycteroperca interstitialis*; Figure 13). For the six survey years evaluated, annual variation was observed however, densities remained similar over time; no significant trends were observed.

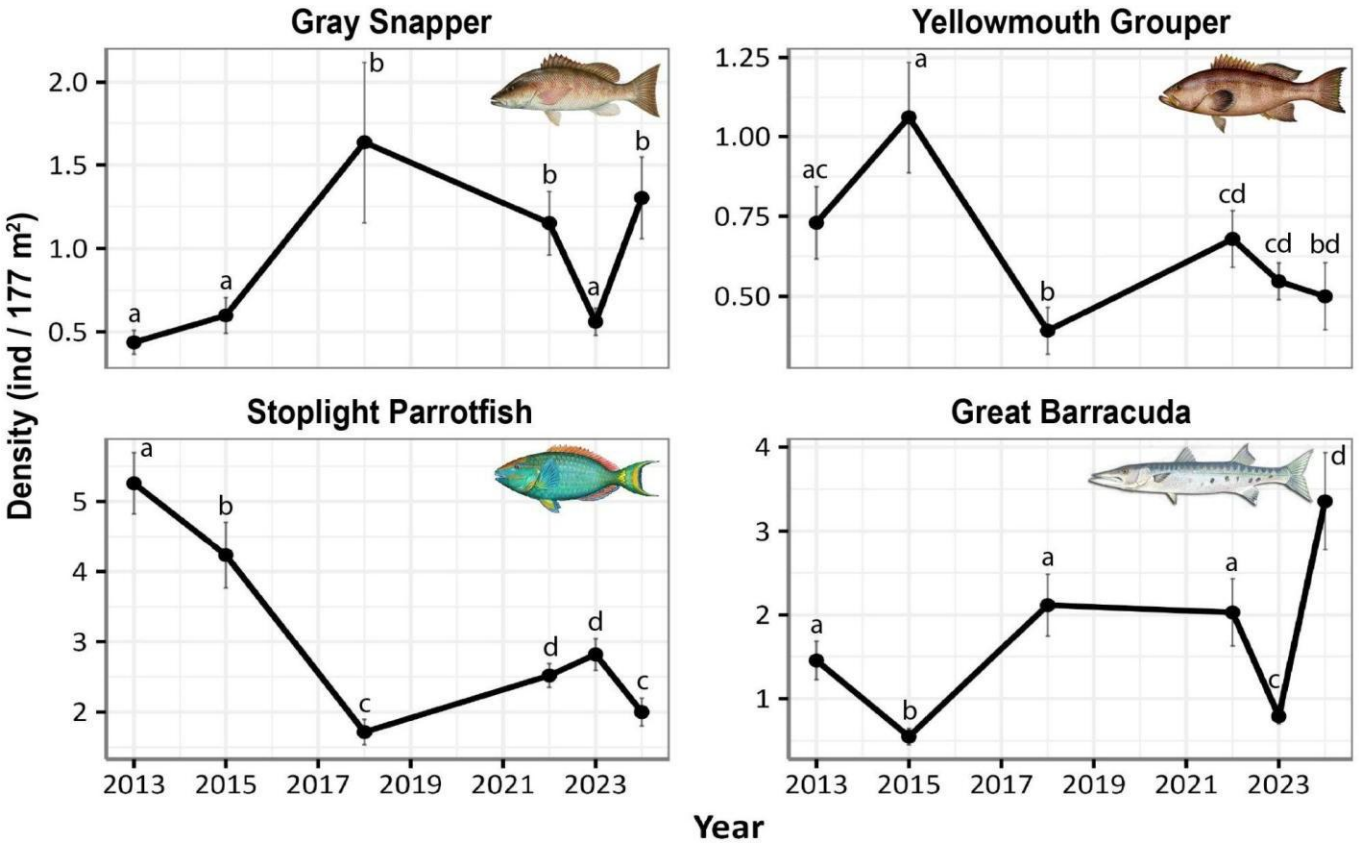


Figure 13. Density of gray snapper, great barracuda, stoplight parrotfish, and yellowmouth grouper for six NCRMP survey years at East Flower Garden Bank (EFGB) and West Flower Garden Bank (WFGB). Densities are reported as the number of individuals per 177 m^2 ± SE, represents all life stages, and significance was reported by year at $p < 0.05$ (*). Note: y-axis ranges differ by species. Fish image credits: Diane Rome Peebles (gray snapper, yellowmouth grouper), Dawn Witherington (stoplight parrotfish), and Duane Raver (great barracuda).

Fish Length Frequency

Length compositions provide a detailed description of the observed fish's population structure. These highly informative figures can show the length at which a fish species recruits to the coral reef from their nursery habitat, the length classes that are selected by the local recreational and commercial fisheries, and the success of some fisheries management regulations (e.g., minimum length of capture). In general, healthy fish populations typically consist of more younger, smaller fish rather than older, larger fish. As such, once fishes fully recruit to the coral reef habitat (i.e., survey area), each subsequent length class should have fewer observed fish. A primary goal of fisheries management is to maintain enough large, mature fish to support successful reproduction to ensure both the health of the stock and future of the fishery.

Length composition data are shown for the same representative suite of reef fish species (gray snapper, yellowmouth grouper, great barracuda, and stoplight parrotfish; Figures 14–17). At EFGB and WFGB, each of these four species is subject to different management regulations. NCRMP data shows that gray snapper recruited to the reef from their nursery habitat at > 10 cm, were often observed from 15 to 60 cm, and many individuals were above their minimum length-at-capture and length-at-maturity estimates of 30 cm (SEDAR 2018; Figure 14). Yellowmouth grouper do not have a minimum length at capture, rather a bag limit and seasonal closure for recreational anglers. This species appears to recruit directly to coral reef habitat and, depending on the year, were observed from ≤5 to 60 cm, including above their length-at-maturity estimate of 45 cm (Farmer et al., 2016; Figure 15). Notably, yellowmouth grouper showed a higher recruitment to the reef in 2022, which is evident in the subsequent survey years (2023 and 2024) in the larger size classes. Great barracuda and stoplight parrotfish presently have no fishery regulations. Great barracuda were most often observed from 35 to 120 cm (Figure 16) and all sizes of stoplight parrotfish were regularly observed (< 5cm to 50 cm; Figure 17).

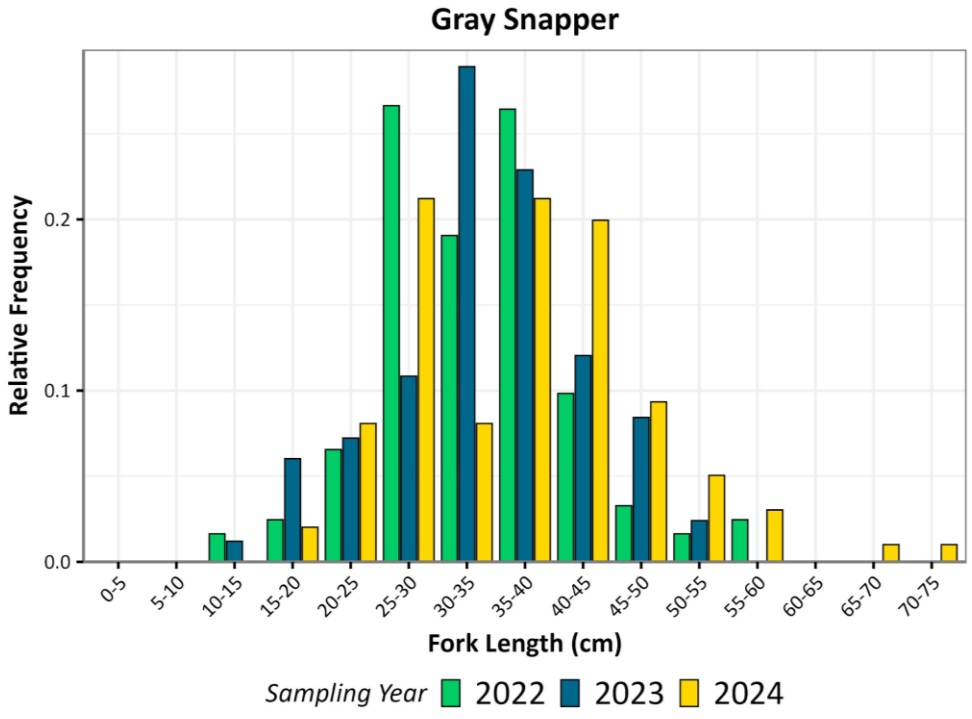


Figure 14. Relative length frequency of gray snapper for the three most recent NCRMP sample years at East Flower Garden Bank and West Flower Garden Bank.

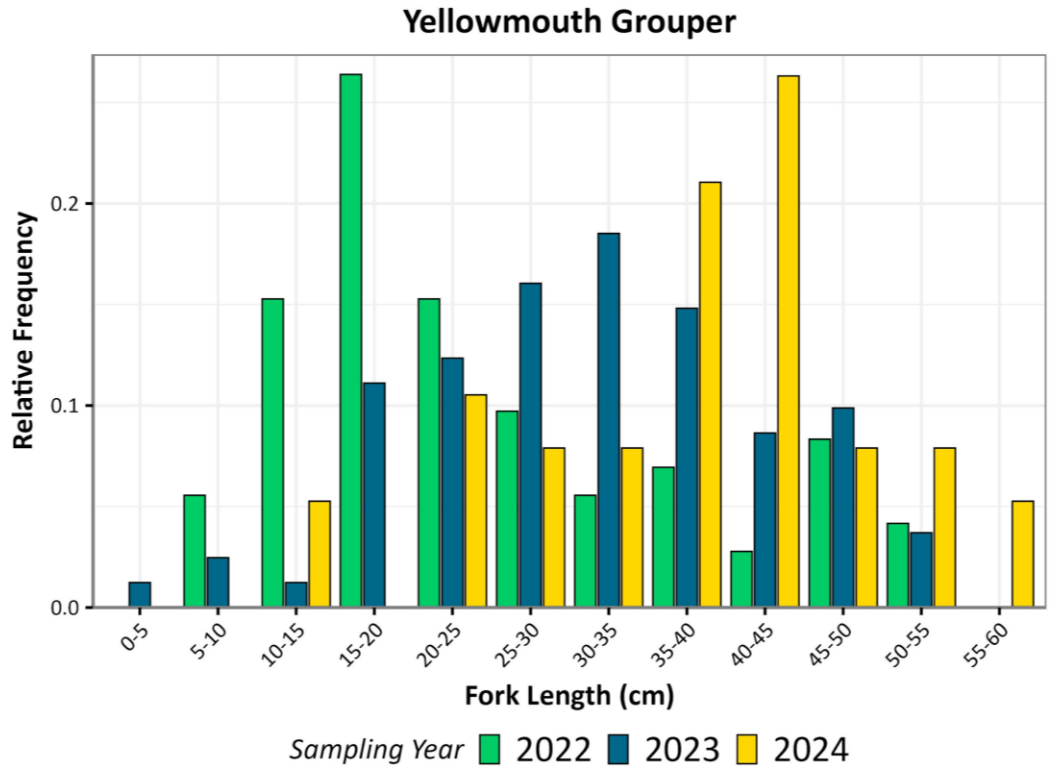


Figure 15. Relative length frequency of yellowmouth grouper for the three most recent NCRMP sample years at East Flower Garden Bank and West Flower Garden Bank.

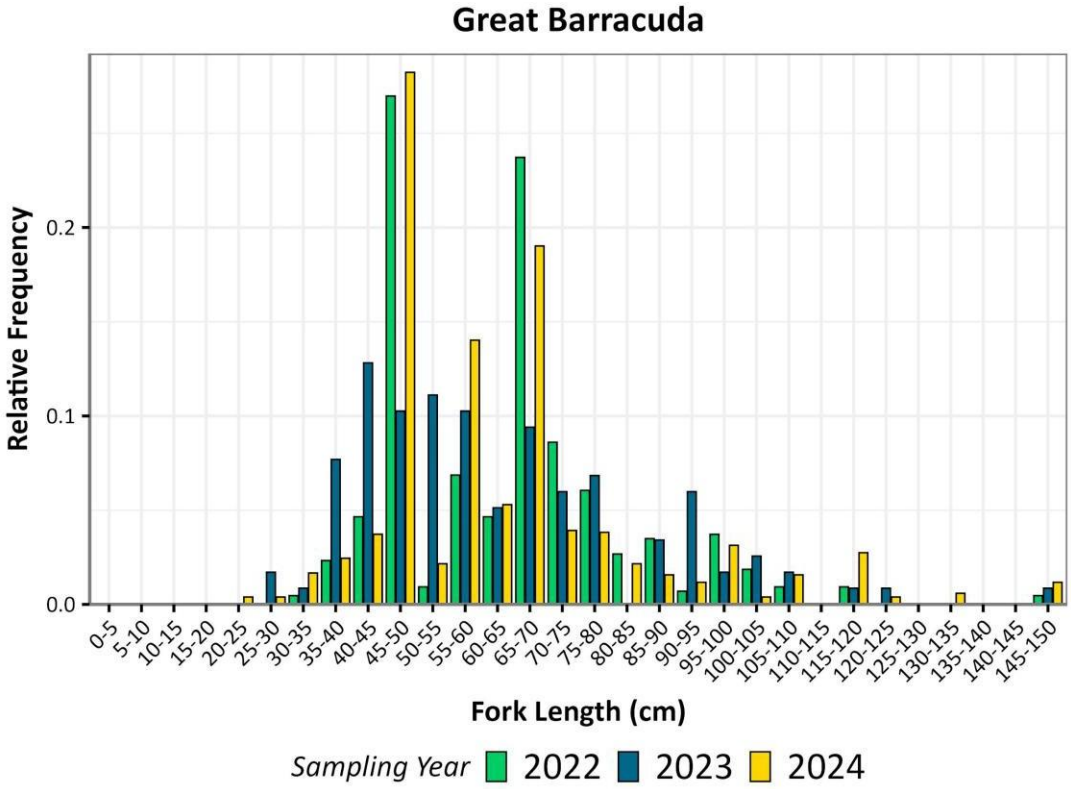


Figure 16. Relative length frequency of great barracuda for the three most recent NCRMP sample years at East Flower Garden Bank and West Flower Garden Bank.

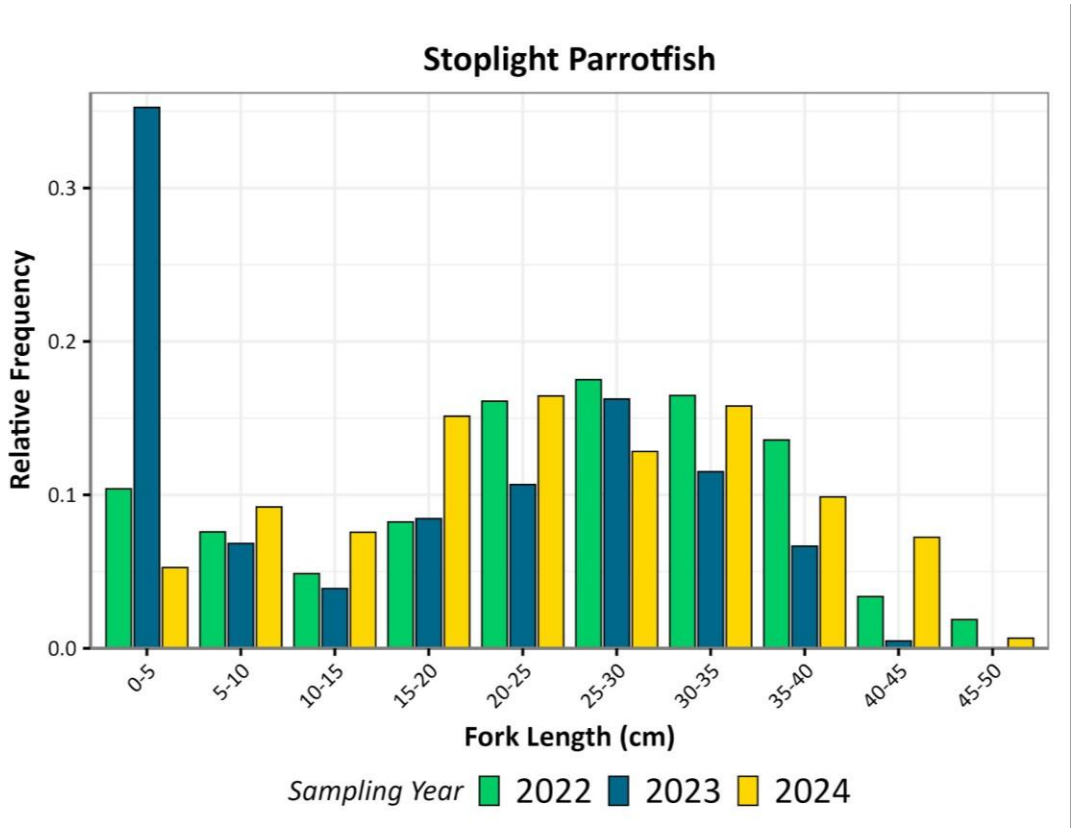


Figure 17. Relative length frequency of stoplight parrotfish for the three most recent NCRMP sample years at East Flower Garden Bank and West Flower Garden Bank.

Summary

NCRMP FGBNMS coral data continue to show high coral cover (56.7–65.0%) and many large colonies of multiple species, suggesting relatively stable populations of multiple reef-building coral species (Figures 5, 7; Towle et al., 2022, Viehman, Groves et al., 2023, Eisenbach et al., 2025). In addition, macroalgae cover has continued to decline through time. NCRMP EFGB and WFGB surveys did not observe the widespread coral mortality seen in the Caribbean and Florida from SCTLD and, more recently, from severe bleaching from record-breaking thermal stress events. However, over the past few survey years, NCRMP has observed consistent, albeit low, presence of bleaching and disease. In 2022, coral mortality driven by a putative disease outbreak was observed within the study area (Johnston et al., 2023). Although gross and histopathological characterizations of the disease lesions are currently ongoing, it is thought that this putative disease is not SCTLD (Rossin 2024). Future NCRMP EFGB and WFGB surveys should include additional sites to increase the CV for multiple coral species. Incorporation of photogrammetry appears to be a promising field data collection method for NCRMP EFGB and WFGB benthic data given the limited dive time at relatively deeper depths (> 60 feet); a statistical calibration of methods is in progress.

NCRMP fish data can be used to reliably monitor the status and trends of many species including economically valuable fisheries species (e.g., groupers and snappers), ecologically valuable species (e.g., herbivores or smaller prey species), and species of interest (e.g., ESA-listed species, invasive species). In 2024, the reef caps of EFGB and WFGB continued to be dominated by many smaller, often schooling, species. Among herbivores, five of the 18 species accounted for ~73% of the total density, emphasizing the need for species-specific analyses rather than broader groupings. Broader groupings (e.g., herbivores, piscivores, groupers, snappers, etc.) can be unintentionally misleading, as it is often assumed that species equally contribute to the results. Among the four larger reef fish species evaluated (i.e., gray snapper, yellowmouth grouper, great barracuda, and stoplight parrotfish), densities showed some variability, but remained relatively similar over time, and relative length-frequency data showed mature fishes were present on the reef. Notably, yellowmouth grouper length-frequency data captured a recruitment pulse in 2022, with those fishes approaching reproductive size in the 2024 survey. As a fishery-independent survey, NCRMP collects numbers and lengths on all observed fishes to the nearest cm. These population and size structure data are critical to support effective fisheries management actions, including best fishing practices, sustainable landings, and length regulations that ensure fishes have the opportunity to reproduce before becoming susceptible to capture by the fishery.

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Appendix: Supplemental Information

NCEI Data Package References

- **FGBNMS Benthic Collections** (all years):
  NOAA National Centers for Coastal Ocean Science; NOAA Southeast Fisheries Science Center (2024). National Coral Reef Monitoring Program: Assessment of coral reef benthic communities in Flower Garden Banks National Marine Sanctuary [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. doi: 10.7289/v5vd6wts
- **2024 FGBNMS Benthic Data:**
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- **FGBNMS Fish Collections** (all years):
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- **2024 FGBNMS Fish Data:**
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NCRMP Data Visualization Tool

This GIS-based tool allows users to see where and when NCRMP data were collected, visualize status and trends, and download summarized data in an easier way than ever before, see https://ncrmp-visualization-tool-noaa.hub.arcgis.com/

NCRMP Local Partner Programs

NCRMP provides a broad geographic context to supplement local monitoring efforts and studies of tropical reef ecosystems. For more information on local partner program(s) in the region, see *Flower Garden Banks National Marine Sanctuary Monitoring Program.*