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National Coral Reef Monitoring Program

Biological Monitoring Summary

Flower Garden Banks: 2022

2023

NOAA | NOS Coral Reef Conservation Program
NOAA | NOS National Centers for Coastal Ocean Science
NOAA | NMFS Southeast Fisheries Science Center

NOAA Technical Memorandum NOS CRCP 47

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Cover and infographic photos by Rob Waara, National Park Service.

Disclaimer

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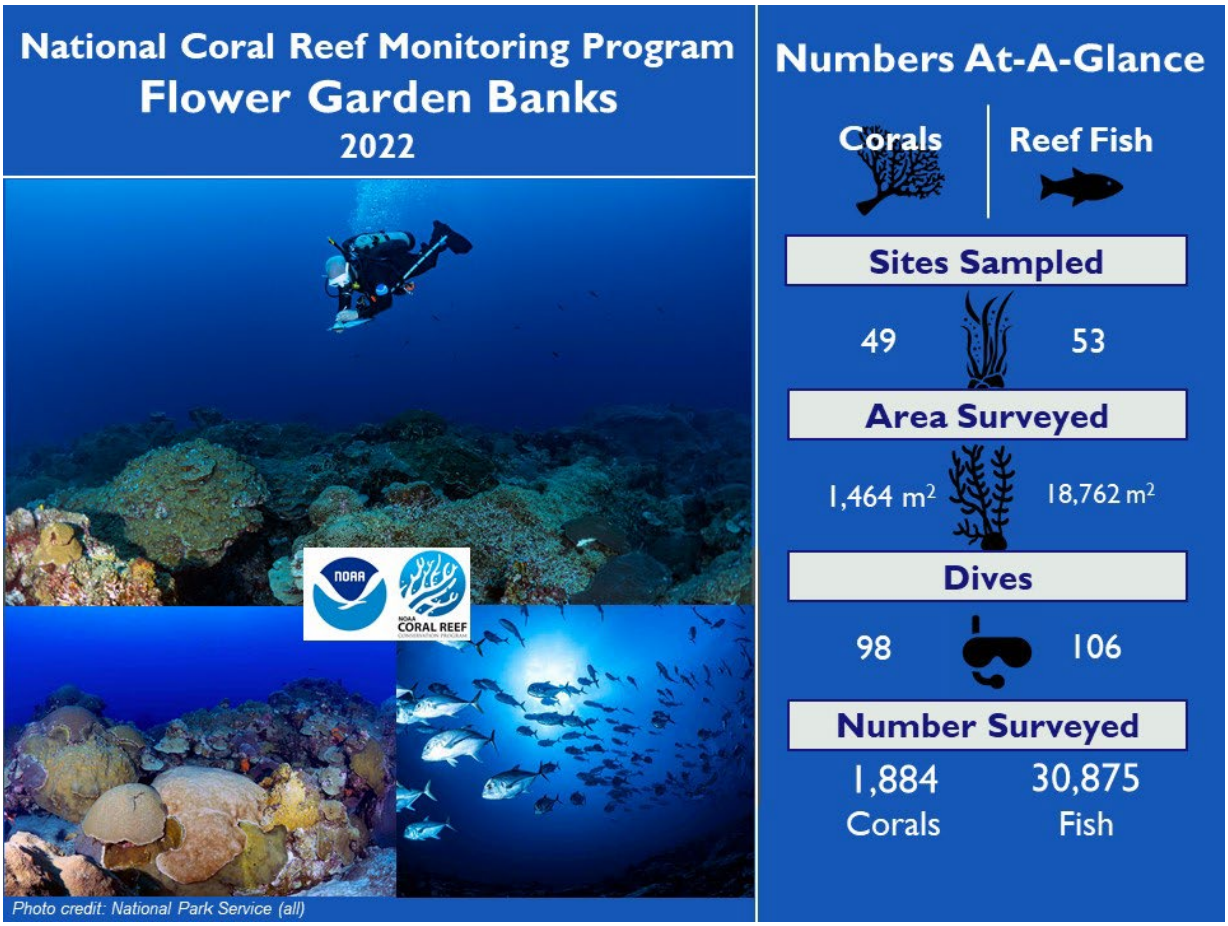
Acronyms

CRCP	Coral Reef Conservation Program
CV	coefficient of variation
ESA	Endangered Species Act
FGB	Flower Garden Banks
FGBNMS	NOAA Flower Garden Banks National Marine Sanctuary
NCCOS	NOAA National Centers for Coastal Ocean Science
NCEI	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
RVC	Reef Visual Census
SCTLD	stony coral tissue loss disease
SEFSC	NOAA Fisheries - Southeast Fisheries Science Center

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 on the East and West Banks of Flower Garden Banks (FGB) in 2013, 2015, 2018, and 2022. In recent years, NCRMP has surveyed FGB in even-numbered years; however, no sampling occurred in 2020 due to the coronavirus pandemic. In 2022, NCRMP dive surveys occurred in a single field mission, spanning late August to early September, on the shallow-water (≤ 30 m) coral reefs of the East and West Banks of FGB. NCRMP data are used to 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 are available on the project website: https://www/coris.noaa.gov/monitoring/biological.html.



Report Overview

NCRMP provides large-scale, stratified-random monitoring data for detection of 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. The goal of this report is to provide a broad overview of NCRMP's accomplishments and regional results in by summarizing the 2022 biological data collected by NOAA and regional partners in the shallow water coral reef ecosystems of East and West Flower Garden Banks (FGB).

Sampling Overview

In 2022, the FGB cruise was August 25–27 (Leg 1) and August 29–September 2 (Leg 2) aboard the Flower Garden Banks National Marine Sanctuary (FGBNMS) Research Vessel *Manta*.

Partners involved in these efforts included:

- Channel Islands National Marine Sanctuary
- Flower Garden Banks National Marine Sanctuary (CV)
- Moody Gardens, Inc.
- National Park Service (NPS)
- NOAA Diving Program (NDP)
- NOAA Fisheries - Southeast Regional Office (SERO)
- Texas A&M University-Corpus Christi (TAMUCC)
- U.S. Environmental Protection Agency (EPA)

Key Report Points

Corals and Benthic Community

- NCRMP coral data showed that FGB continues to have the highest coral cover and the highest density of large reef-building coral species of all of the U.S. Atlantic coral reef jurisdictions (Florida, Flower Garden Banks, Puerto Rico, U.S. Virgin Islands).
- NCRMP divers observed recent mortality on multiple coral colonies in 2022, suggesting an active coral disease event.
- Coral cover in FGB in 2022 was 57.1% ± 2.74, which was not significantly different from previous years (56.7% in 2013 and 61.8% in 2018).

Fish Community

- NCRMP fish data showed that 31 species of surveyed fishes (fishery-targeted and non-targeted) have coefficients of variation (CVs) of density that are 20% or less, meaning there were enough data to perform robust statistical analyses.
- Reefs were dominated by brown chromis (*Chromis multilineata*), bluehead wrasse (*Thalassoma bifasciatum*), creole wrasse (*Clepticus parrae*), Atlantic creolefish (*Cephalopholis furcifer*), and bicolor damselfish (*Stegastes partitus*).
- Both juvenile and adult size classes of gray snapper (*Lutjanus griseus*) and yellowmouth grouper (*Mycteroperca interstitialis*) were observed on FGB reefs.

Introduction

Coral reefs are valuable ecosystems that provide people with goods and services, including food, coastal protection, and recreational opportunities. Despite the importance of coral reefs, these ecosystems are in decline from numerous human-made threats that degrade resources directly 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, climatic, 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 provide robust, quantitative data to document the status and trends of coral reef fishes, corals, and benthic communities in the Atlantic, Caribbean, and Gulf of Mexico basins at a regional (or jurisdictional) scale (NOAA CRCP, 2021; Towle et al., 2022). NCRMP generates large-scale, regional status and trend information of U.S. shallow-water (≤ 30 m) coral reef ecosystems. This context and perspective provide a dataset that can be used to inform coral reef management. Biological sampling occurs on a two-year cycle within the Atlantic, Caribbean, and Gulf of Mexico coral reef jurisdictions, including the U.S. Virgin Islands (USVI; including St. Thomas, St. John, and St. Croix), Puerto Rico, Florida, and Flower Garden Banks (FGB; Figure 1).

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

This report provides a summary of data collected by the biological sampling of NCRMP shallow water coral reef ecosystems in FGB in 2022. 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 2022 and prior can be obtained from the NCRMP Biological project webpage (https://www.coris.noaa.gov/monitoring/biological.html) and the NOAA's National Centers for Environmental Information (NCEI) database (see Appendix for additional reference and archive information).

NCRMP has surveyed FGB since 2013. This is the first NCRMP FGB report to show trend data for fish and benthic communities between 2013 and 2022. NCRMP in FGB complements Flower Garden Banks National Marine Sanctuary (FGBNMS) monitoring at fixed sites that have been surveyed annually since 1988 (Johnston et al., 2022).

Methods

Sample Design

NCRMP biological monitoring (i.e., fish, corals and benthic communities) uses a grid-based stratified random design that is optimized to efficiently sample for ecologically and commercially important species. 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 hard bottom habitat type (in this case, low relief and high relief) and geography (East and West Banks) to a maximum depth of 30 m in FGB.

The NCRMP biological monitoring team and partners strive to sample a specific number of sites each year in each jurisdiction. The actual number of sites sampled varies each survey year due to numerous factors such as weather conditions and resource availability (e.g., ship time). 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 strength of the data and trend analyses will continue to grow.

Sample Protocols

Field Surveys

Corals and benthic communities were monitored using a Benthic Community Assessment survey and a Coral Demographics survey (NOAA CRCP, 2022a; 2022b; Figure 2). 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, 2022a). At the same site, Coral Demographics surveys are conducted within a 10 m × 1 m belt-transect area (NOAA CRCP, 2022b). Within this transect, all live coral colonies ≧4 cm were counted, identified to species, 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, 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 completely dead coral skeletons. In the Coral Demographics surveys, small corals (< 4 cm) 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, 2022b). Disease progression rate estimates (i.e., slow or fast rates) 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 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, 2022b). Because NCRMP field sampling dates do not always coincide with bleaching events, peak bleaching events may not be represented comprehensively in NCRMP data.

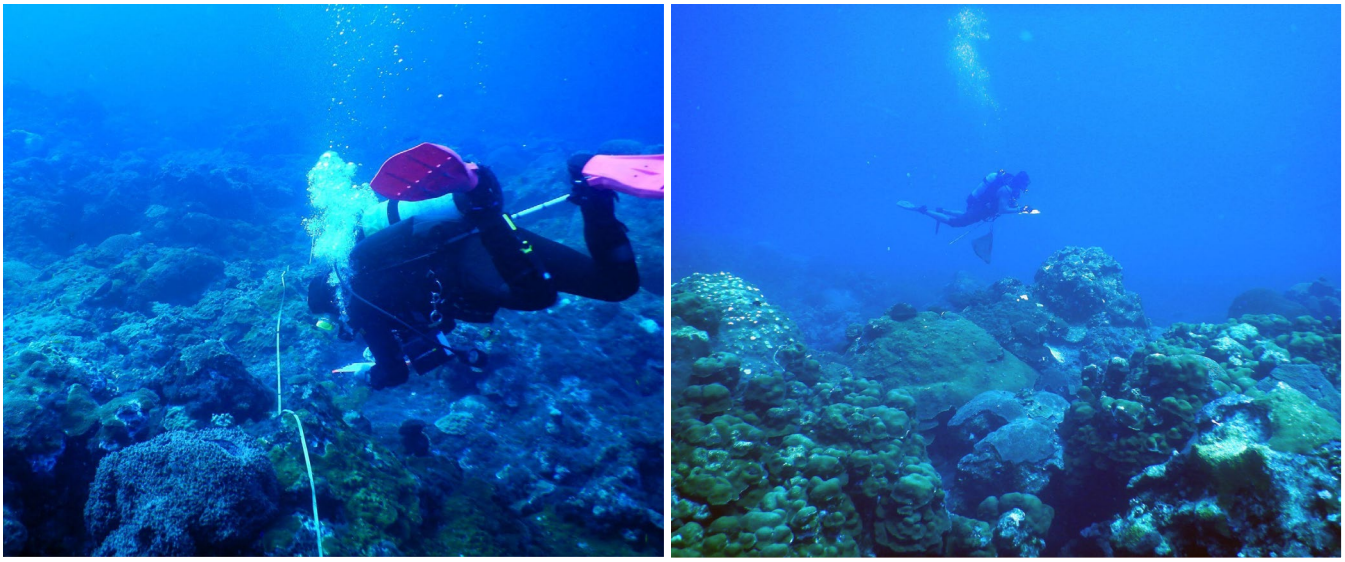


Figure 2. Examples of a diver collecting benthic community data (left) and Reef Fish Visual Census (RVC) fish survey data (right) in Flower Garden Banks. Photo credits: NOAA NCCOS.

The Reef Fish Visual Census (RVC) is a stationary point count sampling protocol (NOAA CRCP, 2022c) modified from Bohnsack and Bannerot (1986). A two-diver 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, fish were identified to the species level and counted, and fork length was estimated to the nearest centimeter (Figure 2). Data collected by the diver survey pair were averaged at the site level.

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 All Purpose Tool (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) Quality checks are applied to data after export from the database. Basic statistical analyses were conducted and included quality checks (e.g., by species and by diver). After the data were fully vetted through these quality checks, data were archived at NCEI and released publicly (Appendix).

Analytical Methods

Corals and Benthic Communities

Standard metrics, including benthic cover (% cover of corals and macroalgae), coral species occurrence, coral density, and relative size composition for select individual species, are reported herein. Computational formulas of standard metrics for single-stage stratified random sampling design are provided in detail in Smith et al. (2011), Groves and Viehman (2023), and Viehman, Groves, et al. (2023). Length frequency distributions were generated from total colony size measurements (maximum diameter) of colonies greater ≥ 4 cm, which included areas of partial mortality (Bak and Meesters, 1999, Meesters et al., 2001). For temporal comparisons, a pairwise two-tailed T-test was performed to evaluate differences between years (see Results section). Site-level coral bleaching and disease prevalence were calculated as the percentage of colonies with any bleaching or disease divided by the total number of corals by species at each site. Domain-level coral bleaching and disease prevalence by species were calculated as the mean percentage of colonies with any bleaching/disease divided by the total number of corals for each species across all sites and strata; this was then weighted by the proportion of the strata within the entire sampling domain (Smith et al., 2011).

NCRMP analysis scripts for corals and benthic communities are open source and available at NCRMP **Benthic R package** (Groves and Viehman, 2023).

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. (2011) 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).

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

Results

In 2022, NCRMP surveyed 53 sites on East and West Flower Garden Banks (Table 1, Figure 3). The number of sites surveyed in 2022 was similar to previous NCRMP years, with the exception of 2020. Of note, fish surveys in 2013 and 2015 are not reported here due to a methodology change; a calibration study is underway.

Table 1. NCRMP fish and benthic surveys completed by year in Flower Garden Banks.

Year	Flower Garden Banks					
	East Bank		West Bank		Total	
	Fish	*Benthic*	*Fish*	*Benthic*	*Fish*	*Benthic*
2022	30	29	23	20	53	49
2020	-	-	-	-	-	-
2018	17	17	20	20	37	37
2015	-	37	-	26	-	63
2013	-	39	-	30	-	69

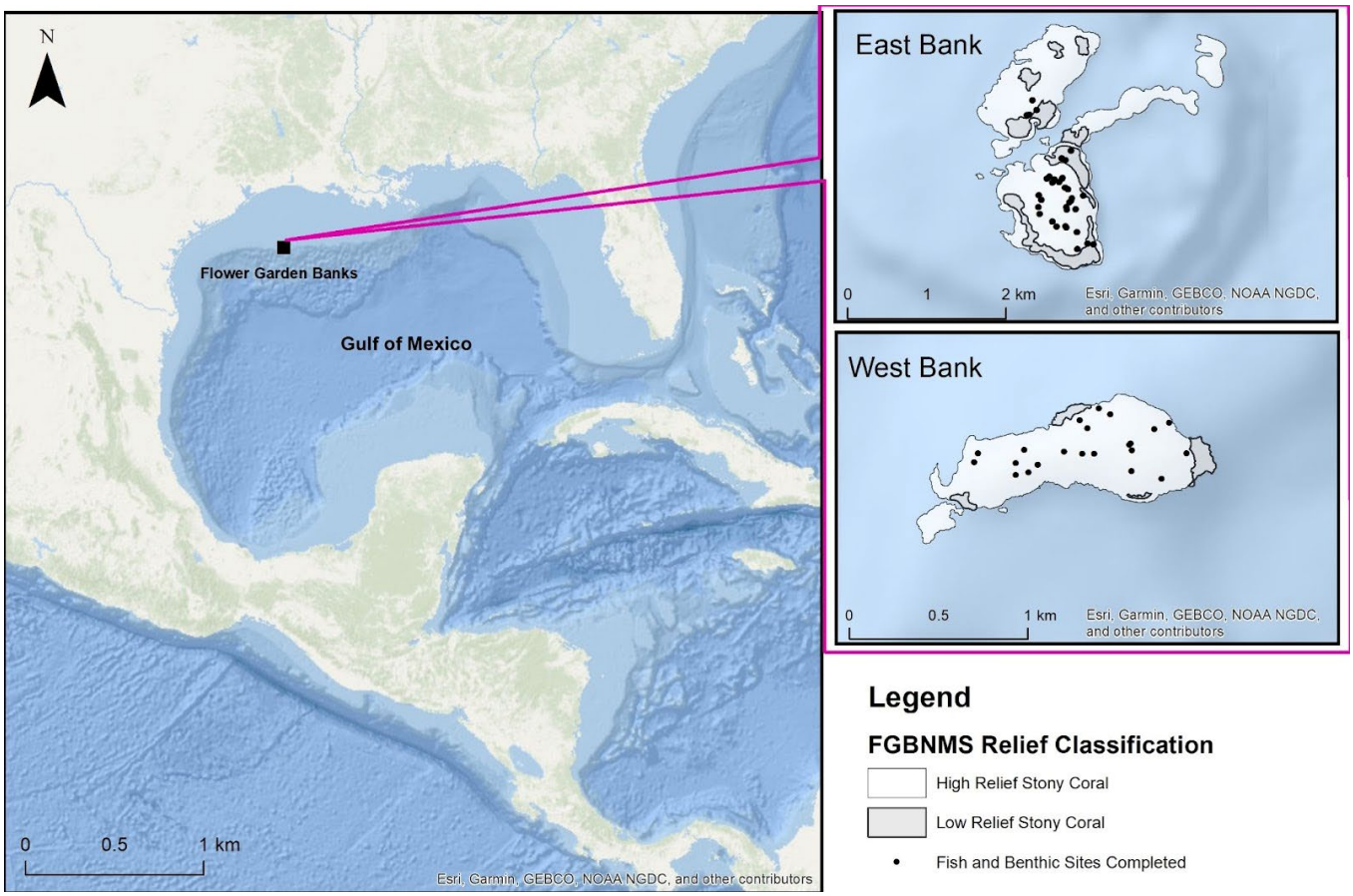


Figure 3. NCRMP survey sites sampled in Flower Garden Banks in 2022 on the East Bank (top) and the West Bank (bottom).

Benthic Community Results

During the FGB 2022 mission, divers observed coral disease on multiple coral colonies and species (Figure 4). The disease was initially suspected to be SCTLD, but its identification remains unconfirmed (Johnston et al., 2023). Collaborative efforts across the Atlantic and Caribbean are researching and addressing the outbreak of the disease (McLaughlin and Wusinich-Mendez, 2022).

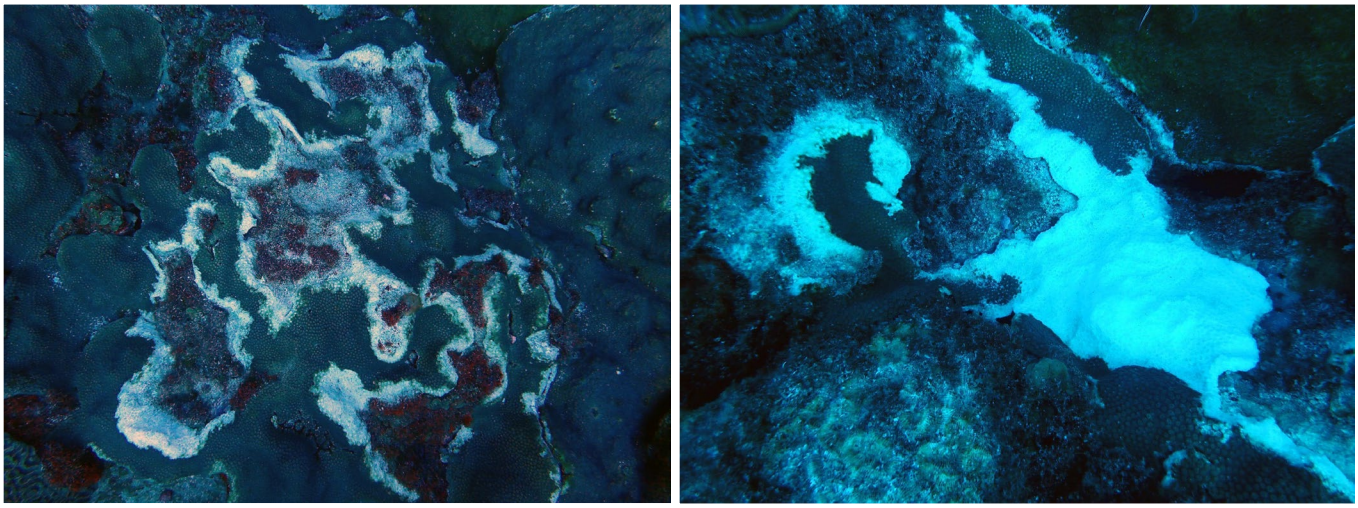


Figure 4. Examples of diseased corals observed on NCRMP 2022 surveys at Flower Garden Banks. Photo credit: NOAA NCCOS.

Coral and Macroalgae Cover

Mean coral cover on East and West Flower Garden Banks remains consistently high, with no significant changes over time (Figure 5; Johnston, et al., 2022; Viehman, Groves, et al., 2023). In 2022, mean coral cover was 57.1% ± 2.74. In contrast, macroalgae cover has declined significantly over time, reaching 18.2% ± 2.09 (Figure 5) in 2022. However, macroalgae cover can be strongly influenced by the timing of the sampling season, the habitat type surveyed, and the specific functional group or species of macroalgae.

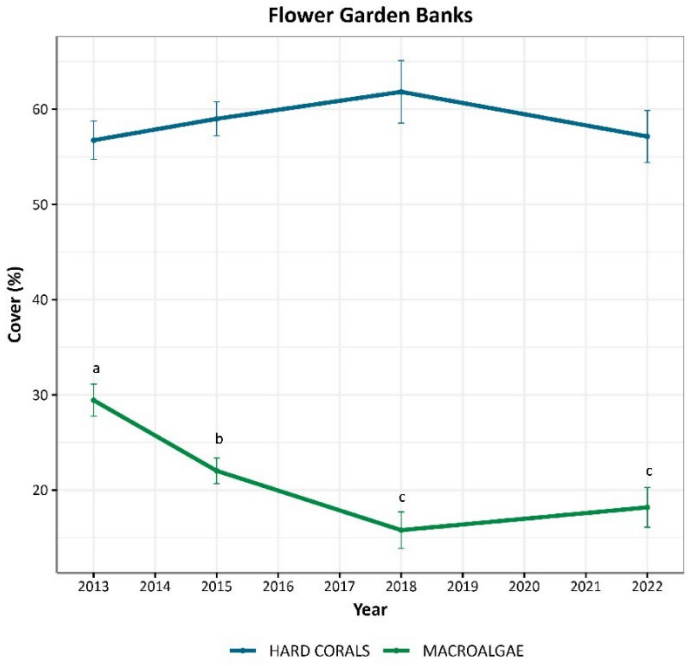


Figure 5. Mean cover (%) ± SE for corals and macroalgae on Flower Garden Banks. Statistical significance (Tukey's two-tailed t-test), if present, is reported at $p < 0.05$, and different letters (i.e., a, b, c) denote a difference between survey years.

Coral Species Occurrence

In 2022 NCRMP coral demographic surveys, four coral species had CVs of 20% or lower: *Montastraea cavernosa, Orbicella faveolata, O. franksi*, and *Pseudodiploria strigosa* (Figure 6). 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 conducting additional surveys at more sites to enhance CVs for a broader range of coral species in future assessments.

Coral species listed as Threatened under the U.S. Endangered Species Act (Federal Register, 2014) were highly prevalent on the East and West Banks, and present at 96% of the 49 NCRMP 2022 benthic survey sites. In FGB, ESA-listed species include *O. franksi* (present at 96% of the 49 NCRMP 2022 sites), *O. faveolata* (present at 90% of the 49 sites), and *O. annularis* (present at 49% of the 49 sites).

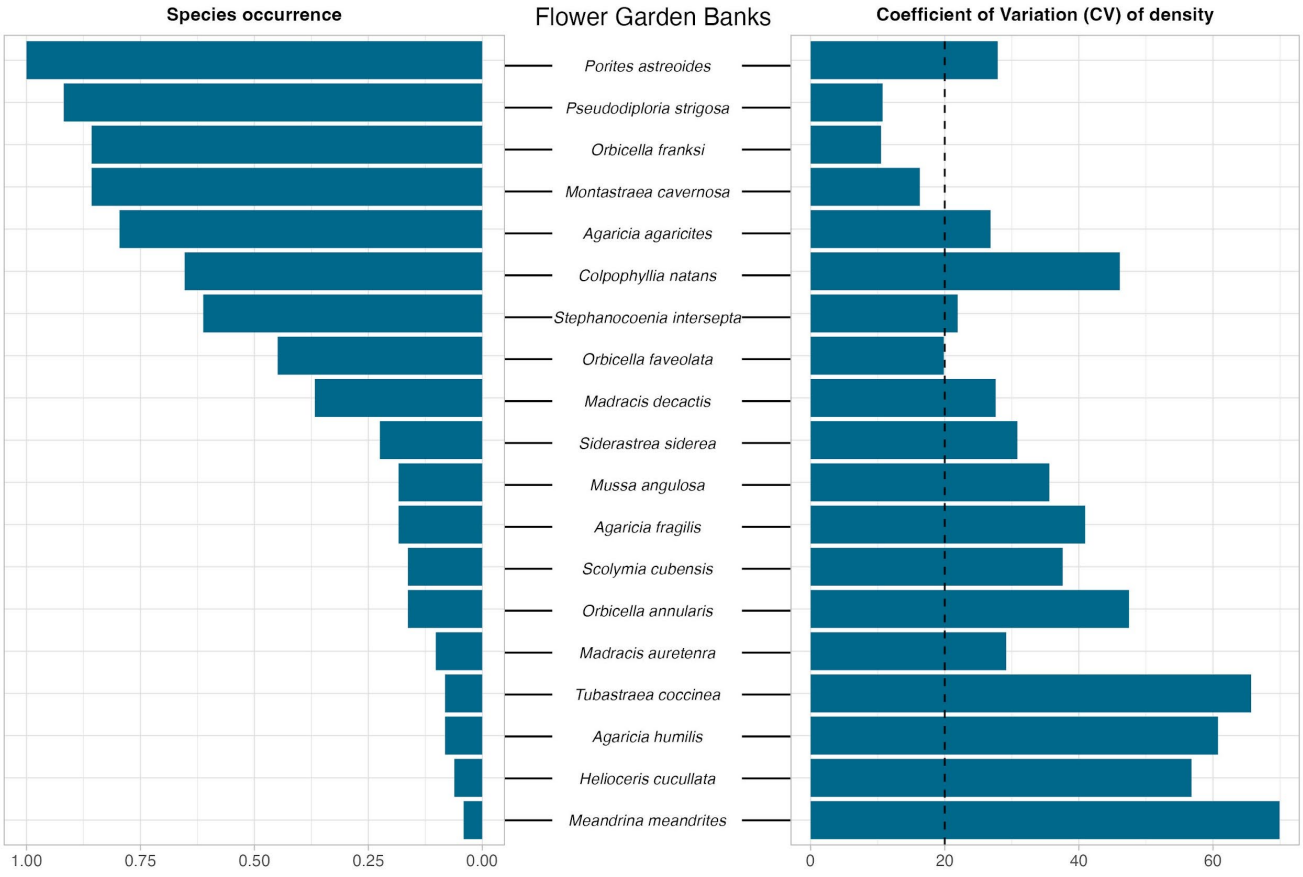


Figure 6. Coral species occurrence and coefficient of variation (CV) of density based on NCRMP coral demographics surveys in Flower Garden Banks in 2022. Species with an occurrence less than 0.01 are not shown. Dashed vertical line on the CV plot indicates the target CV of 20%.

Coral Density and Size Distribution

NCRMP FGB 2022 surveys show a decline in overall coral density over time, with a statistically significant changed observed between 2015 (5.7 corals per m^2 ± 0.33 SE) and 2022 (4.9 corals per m^2 ± 0.36 SE; Figure 7). The dominant coral species contributing to overall density were *Porites astreoides, Madracis auretenra, O. franksi, Agaricia agaricites,* and *P. strigosa* (Figure 8). Coral density is influenced by species composition, species size distributions, and colony mortality; density alone does not equate to large, healthy, reef building corals. In 2022, the mean percentage of old mortality on corals remained consistently low relative to other U.S. Atlantic coral reef jurisdictions at less than six percent (5.6% ± 0.62 SE in 2022; Figure 8), and the mean percentage of corals showing recent coral mortality at less than 0.5% (0.28% ± 0.05 SE in 2022; Figure 7).

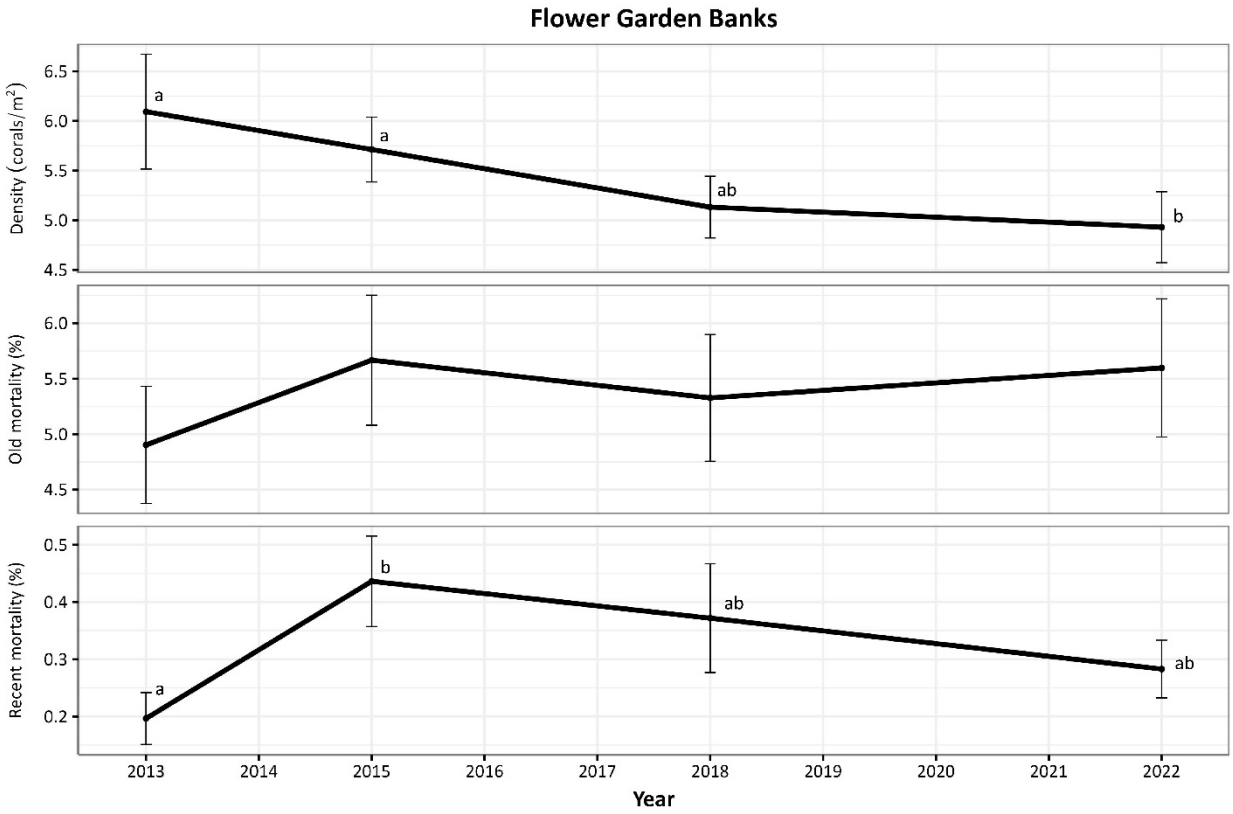


Figure 7. Top to bottom; mean adult coral density, old mortality, and recent mortality, ± SE in Flower Garden Banks from 2013 to 2022. Statistical significance (Tukey's two-tailed t-test), if present, is reported at $p < 0.05$, and different letters (i.e., a, b, c) denote a difference between survey years. Note: y-axis ranges vary by panel.

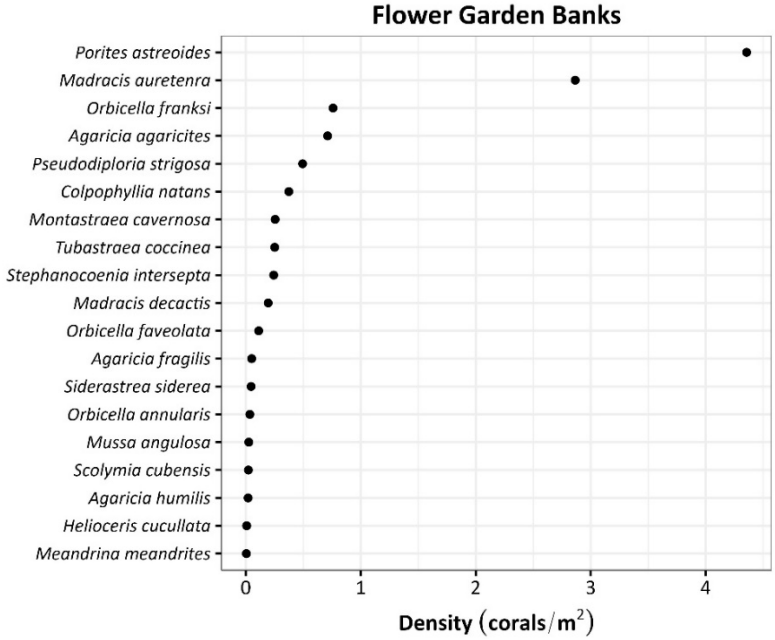


Figure 8. Density of corals (per m^2) by species in NCRMP surveys of Flower Garden Banks in 2022.

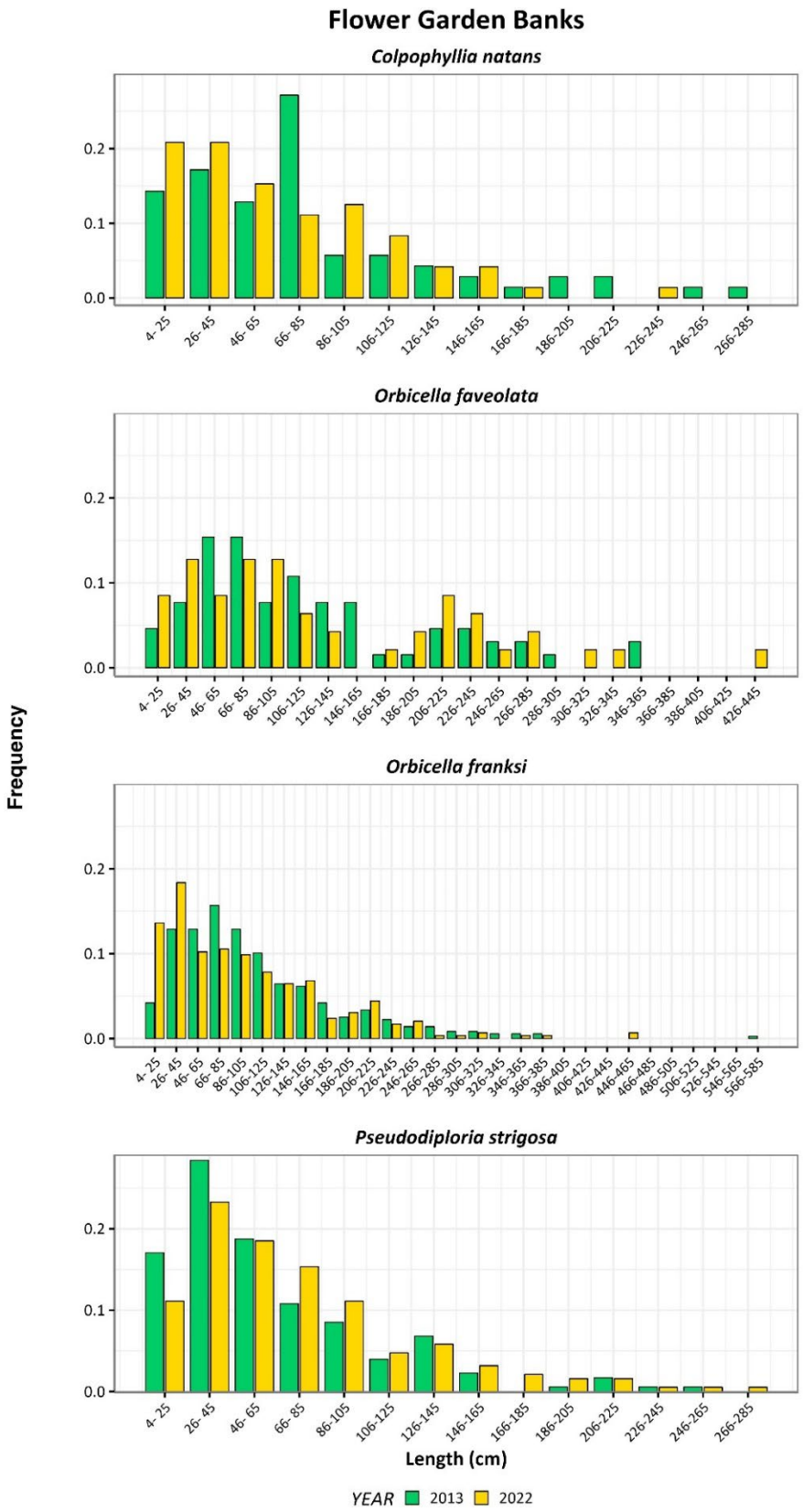


Figure 9. Relative length (maximum diameter) frequency of representative coral species in Flower Garden Banks by year to show changes in size distribution over time.

Size distributions provide a detailed description of a selected coral species' population structure and result from the combination of demographic processes of recruitment, growth, and survival. Over time, coral colonies can remain in the same length class (due to partial mortality), transition to a larger length class (survival and growth), or suffer total mortality over time. Individual colonies move backwards over time only if colonies fragment. These highly informative figures can show juvenile input (growth and survival) to the adult length classes (≥ 4 cm), colonies that remain within length classes due to partial mortality, and the end result of growth and survival to larger sizes. Peak frequency in medium size length classes could signify a decrease in juvenile input, a previous (episodic) recruitment event that resulted in large juvenile input into the population, or an accumulation of colonies over time due to partial mortality. Missing size classes may have resulted from a historical event where colonies suffered total mortality, cumulative effects of partial mortality or a period of no recruitment into the adult population (Underwood and Koegh, 2001). In general, populations typically consist of a higher frequency of younger, smaller corals than older, larger colonies and each subsequent length class normally has fewer observed corals.

Relative length frequencies (using maximum diameter) for select coral species in FGB indicate relatively stable size distributions (by maximum colony length) of *Colpophyllia natans, O. faveolata, O. franksi, and P. strigosa* over time from 2013 to 2022 (Figure 9). This subset of species was selected based on CV, ESA status, SCTLD susceptibility, and ecological value (e.g., reef building capability).

NCRMP observed bleaching and disease in multiple coral species in FGB 2022 surveys (Figure 10), although the percentage of recent mortality on colonies was low (Figure 7). *O. faveolata* had the highest prevalence of both bleaching and disease (Figure 10). Coral disease was observed on *O. faveolata, P. strigosa, O. franksi, C. natans*, and *P. astreoides* (Figure 10). This disease has not been confirmed as SCTLD (Johnston et al., 2023).

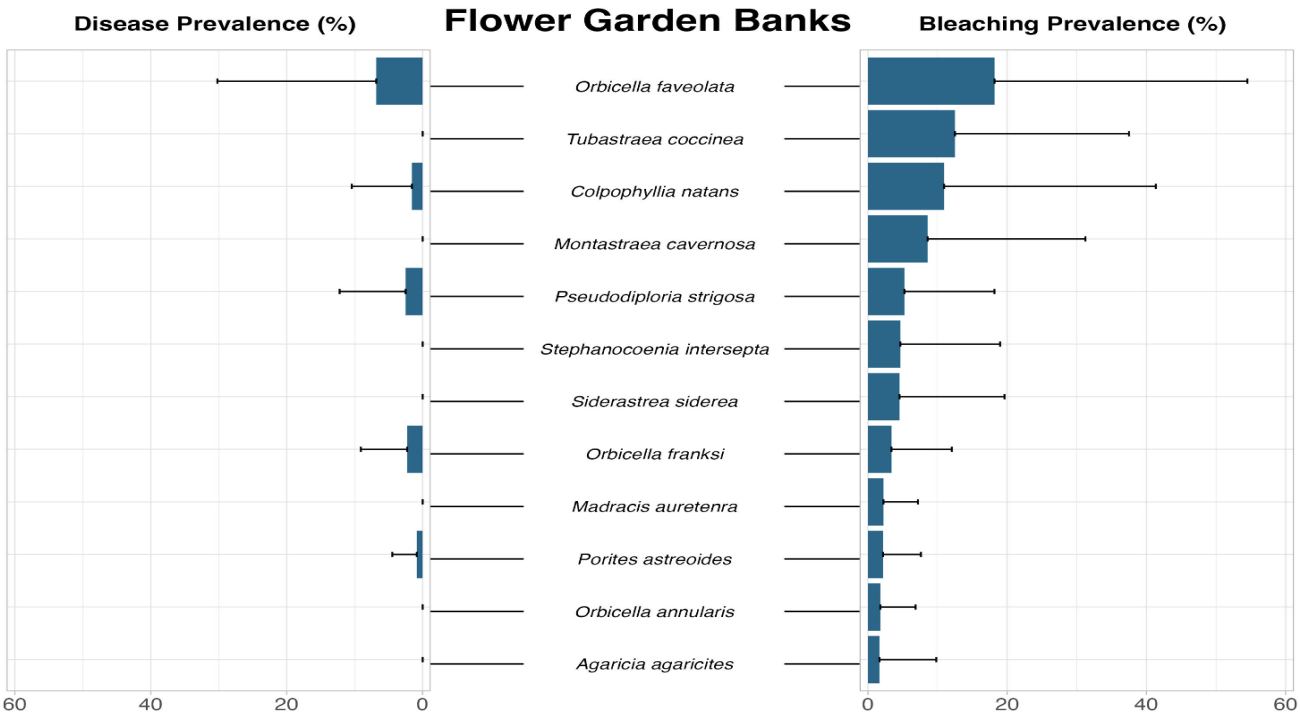


Figure 10. Mean disease prevalence (left) and bleaching prevalence (right) ± SE by coral species for Flower Garden Banks in 2022. Only species with disease or bleaching observed in the 2022 NCRMP coral demographics surveys are included.

Fish Community Results

Fish Species Occurrence

NCRMP fish survey results show that 31 individual species have CVs of density that are 20% or less (Figure 11). 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 the invasive red lionfish (*Pterois volitans/mil*es complex) and three fishery-targeted species, gray snapper, dog snapper (*Lutjanus jocu*), and yellowmouth grouper, were regularly observed and had CVs of density that were less than 20%. Notably, four fish species including Spanish hogfish (*Bodianus rufus*), bluehead wrasse, blue chromis (*Chromis cyanea*), and bicolor damselfish were observed at every survey site in 2022, resulting in CVs of density below 15% (Figure 11).

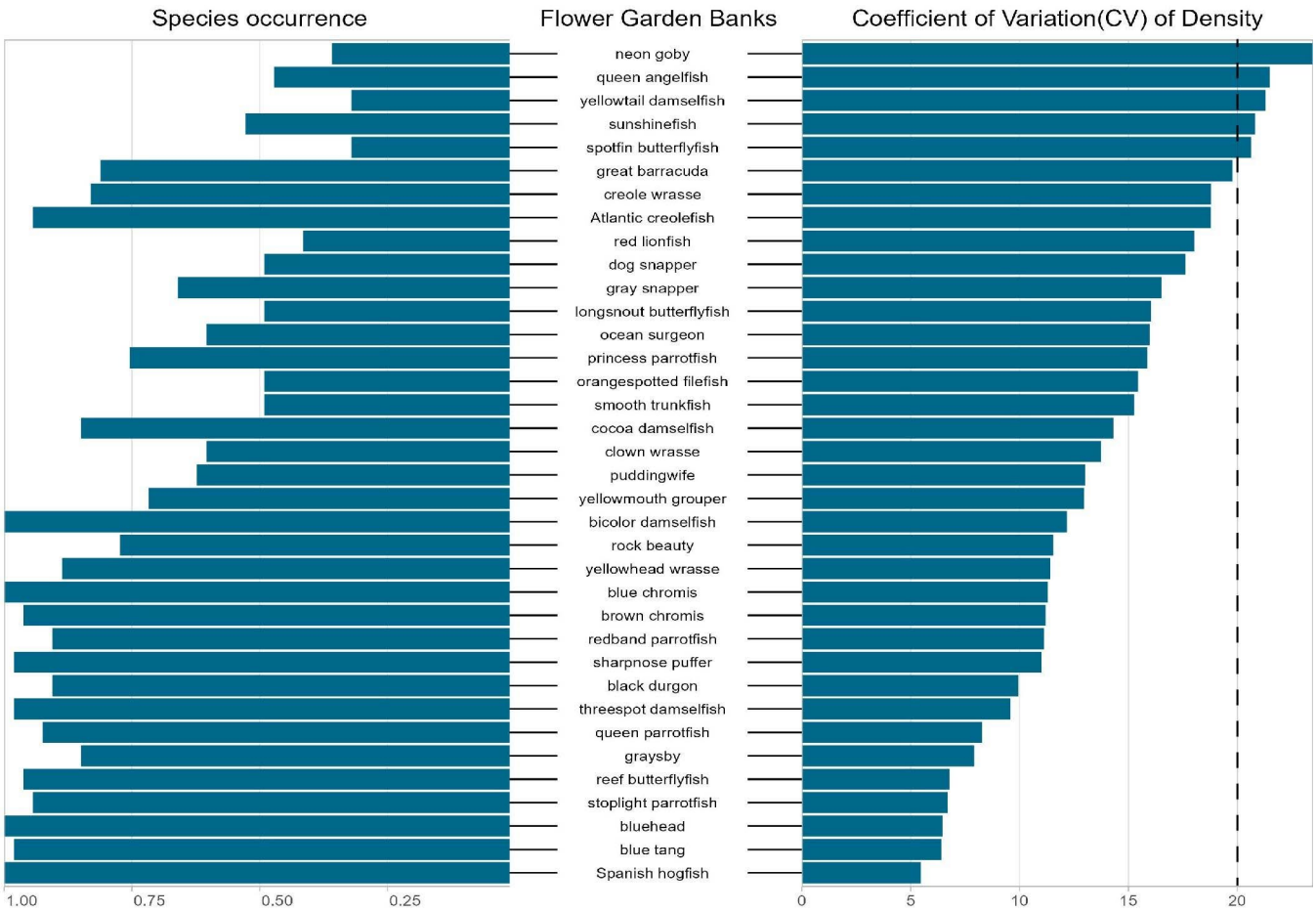


Figure 11. Occurrence of reef fish species with a CV of density ≤ 25%. Species are sorted by increasing CV of density in Flower Garden Banks in 2022. Dashed vertical line on the CV plot indicates the target CV of 20%.

Fish Density

Typically, fishes are grouped together (e.g., guilds, trophic, genera) and presented as a single analysis metric (e.g., density, occurrence, biomass). However, these 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. In Flower Garden Banks, four species of herbivores make up 75% of the total herbivore density, highlighting the importance of analyzing and reporting species-specific information. Bicolor damselfish, Bermuda chub (*Kyphosus sectatrix*), queen parrotfish (*Scarus vetula*), and black durgon (*Melichthys niger*) dominate the herbivore trophic group (Figure 12).

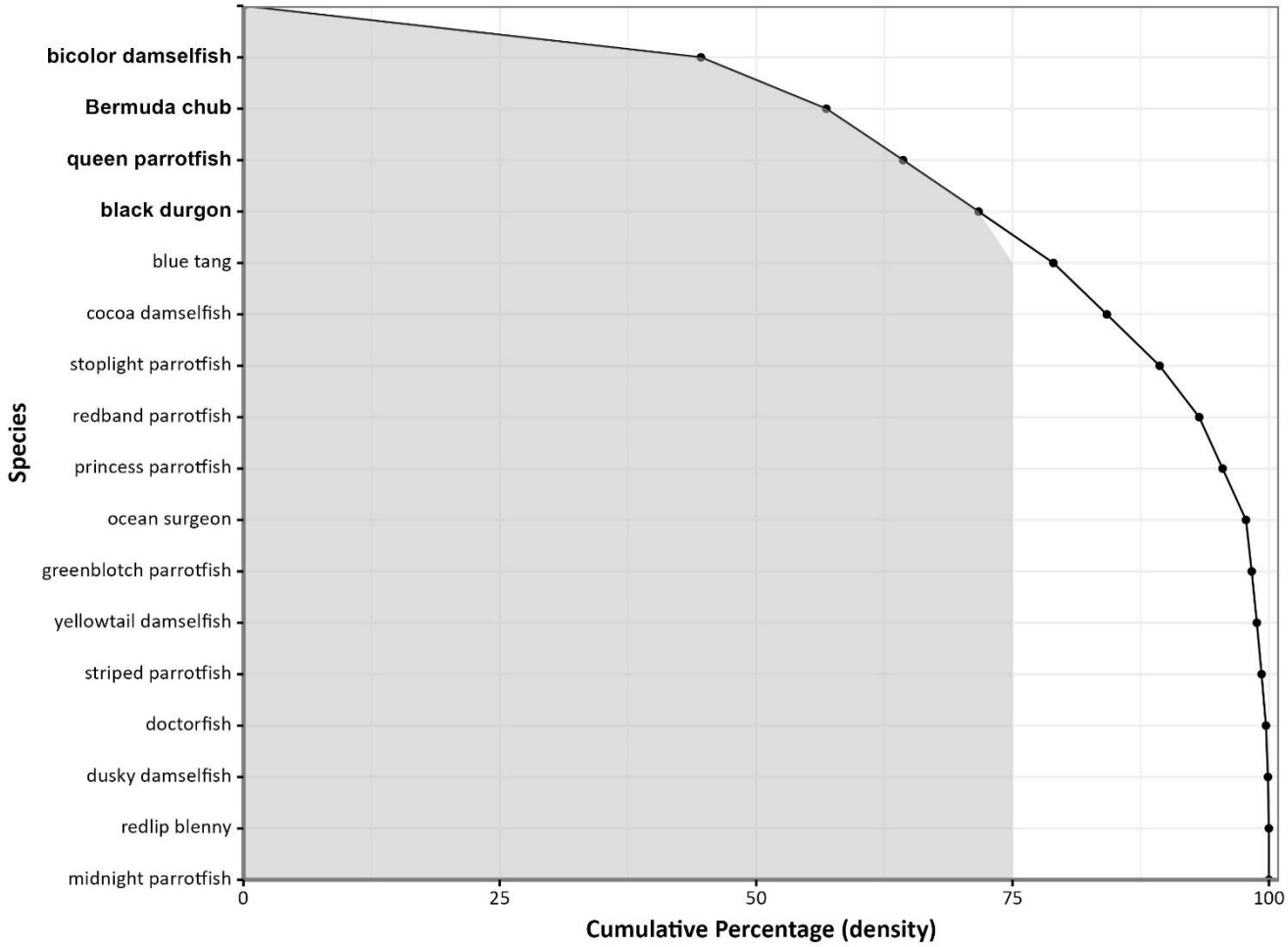


Figure 12. Cumulative density for herbivores in NCRMP Flower Garden Banks 2022 surveys. The four dominant species of herbivores are in bold, and the shaded area represents their contribution (%) to the total herbivore density.

NCRMP's comprehensive sampling design strategy provides a broad, population-level perspective on the reef fish community. 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. The reef caps of East and West FGB are dominated by brown chromis, bluehead wrasse, creole wrasse, Atlantic creolefish, and bicolor damselfish (Figure 13).

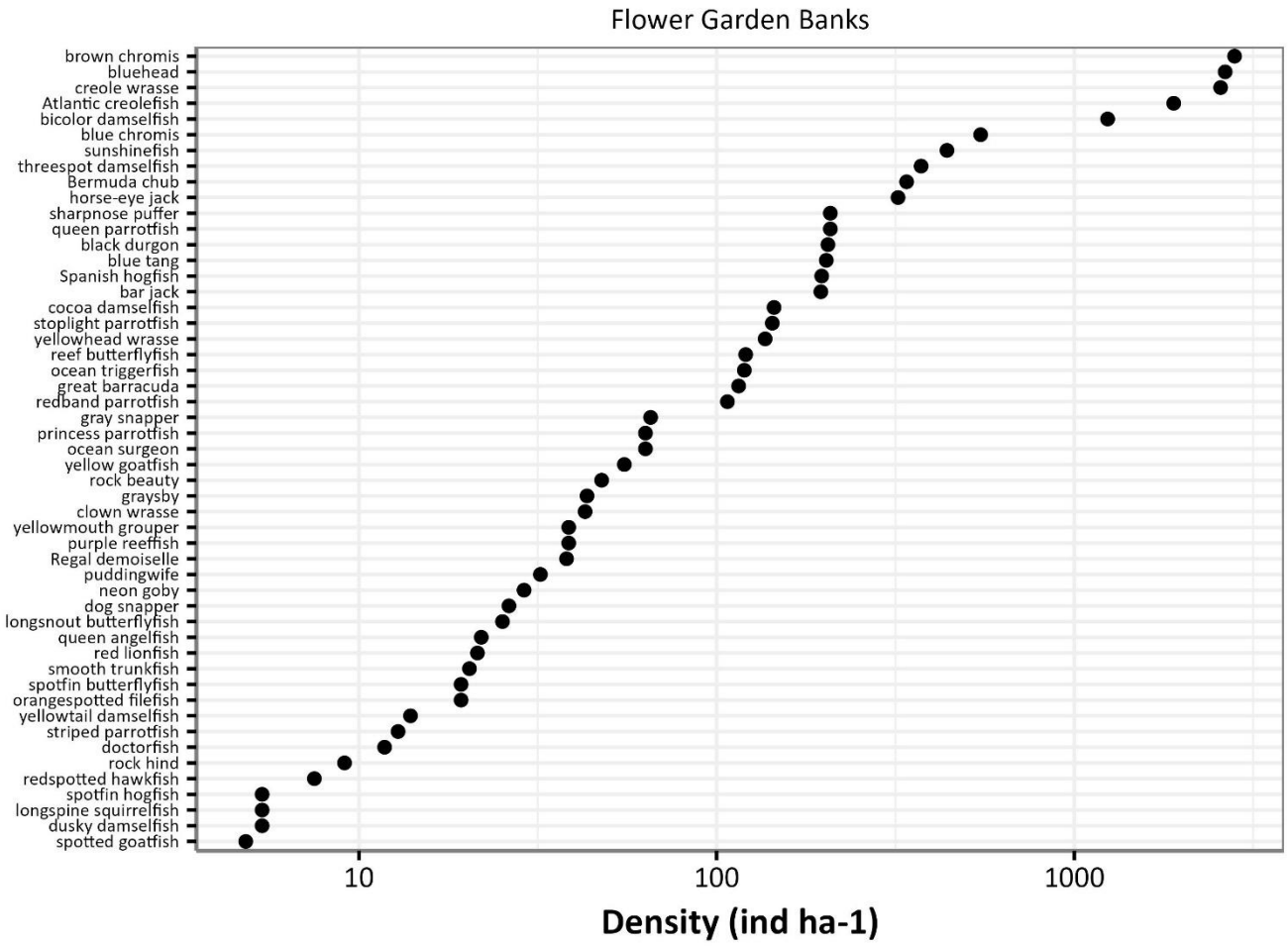


Figure 13. Mean density of the top 50 reef fish species (by occurrence) in NCRMP Flower Garden Banks 2022 surveys. Fish densities are presented on a log scale and show the number of fish per hectare.

NCRMP surveys capture an annual snapshot of coral reef fish populations. Reporting annual trends over time provides a more comprehensive perspective of changes in reef fish populations. In particular, trend data can provide insight into how fishery target species respond to management actions including fishing regulations (e.g., minimum size at capture, bag limits, and gear limitations) and natural events (e.g., hurricanes). The diverse and representative group of ecologically and/or fishery important species included gray snapper, great barracuda, stoplight parrotfish (*Sparisoma viride*), and yellowmouth grouper (Figure 14). Both stoplight parrotfish and yellowmouth grouper had significantly higher densities in 2022 compared to 2018 (Figure 14). Of note, the time series shown is limited due to the coronavirus pandemic (no 2020 data) and a methodology change (pre-2018 data). A method calibration study is in progress that will allow for a more complete time series in future reports.

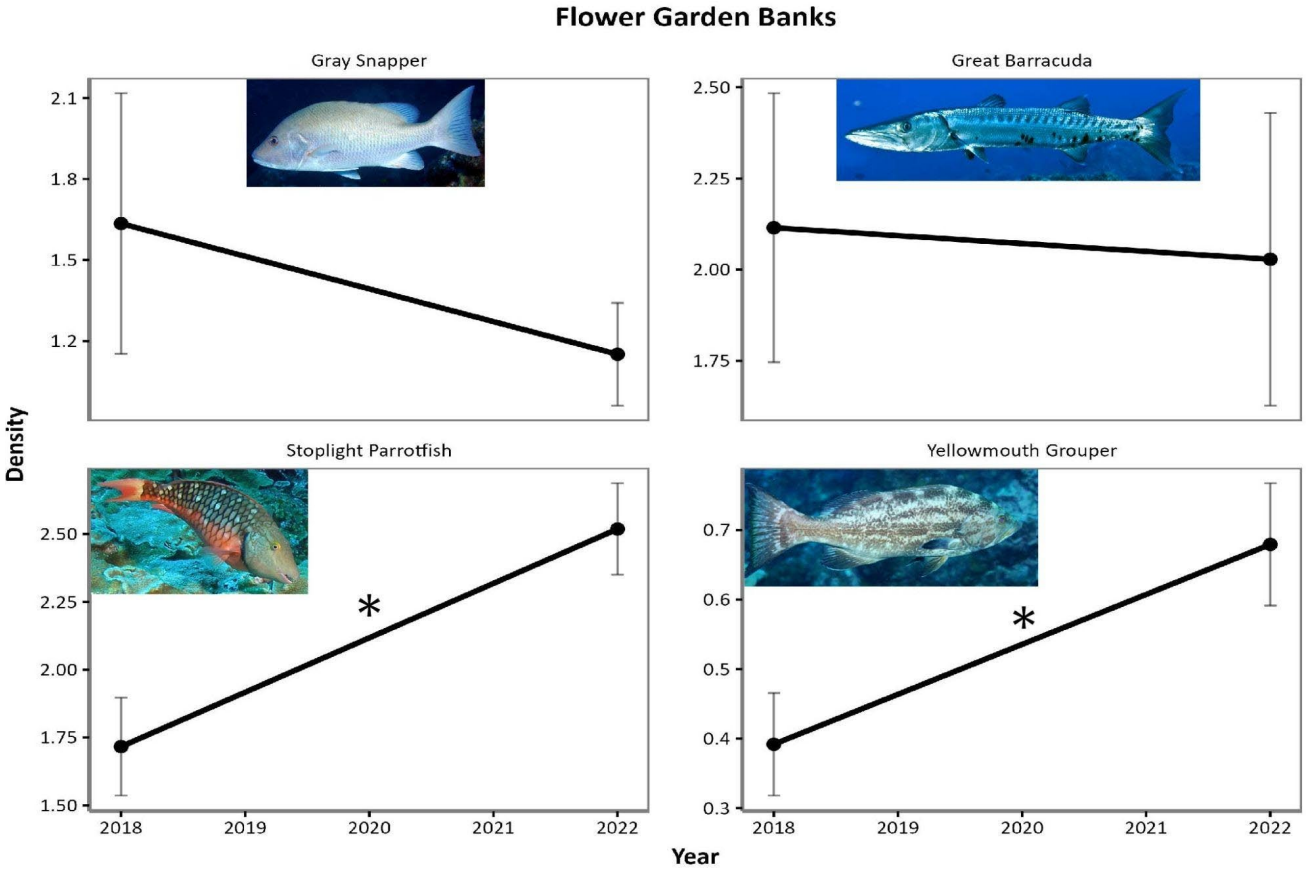


Figure 14. Density of gray snapper, great barracuda, stoplight parrotfish, and yellowmouth grouper for the two most recent survey years (2018, 2022). Densities are reported as the number of individuals per 177 m^2 ± SE, represents all life stages, and significance (Tukey's two-tailed t-test) was reported by year at $p < 0.05$ (*). Note: y-axis ranges differ by species. Photos Credit: NOAA FGBNMS.

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, 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 15–18). In the Gulf of Mexico, each of these four species are 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 10 to 60 cm, and many individuals observed were above their minimum length-at-capture and length-at-maturity estimates of 30 cm (SEDAR, 2018; Figure 15). 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 were observed from ≤ 5 cm to 60 cm, including above their length-at-maturity estimate of 45 cm (Farmer et al., 2016; Figure 16). While both of these fishery-targeted species were observed in FGB above published length-at-maturity estimates, the largest size classes (60 to 89 cm for gray snapper and 60 to 85 cm for yellowmouth grouper), were not observed (Kobara et al., 2017; SEDAR, 2018). Great barracuda and stoplight parrotfish presently have no fishery regulations. Great barracuda were most often observed from 35 to 120 cm (Figure 17) and all sizes of stoplight parrotfish were regularly observed (< 5cm to 50 cm; Figure 18).

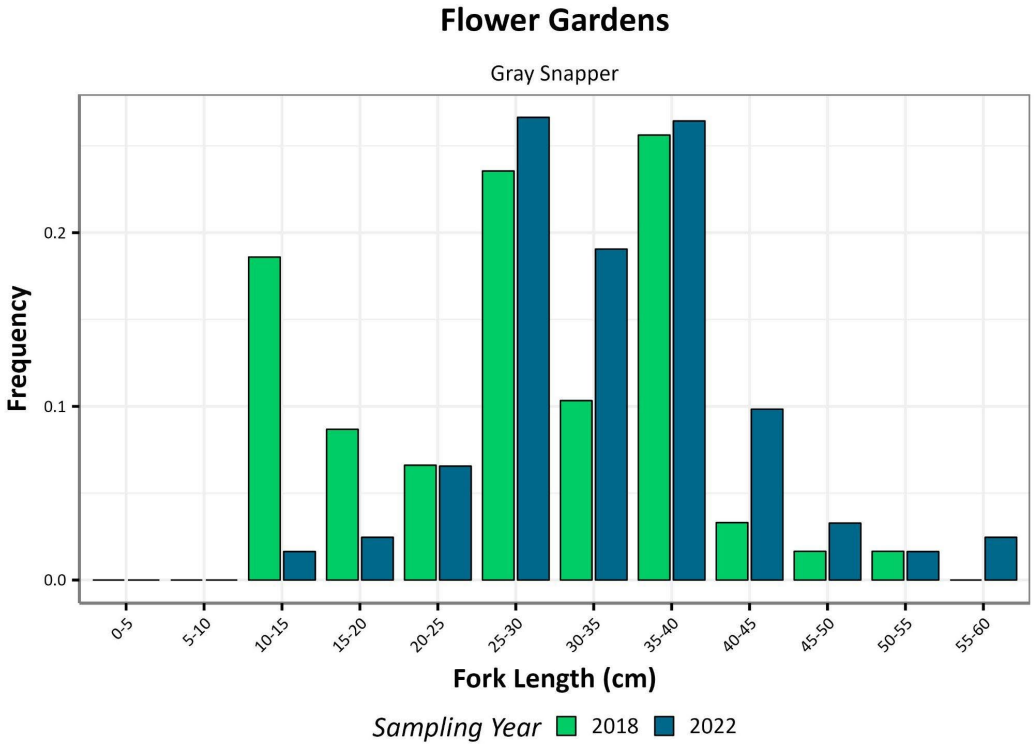


Figure 15. Relative length frequency of gray snapper for the two most recent NCRMP sample years in Flower Garden Banks.

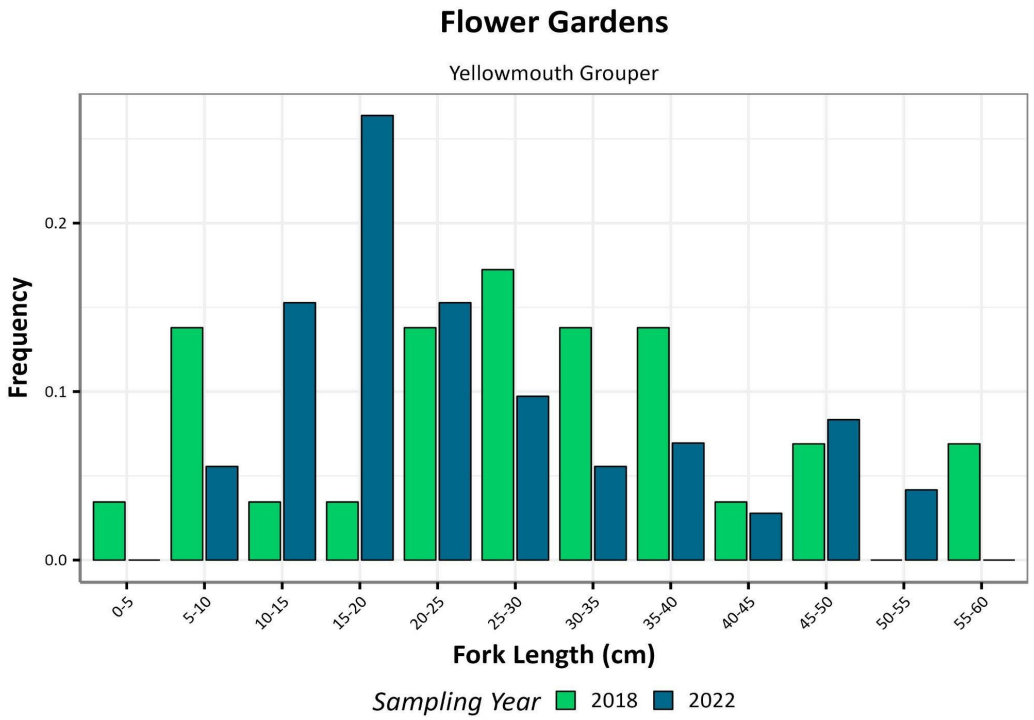


Figure 16. Relative length frequency of yellowmouth grouper for the two most recent NCRMP sample years in Flower Garden Banks.

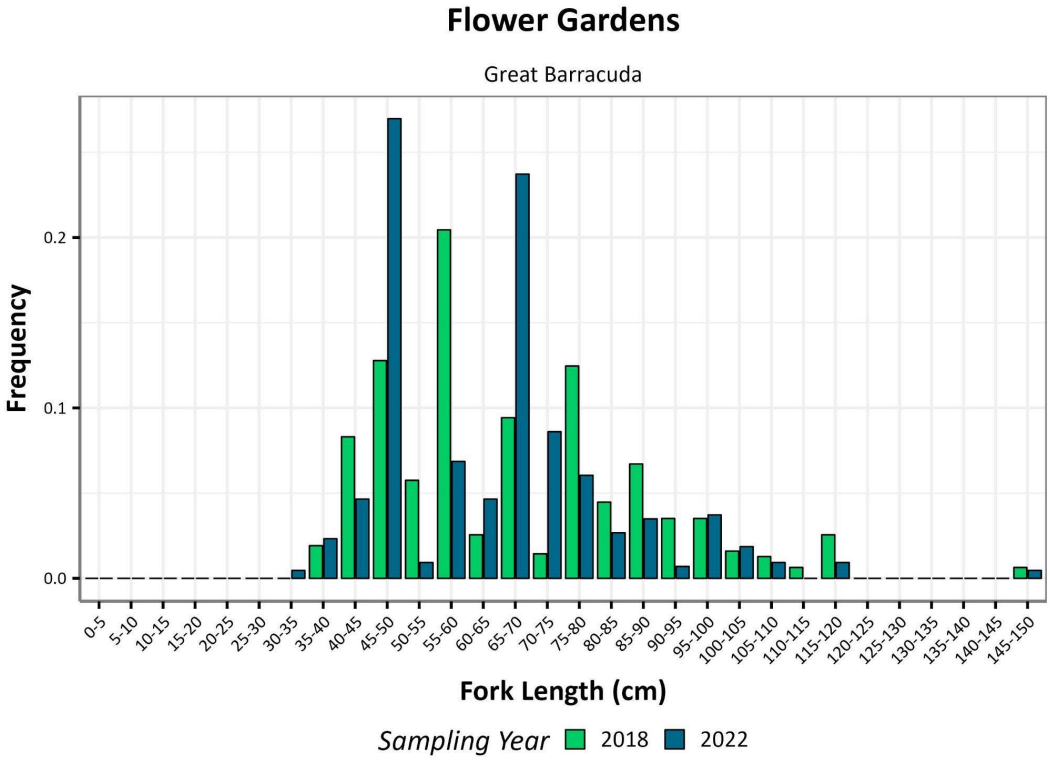


Figure 17. Relative length frequency of great barracuda for the two most recent NCRMP sample years in Flower Garden Banks.

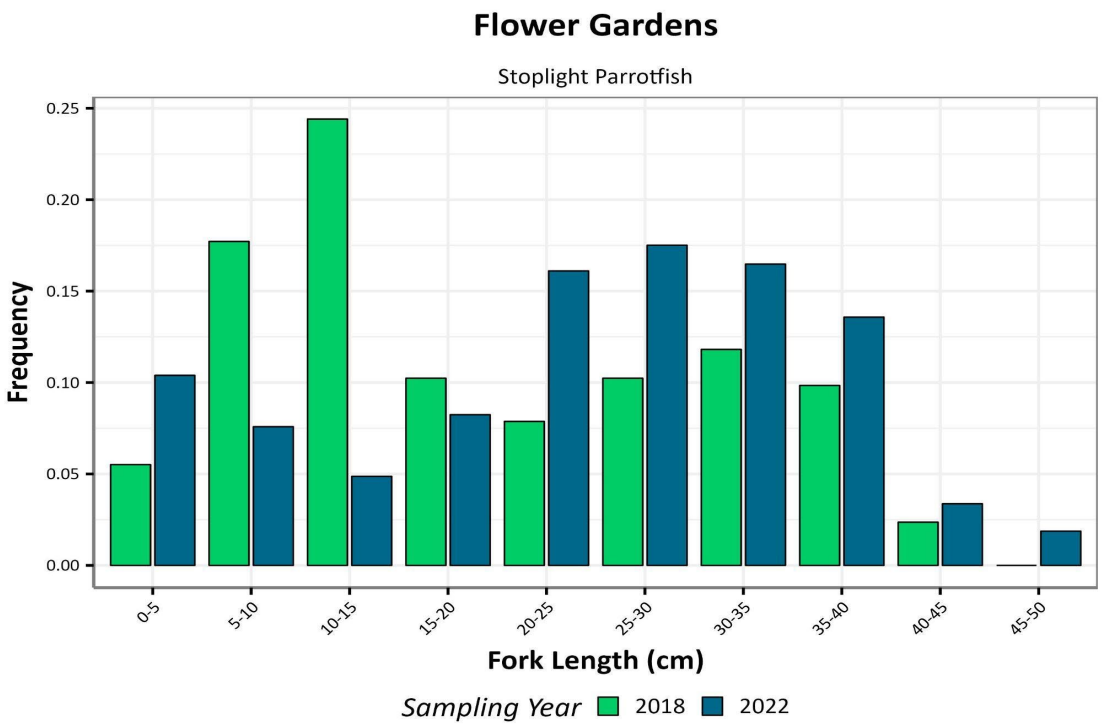


Figure 18. Relative length frequency of stoplight parrotfish for the two most recent NCRMP sample years in Flower Garden Banks.

Summary

NCRMP benthic data indicates that FGB continues to maintain high coral cover and many large colonies of multiple coral species, suggesting stable coral populations (Figure 19; Towle et al., 2022, Viehman, Groves et al., 2023). Unlike in other U.S. Atlantic jurisdictions and the wider Caribbean where coral mortality due to SCTLD and other stressors, such as bleaching, have been widespread, FGB corals seem to be resilient to such stressors. However, some recent coral mortality was observed within the study area, although it has not been confirmed as SCTLD (Johnston et al., 2023). Future NCRMP FGB surveys should include additional sites to increase the CV for multiple coral species.

NCRMP fish data showed that 31 surveyed reef fish species, including fishery targeted and non-targeted species, have CVs of density that are 20% or less. This diverse group of species can be used to reliably monitor trends in 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). Among herbivores, four species made up 75% of the total density, emphasizing the need for species-specific analyses rather than broader groupings. Broader groupings such as "herbivores" can be unintentionally misleading, as it is often assumed that each species equally contributes to the results (e.g., density, trends); however, in this case, 4 out of the 17 herbivore species observed would predominantly be responsible for any results in a broader grouping. As a fishery-independent survey, NCRMP collects numbers and lengths on all observed fishes to the nearest cm. These population and size data are critical to support effective fisheries management actions, such as best fishing practices, sustainable landings, and length regulations that allow fishes to reproduce before they are susceptible to capture by the fishery. Relative length frequencies for the four representative species evaluated (gray snapper, yellowmouth grouper, great barracuda, and stoplight parrotfish) showed that mature fishes were present on the reefs.

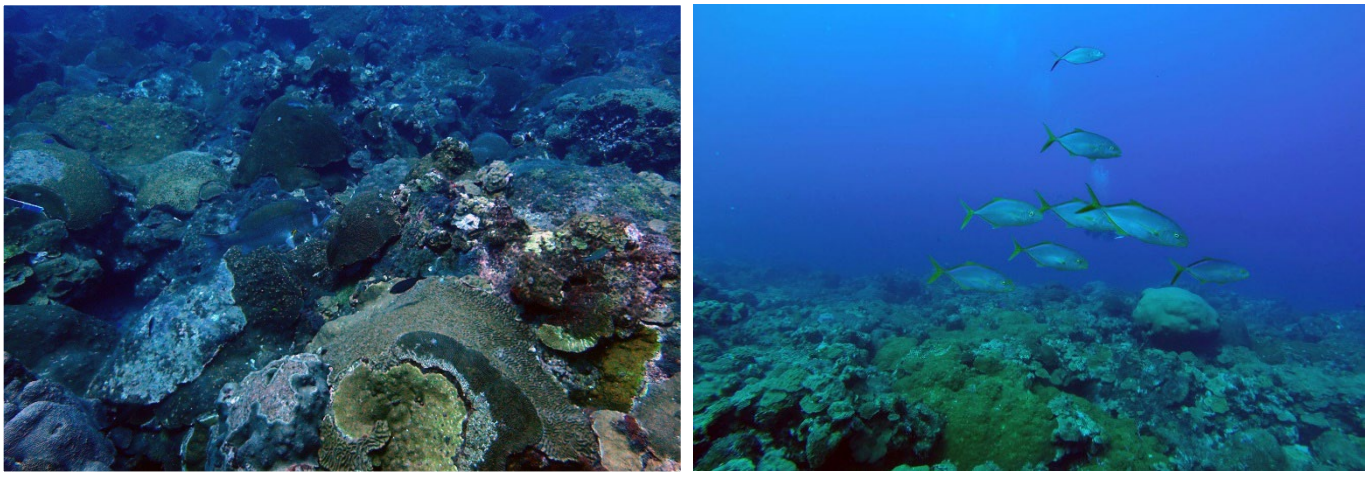


Figure 19. Examples of a high coral cover site (left), and a yellow jack (*Caranx bartholomaei*) at a high coral cover site (right) on Flower Garden Banks. Photo credit: NOAA NCCOS

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Appendix: Supplemental Information

NCEI Data Package References

- **FGB Benthic Collections** (all years):
  NOAA National Centers for Coastal Ocean Science; NOAA Southeast Fisheries Science Center (2022). 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
- **2022 FGB Benthic Data:**
  National Centers for Coastal Ocean Science (NCCOS) and Southeast Fisheries Science Center (SEFSC) (2022). National Coral Reef Monitoring Program: Assessment of coral reef benthic communities in Flower Garden Banks National Marine Sanctuary from 2022-08-25 to 2022-09-02 (NCEI Accession-0277838). [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. https://accession.nodc.noaa.gov/0277838.
- **FGB Fish Collections** (all years):
  NOAA National Centers for Coastal Ocean Science (2022). National Coral Reef Monitoring Program: Assessment of coral reef fish communities in Flower Garden Banks National Marine Sanctuary. [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. doi: 10.7289/v5057d81
- **2022 FGB Fish Data:**
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  https://www.ncei.noaa.gov/archive/accession/0277994

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 FGB region, see ***Flower Garden Banks National Marine Sanctuary Monitoring Program.***

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