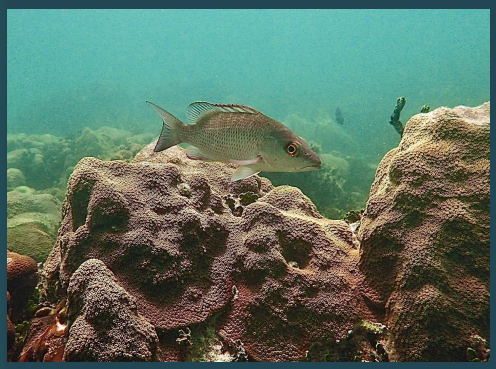
https://doi.org/10.25923/ez2f-5n57

National Coral Reef Monitoring Program

Biological Monitoring Summary



Florida: 2024

2026

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 56

National Coral Reef Monitoring Program
Biological Monitoring Summary

Florida: 2024

Laura Jay W. Grove[1], T. Shay Viehman[2], Jeremiah Blondeau[1], Erin Cain[1,3], Nicole Krampitz[4,5], Caitlin Langwiser[1], Julia Mateski[5], Alexis B. Sturm[2], Dione Swanson[1,3], and Erica K. Towle[6]

[1] *NOAA National Marine Fisheries Service, Southeast Fisheries Science Center*
[2] *NOAA National Ocean Service, National Centers for Coastal Ocean Science*
[3] *University of Miami, Cooperative Institute for Marine and Atmospheric Science*
[4] *RPI-CSS, LLC under contract to NOAA National Ocean Service, National Centers for Coastal Ocean Science*
[5] *CSS, Inc. under contract to NOAA National Ocean Service, National Centers for Coastal Ocean Science*
[6] *NOAA National Ocean Service, Coral Reef Conservation Program*

2026

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 56

Suggested Citation

Grove, L.J.W., Viehman, T. S., Blondeau, J., Cain, E., Krampitz, N., Langwiser, C., Mateski, J., Sturm, A.B., Swanson, D., and Towle, E. K. (2026). National Coral Reef Monitoring Program, Biological Monitoring Summary – Florida: 2024. NOAA Technical Memorandum NOS CRCP 56. https://doi.org/10.25923/ez2f-5n57

Points of Contact

NCRMP Atlantic and Caribbean Biological Team Leads:
Benthic: Shay Viehman (shay.viehman@noaa.gov)
Fish: Jay Grove (jay.grove@noaa.gov)

NCRMP Field Coordination Leads:
Florida: Jay Grove (jay.grove@noaa.gov)
U.S. Caribbean and Flower Garden Banks: Lexie Sturm (lexie.sturm@noaa.gov)

Acknowledgments

We would like to extend our gratitude to the many partners in Florida who helped with the 2024 NCRMP sampling, including Florida Fish and Wildlife Conservation Commission, Florida Keys National Marine Sanctuary, Miami-Dade County, National Park Service, Nova Southeastern University, University of Miami, and University of the Virgin Islands. In addition, we thank two reviewers for constructive suggestions to improve this report. This work was funded by NOAA's Coral Reef Conservation Program (project #743). NOAA NCRMP permits for each location sampled in 2024 were: 1) Florida Keys National Marine Sanctuary (FKNMS-2020-047; TER-2024-23; TER-2024-38; TER-2024-42); 2) Biscayne National Park (BISC-2024-SCI-0013); 3) Dry Tortugas National Park (DRTO-2023-SCI-0010), and 4) Florida's State Parks (05162425). CSS, Inc. employees were supported under Contract No. EA133C17BA0062 to CSS, Inc. and RPI-CSS LLC employees were supported under Contract No. 1305M225A0002 to RPI-CSS LLC.

Cover photos were taken by Nicole Krampitz (top, bottom) and Erin Cain (middle). Infographic photos by Erin Cain (left), Sophie Cook (top right), and Leslie Henderson (bottom right).

Disclaimer

Contents

List of Figures and Tables

Figures

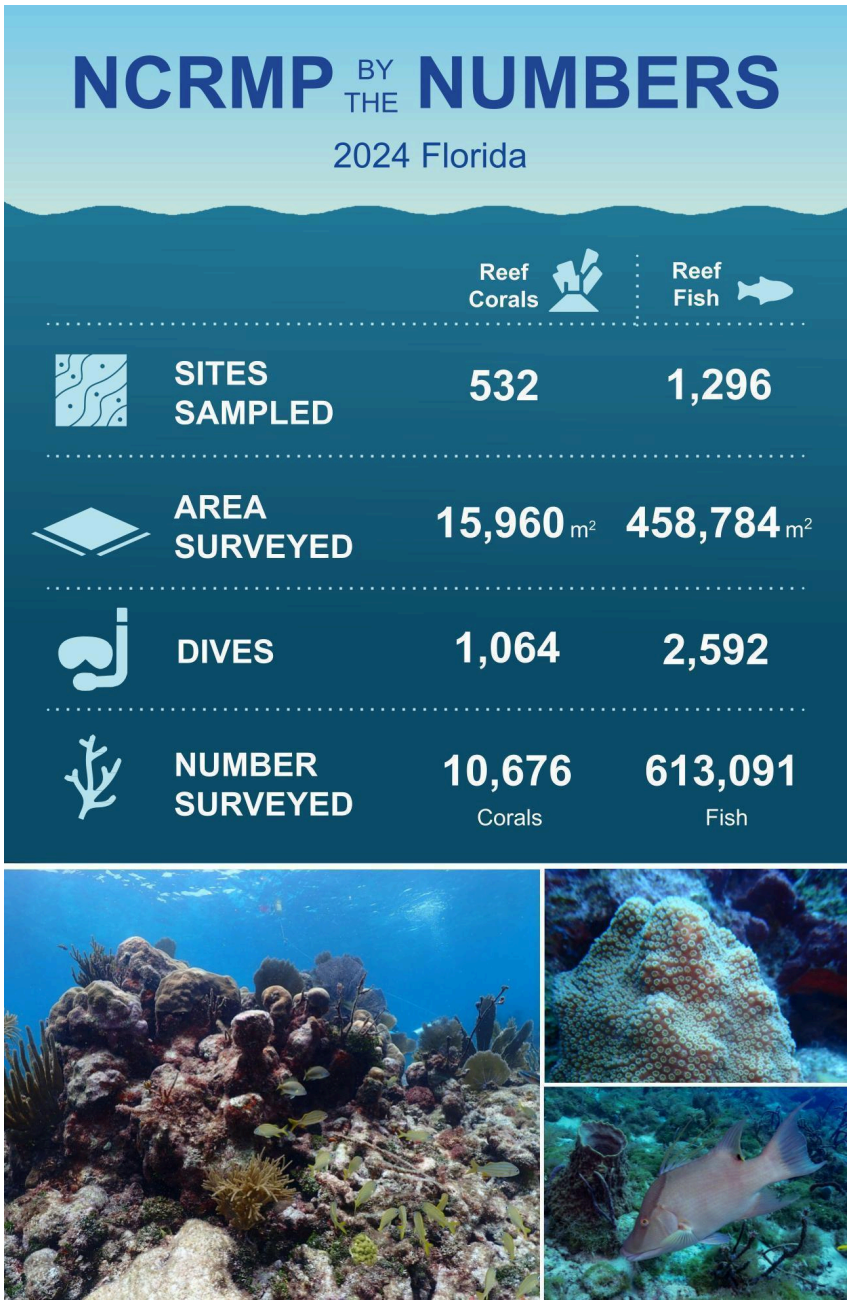
Tables

Acronyms

APT	All-Purpose Tool
CRCP	Coral Reef Conservation Program
CV	Coefficient of variation
DRM	Disturbance Response Monitoring
DRTO	Dry Tortugas National Park
ESA	Endangered Species Act
FKNMS	Florida Keys National Marine Sanctuary
FWC	Florida Fish and Wildlife Conservation Commission
GAM	Generalized Additive Model
M:IR	Mission: Iconic Reefs
NCCOS	National Centers for Coastal Ocean Science
NCEI	National Centers for Environmental Information
NCRMP	National Coral Reef Monitoring Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	NOAA National Ocean Service
NPS	National Park Service
RVC	Reef fish Visual Census
SCTLD	Stony Coral Tissue Loss Disease
SE	Standard Error
SEFSC	NOAA Fisheries, Southeast Fisheries Science Center
SPA	Sanctuary Preservation Area
TNCA	Tortugas North Conservation Area

Executive Summary

The National Oceanic and Atmospheric Administration (NOAA)'s National Coral Reef Monitoring Program (NCRMP) conducted biological sampling for fish populations and communities, and for coral populations and benthic communities along Florida's Coral Reef in 2024. NCRMP surveys are completed every other year in Florida, normally during even-numbered years. In 2024, NCRMP surveys of Florida's shallow water (≤ 30 m) coral reefs occurred throughout the summer and fall months. NCRMP data are used to inform coral and fish population management strategies, document the occurrence of endangered species and coral disease, and complement local monitoring efforts. Information about NCRMP's methods, data, and data products is available on the project website: https://www.coralreef.noaa.gov/topics/national-coral-reefmonitoring-program/biological.



Report Overview

NCRMP provides large-scale, stratified random monitoring data to evaluate 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 sampling results by summarizing the 2024 biological data collected by NOAA and regional partners in the shallow water coral reef ecosystems in Florida at the sub-jurisdiction or region level (i.e., Dry Tortugas, the Florida Keys, and Southeast Florida).

Sampling Overview

In 2024, Florida NCRMP sampling efforts occurred from May until November at the following locations and dates:

- Southeast Florida:
  - Fish and Benthic Communities: June–November 2024
- Florida Keys:
  - Fish and Benthic Communities: June–October 2024
- Dry Tortugas:
  - Fish: May–August 2024
  - Benthic Communities: September 2024

Partners involved in NCRMP Florida 2024 efforts included:

- Broward County (BC)
- Florida Fish and Wildlife Conservation Commission (FWC)
- Florida Keys National Marine Sanctuary (FKNMS)
- Miami-Dade County (MDC)
- National Park Service (NPS)
- Nova Southeastern University (NSU)
- University of Miami (UM)
- University of the Virgin Islands (UVI)

Key Report Points

Fish Community

- Reefs in all locations are dominated by smaller forage species not targeted by fisheries, including masked goby (*Coryphopterus personatus*), bicolor damselfish (*Stegastes partitus*), bluehead wrasse (*Thalassoma bifasciatum*), and slippery dick (*Halichoeres bivittatus*).
- The fishery target species with the highest mean density was yellowtail snapper (*Ocyurus chrysurus*) in the Dry Tortugas and Florida Keys, and gray triggerfish (*Balistes capriscus*) in Southeast Florida.
- Comparatively, the highest mean density for key fishery target species varied among the three Florida regions: Mutton snapper (*Lutjanus analis*) was observed at its highest densities in Southeast Florida, hogfish (*Lachnolaimus maximus*) was highest in the Florida Keys, and red grouper (*Epinephelus morio*) was highest in the Dry Tortugas.

- The 2024 surveys showed that larger, above minimum legal size, hogfish remained rare in Southeast Florida and the Florida Keys. In contrast, larger, above minimum legal size, red grouper were more frequently observed in the Florida Keys and Southeast Florida in 2024 compared to the previous two survey years.

Corals and Benthic Community

- Reefs in 2024 showed significant declines in coral populations and communities. Hard and soft coral cover, overall coral density, and species-specific coral densities showed effects from severe bleaching in 2023 during record-breaking heat stress. Florida was just one of the geographies impacted by the fourth mass global bleaching event in 2023–2024.
- Hard coral cover continues to remain low across all Florida regions, with 2024 regional mean estimates from <1 to 5% coral cover.
- The population size structure of coral species highly susceptible to SCTLD (e.g., *Meandrina meandrites, Colpophyllia natans*) has shifted towards smaller colony sizes and many have recently increased in density. This suggests that, while high mortality of larger adult colonies occurred during the outbreak phase of SCTLD, new recruits have successfully survived during SCTLD's endemic phase.

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, the 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 ($\leq$ 30 m) coral reef ecosystems. These data provide critical context and perspective for understanding ecosystem conditions and informing coral reef management. Biological sampling occurs on a two-year cycle for the U.S. Virgin Islands (USVI; including St. Thomas, St. John, and St. Croix), Puerto Rico, Florida, and Flower Garden Banks National Marine Sanctuary (Figure 1).

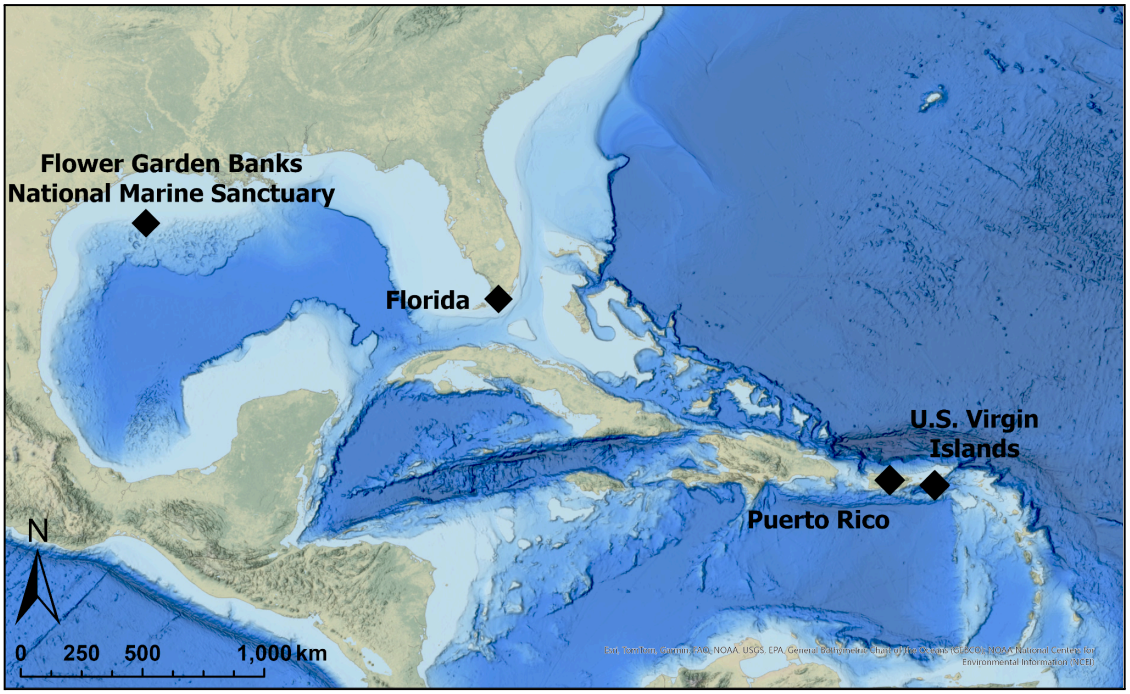


Figure 1. Map of U.S. Atlantic jurisdictions sampled within the National Coral Reef Monitoring Program (NCRMP).

This report summarizes NCRMP biological sampling data in 2024 from the shallow water coral reef ecosystems in Florida. 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 Biological project webpage (https://coralreef.noaa.gov/topics/national-coral-reef-monitoring-program) and NOAA's National Centers for Environmental Information (NCEI) database (see Appendix for additional reference and archive information).

NCRMP has surveyed Florida's Coral Reef since 2014. This is the third NCRMP Biological Summary Report in Florida that shows trend data for fish and benthic communities between 2014 and the present (i.e., Grove et al. 2022, Viehman et al. 2023). The NCRMP program in Florida builds upon historic monitoring for fish (Reef fish Visual Census [RVC]: 1999–2013) and corals and benthic communities (Sanctuary Coral Reef Ecosystem Assessment Monitoring [SCREAM]: 1999–2011).

In Florida, NCRMP is part of a mosaic of monitoring efforts for corals and benthic communities that includes both stratified random sampling and fixed-site monitoring. Florida Fish and Wildlife Conservation Commission's Disturbance Response Monitoring (DRM) is an annual stratified random coral demographics survey focused on coral bleaching and disease (2005–present) that is complementary to NCRMP coral demographic surveys. DRM uses the NCRMP sampling grid to a 20 m water depth, while the NCRMP survey domain extends to a 30 m limitation. The NCRMP and DRM programs collaborate; in even-numbered years, NCRMP has led the sample allocation and provided sites to DRM to ensure complementarity in geographic coverage. In 2022 and 2024, NCRMP and DRM collaborated on coral species allocations. Data for coral demographics, coral bleaching, and coral disease prevalence are compatible between both programs; for concomitant NCRMP and DRM sampling years, data from both programs should be used to provide comprehensive coral population estimates. See Harrell et al. (2024) for 2024 DRM survey details. For more information on Florida coral monitoring programs, see Viehman, Groves et al. (2024).

In 2024, additional NCRMP sites were surveyed in i) the Florida Keys to focus on Mission: Iconic Reefs (M:IR) restoration, and ii) Biscayne National Park to support fisheries management. These data are included in the NCRMP Florida Keys sections.

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 (Ault et al., 2021). Each jurisdiction has a unique set of strata specific to their local protected or managed zones and benthic habitat. The survey design ensures that survey sites for fish and corals are allocated by hard bottom rugosity, depth, and management zone. These sites are distributed around the sampling region from nearshore to offshore and limited to a depth of 30 m. In 2020, the NCRMP Florida survey grid's spatial resolution was updated from 100 m x 100 m grid cells to 50 m x 50 m grid cells. Additionally, the Dry Tortugas and Florida Keys jurisdictional strata were updated (Ault et al., 2021). The 2024 NCRMP survey is the third NCRMP year using this updated, higher-resolution sampling frame. Domain-level time series analyses are still appropriate despite sample design changes and are included in NCRMP R-package analyses (Ganz and Blondeau, 2015; Groves et al., 2025).

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 that are co-located within the same grid cell may not be sampled during the same dive. In Florida, the number of fish sites sampled exceeds the number of benthic sites to support fishery stock assessments. As additional NCRMP data are gathered in future years, the program's ability to detect long-term trends and variability will increase.

Florida includes three distinct regions (i.e., sampling domains): Southeast Florida, the Florida Keys, and the Dry Tortugas. These three regions vary in their implementation of spatially explicit closure areas (i.e., marine reserves) for recreationally and commercially targeted fish species. In Southeast Florida, no spatially explicit closure areas exist; the Kristin Jacobs Coral Aquatic Preserve presently allows extractive fishing. In the Florida Keys, 17 smaller, no-take marine reserves are known as Sanctuary Preservation Areas (SPAs). The Dry Tortugas has two distinct no-take marine reserves within the NCRMP sampling domain: Tortugas North Conservation Area (TNCA) in Florida Keys National Marine Sanctuary (FKNMS), and the Research Natural Area within the Dry Tortugas National Park (DRTO). It should be noted that the Tortugas South Conservation Area and the Marquesas are not currently included in the NCRMP sampling domain. The majority of NCRMP sampling occurs outside of the marine reserves; however, the sampling design provides enough power to detect differences in fish densities inside versus outside marine reserves, if relevant. In Southeast Florida, no marine reserve comparisons were made.

Sample Protocols

Field Surveys

The Reef fish Visual Census (RVC) is a stationary point count sampling protocol (NOAA CRCP, 2024a) 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 and counted, and fork length was estimated to the nearest centimeter (Figure 2 [left]). Fishes' sizes were verified using an All Purpose Tool (APT), a 1-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.

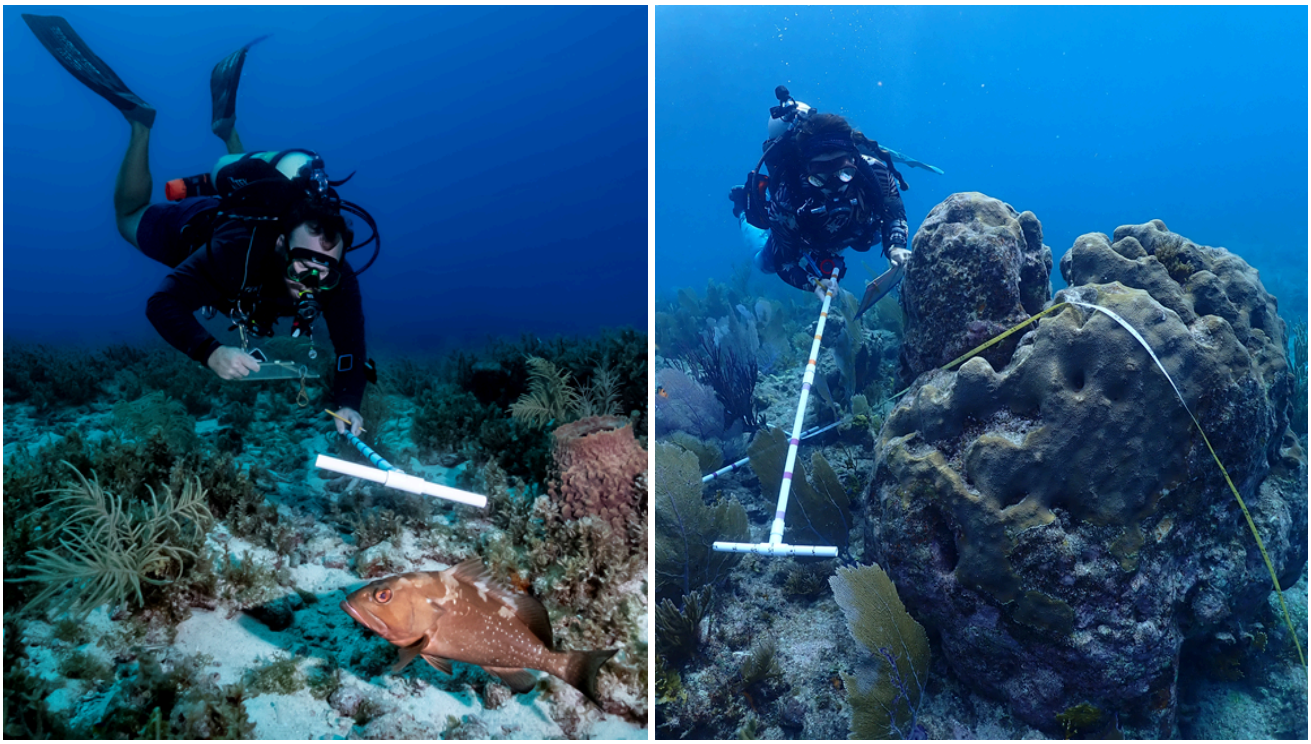


Figure 2. Examples of (left) a diver collecting Reef fish Visual Census fish survey data in the Dry Tortugas; and (right) a diver collecting coral demographic data in the Florida Keys. Photo credits: (left) Lee Richter, National Park Service; (right) Erin Cain, University of Miami/NOAA.

Corals and benthic communities were monitored using a Benthic Community Assessment and a Coral Demographics survey (NOAA CRCP, 2024b, 2024c). The Benthic Community Assessment includes: 1) benthic cover (%) estimates along a 15-m transect with a line point intercept method, 2) presence/absence of Endangered Species Act (ESA) listed coral species (NOAA National Marine Fisheries Service, 2014; 2024), 3) abundance of key macroinvertebrates, and 4) reef rugosity measurements within a 15 m x 2 m belt-transect area (NOAA CRCP, 2024b). At the same site, coral demographics were surveyed within a 10 m x 1 m belt-transect area (NOAA CRCP, 2024c). In the Coral Demographics surveys (Figure 2 [right]), all live coral colonies $\geq$ 4 cm were counted, identified to species, and measured to the nearest centimeter (length, width, height), and estimates were made of the proportion per colony of any present mortality (recent or old), disease (present, slow, fast), and/or bleaching (total, partial, paling). Only live coral colonies were included in the survey; dead colonies with 100% mortality were not surveyed (e.g., colonies killed by coral disease). Juvenile corals (< 4 cm) were reported for species richness and were not included in size measurements or estimates of condition; however, counts of select ESA-listed and SCTLD-susceptible juvenile coral species were recorded in the first 5 m of the transect. These records are not presented herein, but are available in the accompanying dataset.

NCRMP Coral Demographics surveys provide information on disease occurrence on individual coral colonies without identification of specific diseases. 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 the progression 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 is provided in Towle et al. (2021).

Coral bleaching (total, partial, paling, none) is consistently surveyed during NCRMP sampling; however, field sampling dates do not always coincide with bleaching events. Therefore, peak bleaching events may not be represented comprehensively in NCRMP data.

Due to the increase in coral restoration efforts within the NCRMP sampling geography in general, and

specifically within M:IR sites, NCRMP added new fields to all data sheets in 2022 regarding whether coral restoration was observed at an NCRMP site (No/Yes/Unknown), and to Coral Demographics data sheet as to whether surveyed corals were restored (No/Yes/Unknown). In 2024, NCRMP continued to use the datasheet fields for coral restoration (NOAA CRCP, 2024a, 2024b, 2024c) that were added in 2022. Given the expansion of coral restoration in Florida, Puerto Rico, and the U.S. Virgin Islands, it is expected that NCRMP will continue data collection related to coral restoration in future years.

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 or 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 for reference 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 data sheets 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

Fish Communities

NCRMP fish sampling targets a coefficient of variation (CV) of 20% or less for the regionally specific sampling design species. A 20% CV can be translated to the ability to statistically detect a 40% change in density; a lower CV increases the ability to detect changes over time. In Florida, the sample allocation selects for fishery-targeted species. In all sampling domains, the allocation species are red grouper (*Epinephelus morio*), hogfish (*Lachnolaimus maximus*), mutton snapper (*Lutjanus analis*), and yellowtail snapper (*Ocyurus chrysurus*). The final allocation species varies by region based on species occurrence. Black grouper (*Mycteroperca bonaci*) is included in the Dry Tortugas and Florida Keys, while gray triggerfish (*Balistes capriscus*) is selected in Southeast Florida. Other common reef fish species or fishes that share similar characteristics to the allocation species are similarly well-sampled.

Standard fish metrics, including relative density, occurrence, and length composition, are reported herein. Computational formulas of standard metrics for the single-stage, stratified random sampling design are modified from Smith et al. (2011a) and provided in detail in Grove et al. (2021), Bryan et al. (2016), and Feeley et al. (2025). For relative density analyses, we used a confidence interval (CI) t-test (Ault et al., 2013) to evaluate density between years inside versus outside of spatial protection (i.e., marine reserves) where appropriate (see Results section). Additionally, we included a minimum length at capture in the length frequency figures. We converted FWC's minimum total length (inches) regulations for mutton snapper (18 in or 45.7 cm), red grouper (20 in or 50.8 cm), and yellowtail snapper (12 in or 30.5 cm) to fork lengths to align with the NCRMP reef fish survey data. FWC minimum length regulations' fork length equivalents to nearest cm are 42 cm for mutton snapper (SEDAR 2024), 48 cm for red grouper (SEDAR 2006), and 25 cm for yellowtail snapper (SEDAR 2025). FWC uses a minimum fork length regulation of 16 in or 40.6 cm for hogfish; no length conversion was needed.

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

Corals and Benthic Communities

Coral demographic sampling within NCRMP similarly targets a minimum CV of 20% for the regionally specific sampling design. The sample allocation is optimized for species that are identified as major reef-building species or those of interest to management. In Florida, the sample allocation species in 2024 for NCRMP and DRM were: (Southeast Florida) *Meandrina meandrites*, *Montastraea cavernosa*, *Orbicella faveolata*, *Porites astreoides*, *Pseudodiploria strigosa*, and *Siderastrea siderea;* (Florida Keys) *Colpophyllia natans*, *M. cavernosa*, *Orbicella annularis*, *O. faveolata*, *Pseudodiploria clivosa*, *P. strigosa*, *S. siderea*, and *Solenastrea bournoni;* (Dry Tortugas) *C. natans*, *M. meandrites*, *M. cavernosa*, *O. annularis*, *O. faveolata*, *Orbicella franksi*, *P. strigosa*, and *S. siderea.*

Standard metrics, including benthic cover (e.g., % cover of corals and macroalgae), coral species occurrence, coral density, and relative size composition, are reported herein. Coral population metrics include M:IR data and demographics data collected by DRM in years where both were sampled. Computational formulas of standard metrics for the single-stage, stratified random sampling design are provided in detail in Smith et al. (2011b), Groves et al. (2025), and Viehman, Groves et al. (2024). Length frequency distributions were generated from colony size measurements (maximum diameter) of colonies $\geq$ 4 cm, which included areas of partial mortality (Bak and Meesters, 1999; Meesters et al., 2001). Frequency within each length class was composed of colonies that had at least some amount of live tissue. For temporal comparisons, a pairwise two-tailed t-test was used to evaluate differences between years where appropriate. Domain-level coral bleaching and disease prevalence for the temporal figures were calculated by species using a weighted mean. The prevalence defined as the mean percentage of colonies with any bleaching or disease across all sampled sites and strata was determined, and then weighted by the proportional area of its stratum within the entire sampling domain, consistent with the NCRMP stratified random sampling design (Smith et al., 2011ab). For the species-specific 2024 bleaching and disease prevalence data, coral bleaching and disease are reported as the proportion of corals (to species) with bleaching or disease at the time of sampling, where the mean percentage of colonies with any bleaching/disease is divided by the total number of corals for each species across all sites and strata. These proportions are reported for observed colonies only and not extrapolated to the domain or population level.

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

Results

In 2024, a total of 1,828 sites were surveyed along Florida's Coral Reef (Table 1; Figure 3). This included 287 fish sites and 116 benthic sites in Southeast Florida, 622 fish sites and 229 benthic sites in the Florida Keys, and 387 fish sites and 187 benthic sites in the Dry Tortugas (Table 1; Figure 4). The number of fish and benthic sites in the Florida Keys included additional sampling efforts within M:IR restoration areas by FKNMS (100 fish sites and 100 benthic sites) and in Biscayne National Park by the NPS and FWC (174 fish sites; Figure 4). Of the total 1,828 sites, 452 sites had co-located benthic and fish survey data. Fluctuations in the number of sites surveyed for the protracted 2020–2021 season were largely driven by COVID-19 limitations, and results for 2020–2021 in the Florida Keys are not included due to small sample sizes. Similarly, weather and COVID-19 complications resulted in Dry Tortugas fish sampling cruises occurring in 2022 and 2023; fish and benthic surveys in Southeast Florida and the Florida Keys, and benthic surveys in the Dry Tortugas were completely sampled in 2022 (Table 1).

Table 1. NCRMP fish and benthic sites completed by region and year along Florida's Coral Reef.

Year	Southeast Florida		Florida Keys		Dry Tortugas	
	Fish	*Benthic*	*Fish*	*Benthic*	*Fish*	*Benthic*
2024	287	116	622	229	387	187
2022–2023	306	115	648	186	118	96
2020–2021	305	98	218	12	229	129
2018	298	77	434	90	337	139
2016	-	98	405	93	286	98
2014	-	49	432	349	358	106

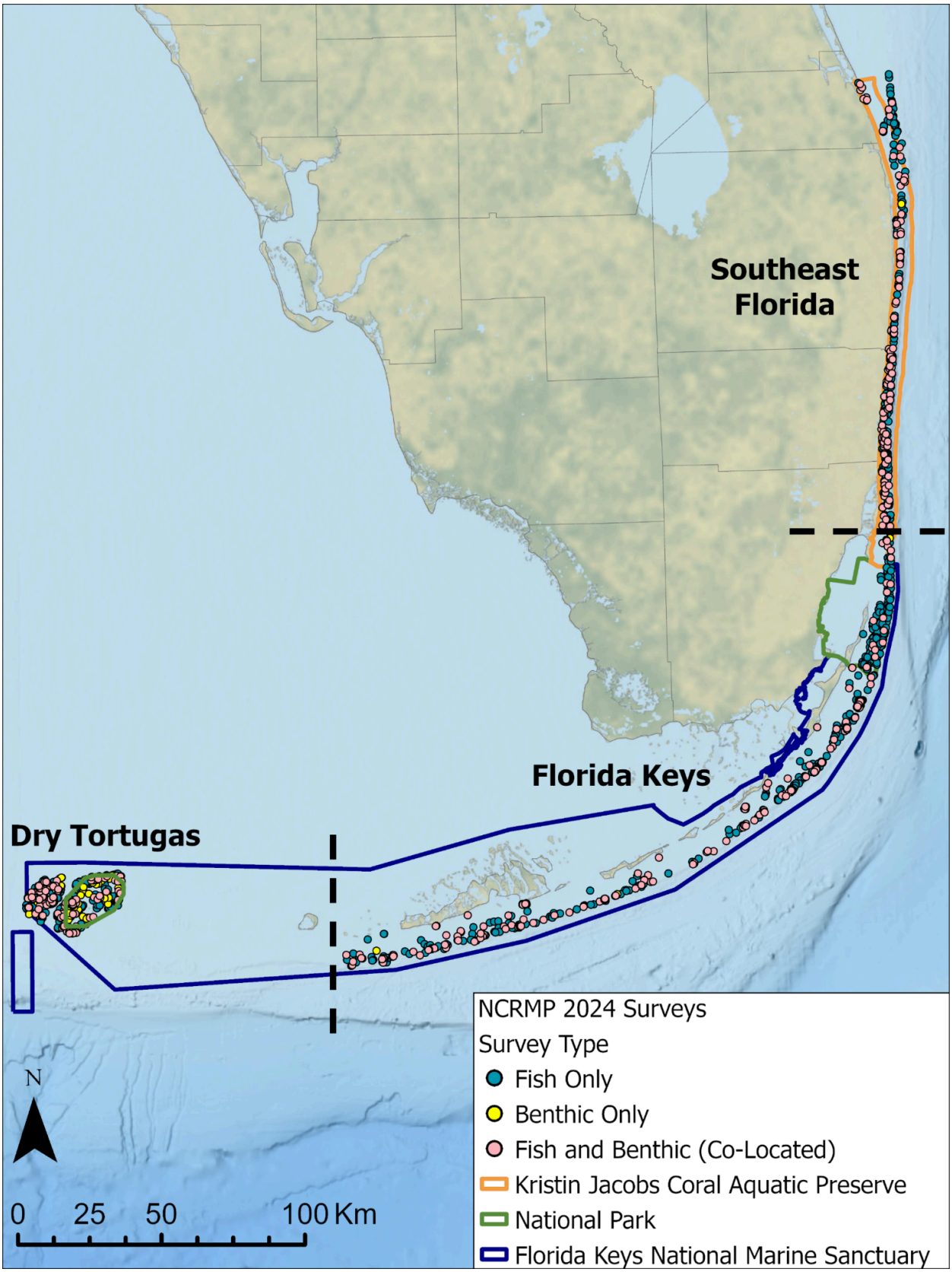


Figure 3. NCRMP's 2024 survey sites on hardbottom habitats within Florida's three sampling domains: Southeast Florida, Florida Keys, and Dry Tortugas. Black dashed lines denote adjacent sampling domain boundaries.

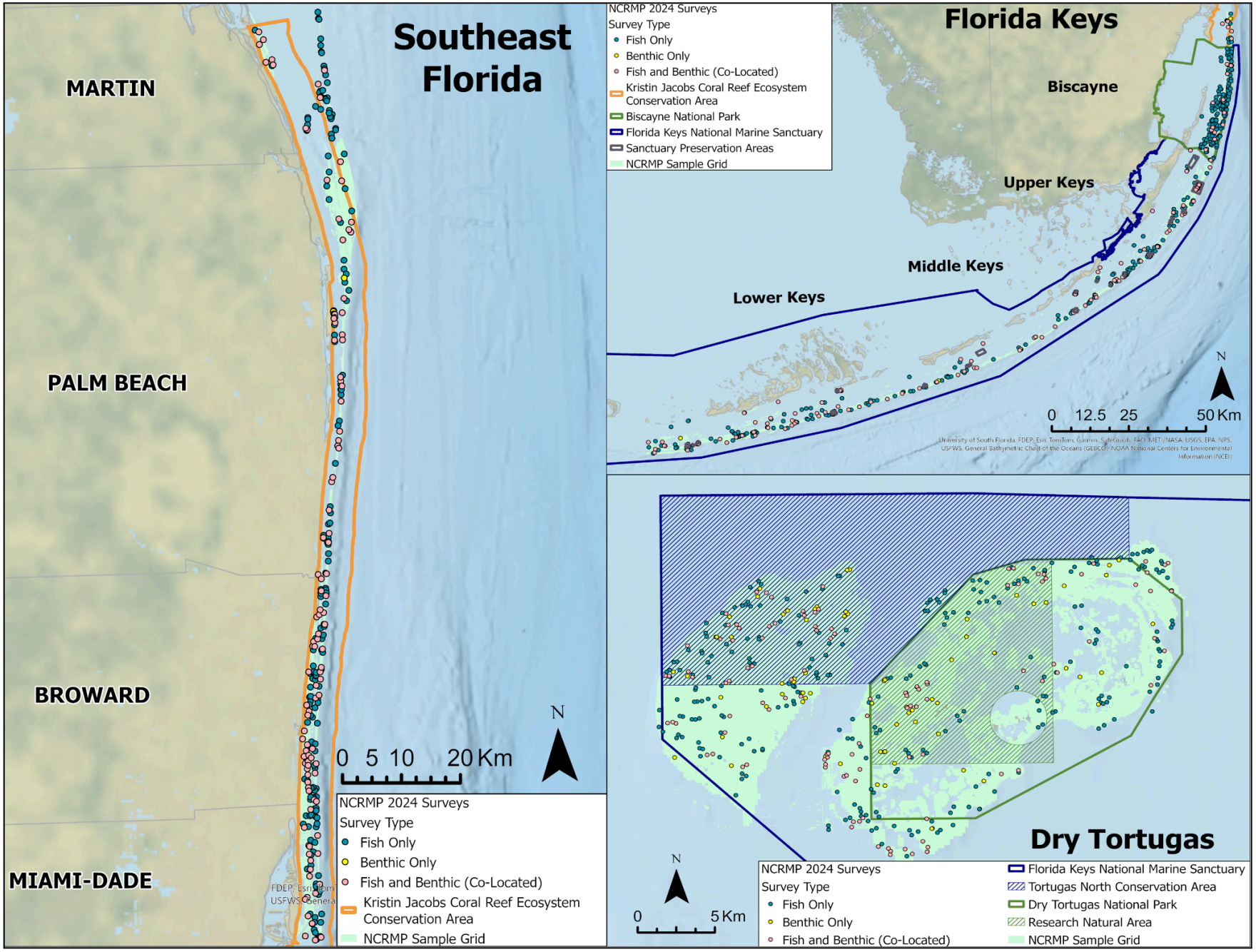


Figure 4. NCRMP survey sites sampled in Southeast Florida (left), Florida Keys (top right), and the Dry Tortugas (bottom right) in 2024.

I. Fish

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. In Florida, two (Dry Tortugas, Florida Keys) or three (Southeast Florida) species of parrotfish make up approximately 75% of the total parrotfish density, highlighting the importance of analyzing and reporting species-specific information. For example, striped (*Scarus iseri*) and redband (*Sparisoma aurofrenatum*) parrotfish dominate the parrotfish taxonomic group in the Dry Tortugas, as illustrated in Figure 5. This pattern was similar in the other Florida regions as well, although not shown graphically. Thus, data from the NCRMP surveys provide the species-specific status and trends necessary for granular reporting and targeted management actions.

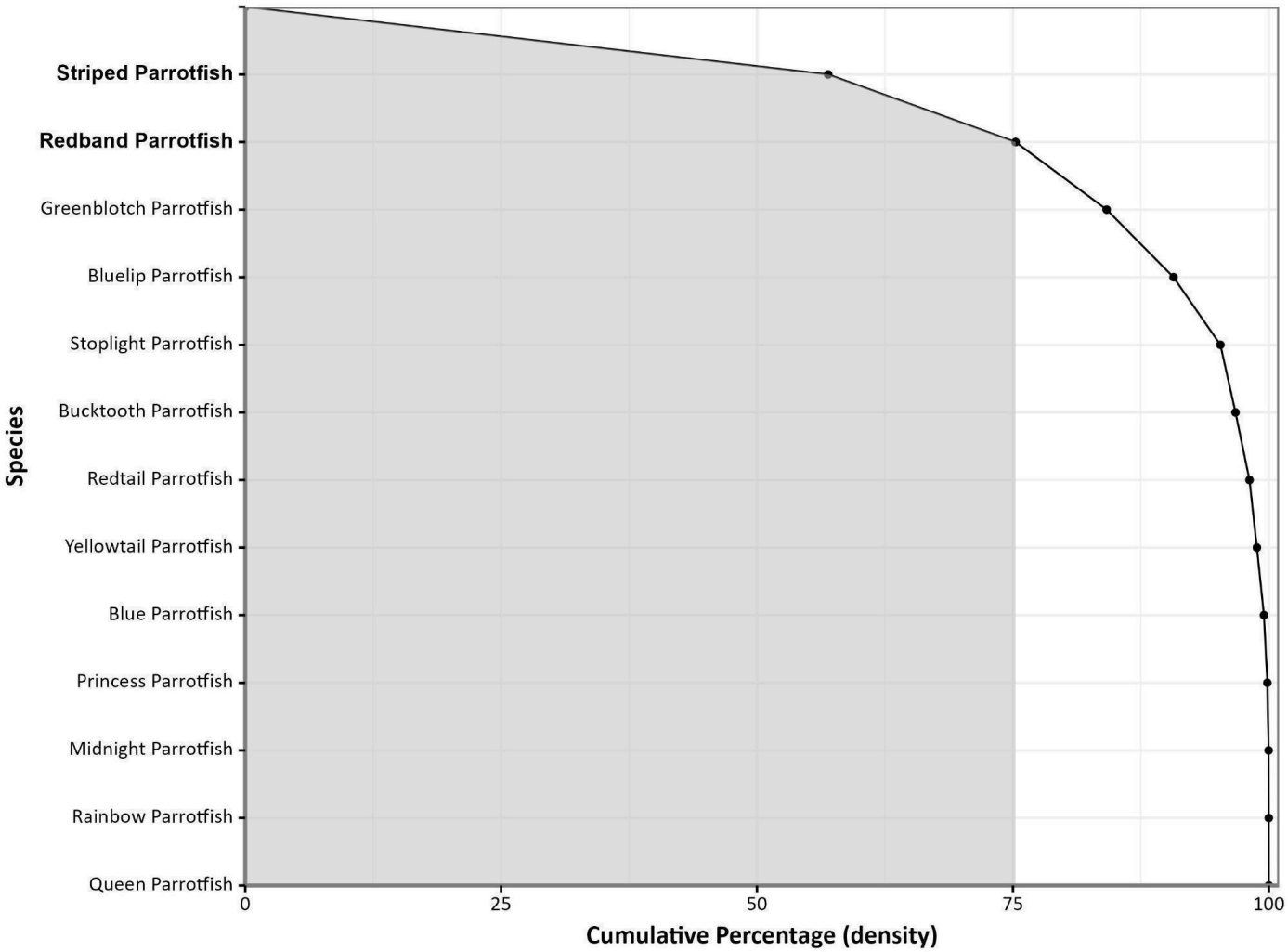


Figure 5. Cumulative density for parrotfishes from NCRMP 2024 surveys in the Dry Tortugas. The two dominant species of parrotfish are in bold, and the shaded area represents their contribution (%) to the total parrotfish density.

Species Occurrence

Statistically robust data are needed to effectively assess the health of fish populations and inform fisheries and ecosystem management efforts. In all three regions, many more fish species than the five allocation species have CVs of density that are less than 20%. A 20% CV of density allows for statistically detecting a 40% change; thus, a lower CV increases the ability to detect differences.

Southeast Florida

In Southeast Florida, NCRMP fish surveys observed 249 unique fish species, with 42 individual species having CVs of density 20% or less; the most frequently occurring 50 species and allocation species with such CVs are presented in Figure 6. NCRMP does not allocate for species such as slippery dick (*Halichoeres bivittatus*), sharpnose puffer (*Canthigaster rostrata*), and bluehead wrasse (*Thalassoma bifasciatum*); however, these species were observed in > 75% of surveys and have CVs of density < 10% due to their ubiquitous nature.

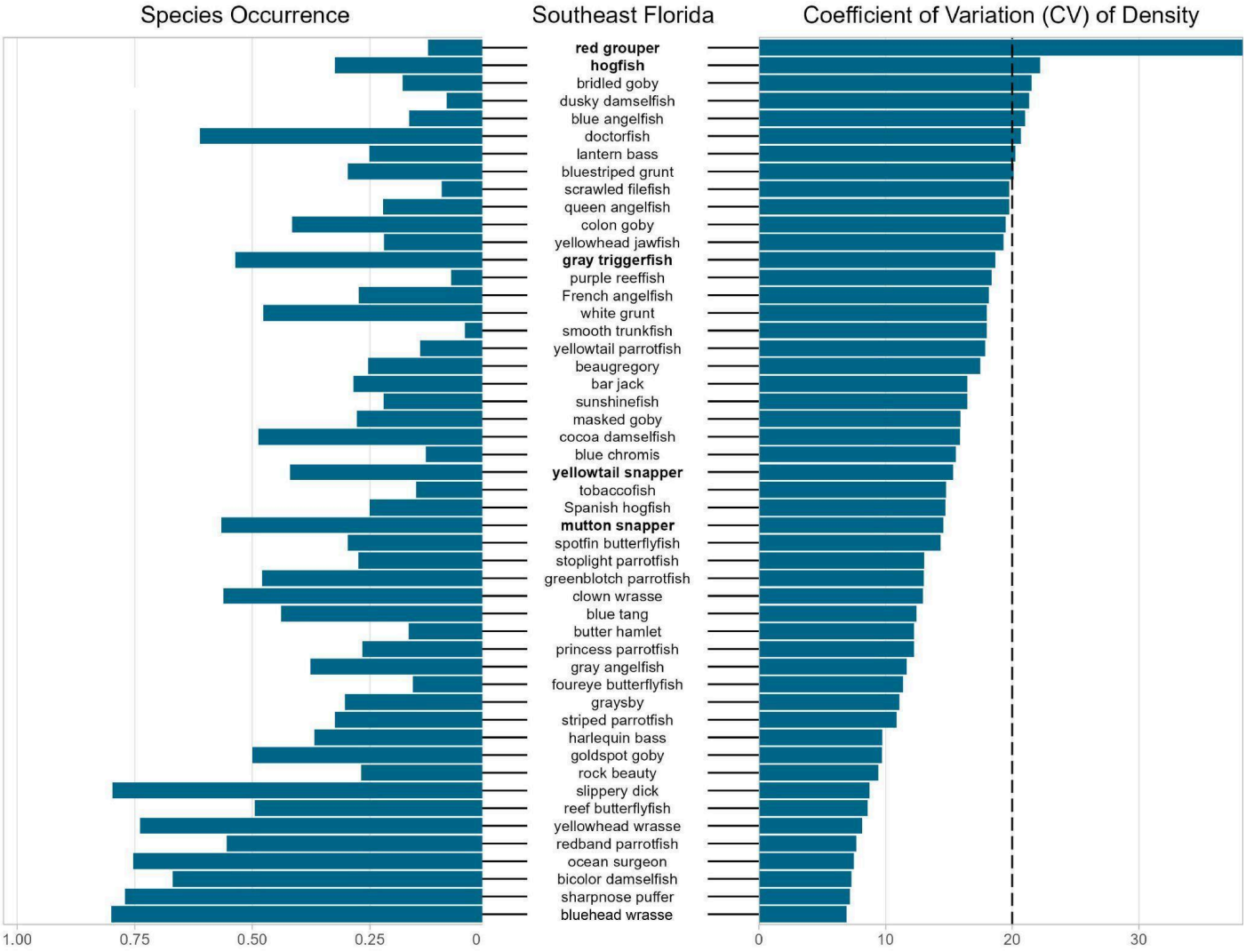


Figure 6. Occurrence of the top 50 most frequent reef fish species with a coefficient of variation (CV) of density ≤ 25% and allocation species (bold). Species are sorted by increasing CV of density in Southeast Florida in 2024. Dashed vertical line on the CV plot indicates the survey's target of a 20% CV of density.

Florida Keys

In the Florida Keys, NCRMP fish surveys observed 235 unique fish species, with 71 individual species having CVs of density that are 20% or less; the most frequently occurring 50 species and allocation species with such CVs are presented in Figure 7. NCRMP does not allocate for species such as striped parrotfish (*Scarus iseri*), redband parrotfish (*Sparisoma aurofrenatum*), and yellowhead wrasse (*Halichoeres garnoti*); however, these species were observed in > 75% of surveys and have CVs of density < 10% due to their ubiquitous nature.

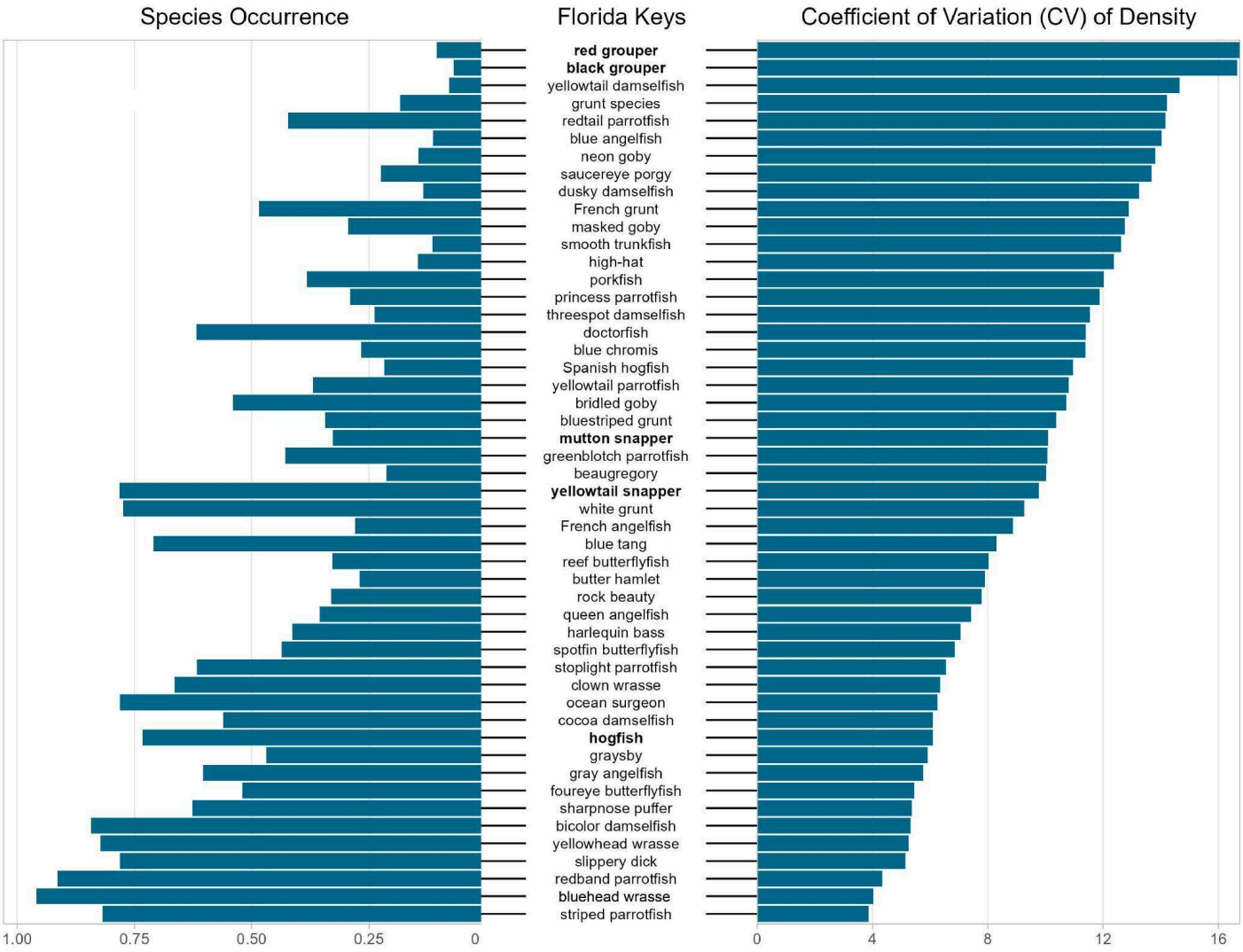


Figure 7. Occurrence of the top 50 most frequent reef fish species with a coefficient of variation (CV) of density ≤ 20% and allocation species (bold) for the survey's target of a 20% CV of density. Species are sorted by increasing CV of density in the Florida Keys in 2024.

Dry Tortugas

In the Dry Tortugas, NCRMP fish surveys observed 236 unique fish species, with 62 individual species having CVs of density that are 20% or less; the most frequently occurring 50 species and allocation species with such CVs are presented in Figure 8. NCRMP does not allocate for species such as striped parrotfish, cocoa damselfish (*Stegastes variabilis*), and slippery dick; however, these species were observed in > 75% of surveys and have CVs of density < 5% due to their ubiquitous nature.

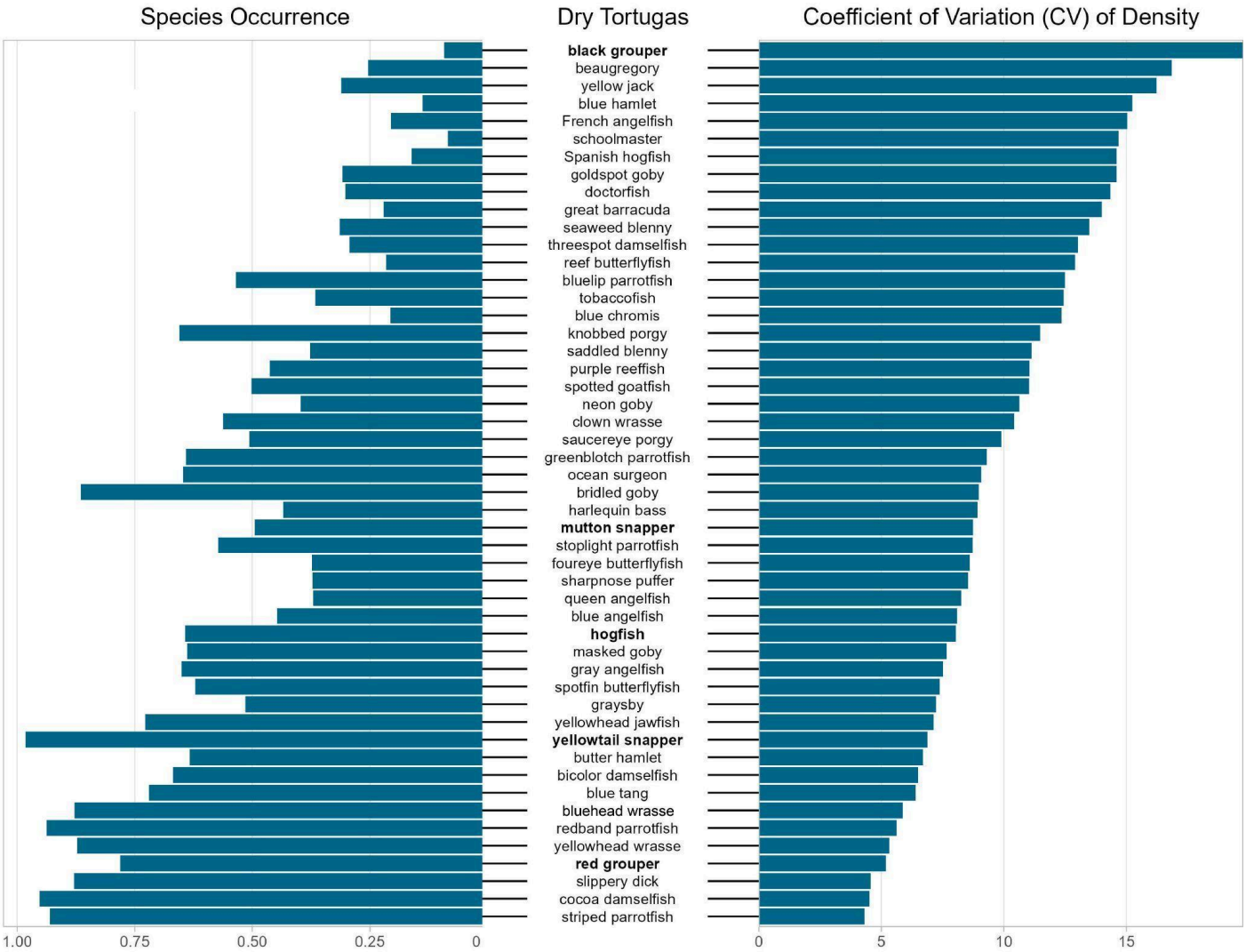


Figure 8. Occurrence of the top 50 most frequent reef fish species with a coefficient of variation (CV) of density ≤ 20% and allocation species (bold). Species are sorted by increasing CV of density in the Dry Tortugas, Florida in 2024.

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. The fish community along Florida's Coral Reef is composed of fishery target and non-target species, ranging from small, cryptic fishes (e.g., gobies [Gobiidae], jawfish [Opistognathidae]) to larger, mobile fishes (e.g., great barracuda), and spans all trophic levels (Figure 9).

NCRMP surveys capture a snapshot of coral reef fish populations every other year. 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 numerous 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).

Southeast Florida

In Southeast Florida, the 2024 survey data showed that fishery target species, such as gray triggerfish, and non-target species, such as doctorfish (*Acanthurus chirurgus*) and porkfish (*Anisotremus virginicus*), were common and numerous (Figure 9).

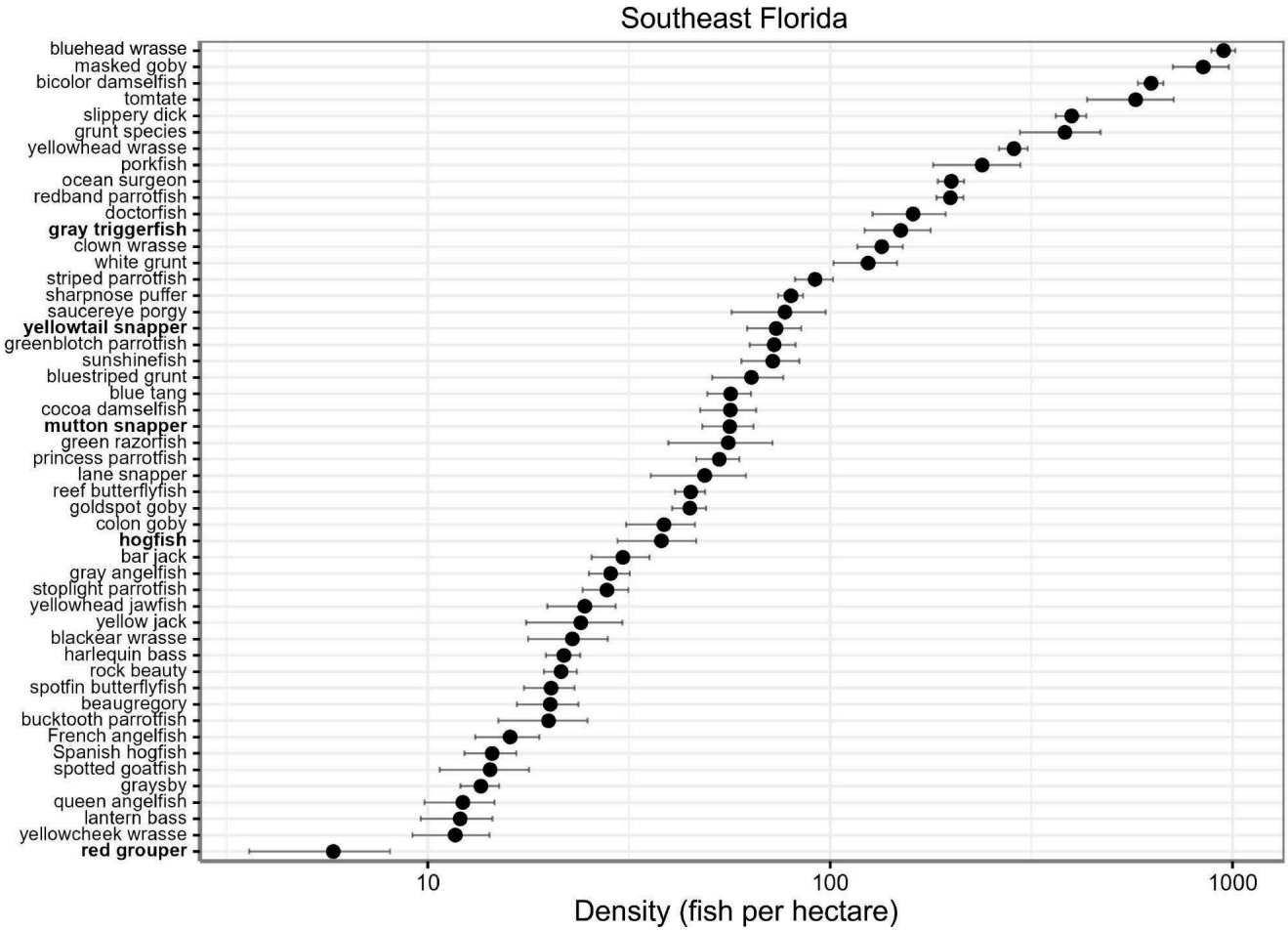


Figure 9. Mean relative density of the most frequently occurring 50 species and allocation species from NCRMP 2024 surveys in Southeast Florida. Allocation species are bold, and fish densities (± SE) are presented on a log scale and show the number of individual fish per hectare.

Southeast Florida does not have any national parks or marine reserves that limit extractive fishing practices. Figure 10 shows statistical comparisons in density between 2018 and 2024 (i.e., outside protection) for four economically important species: hogfish, red grouper, mutton snapper, and yellowtail snapper. Notably, a significant increase in density was detected for hogfish between the 2022 and 2024 survey years, and mutton snapper density has remained consistent for all NCRMP survey years (2018 to 2024) in Southeast Florida.

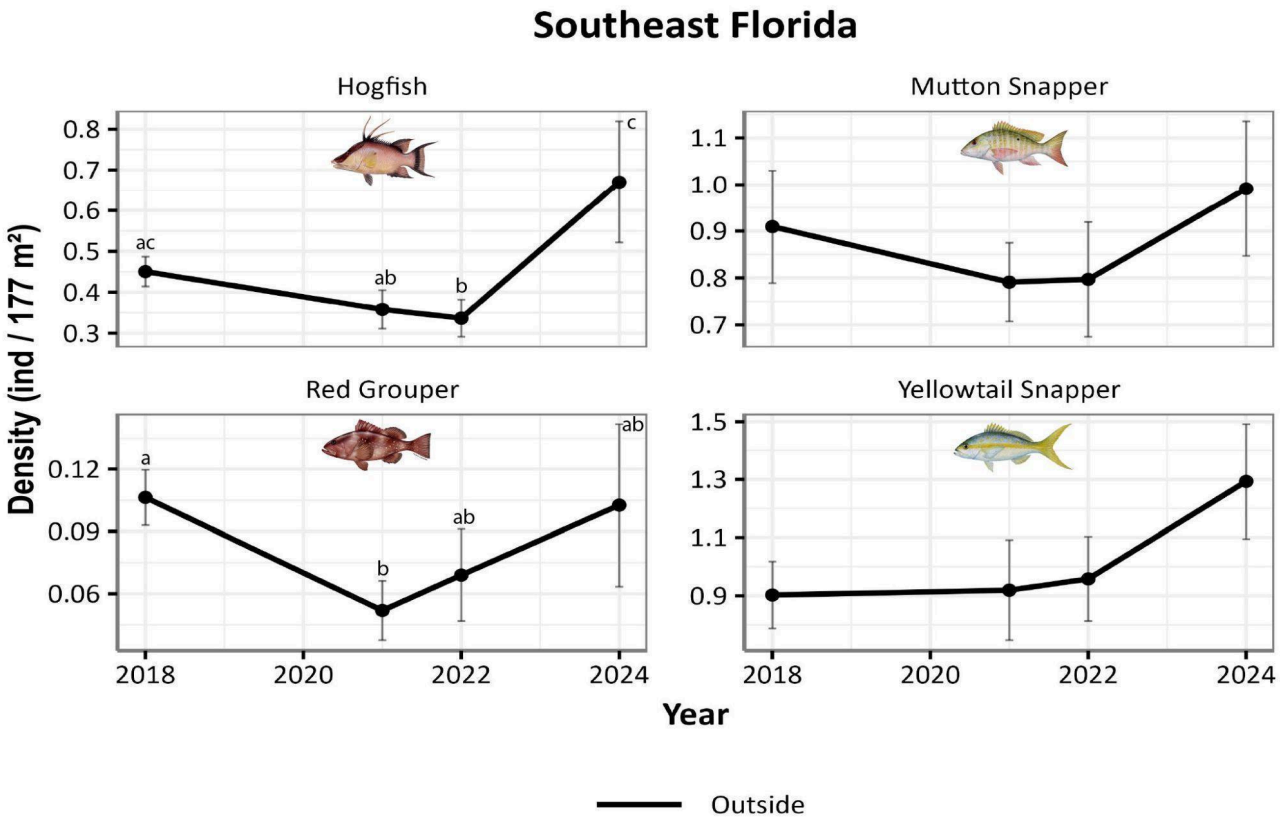


Figure 10. Relative density of hogfish, red grouper, mutton snapper, and yellowtail snapper by NCRMP survey year (2018 to 2024) in Southeast Florida. Densities are reported as the number of individuals in the area of the secondary sampling unit (ind / 177 m^2) ± SE, represent all life stages, and statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., a, b, c) denote differences between survey years. Note: y-axis varies by species.

Florida Keys

In the Florida Keys, the 2024 survey data showed that fishery target species, such as yellowtail snapper, and non-target species, such as bluehead wrasse and bicolor damselfish (*Stegastes partitus*), were common and numerous (Figure 11).

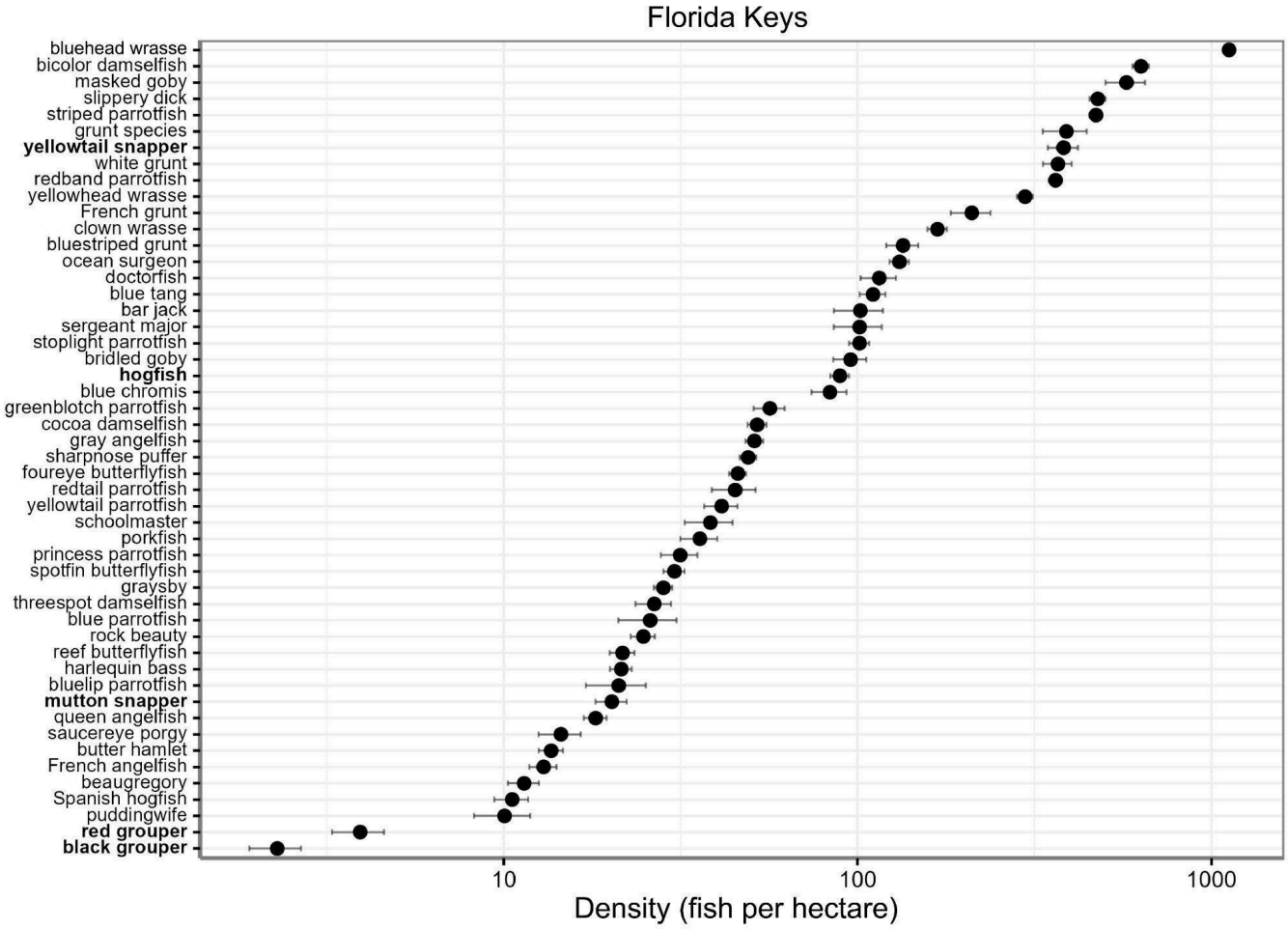


Figure 11. Mean relative density of the most frequently occurring 50 species and allocation species from NCRMP 2024 surveys in the Florida Keys. Allocation species are bold, and fish densities (± SE) are presented on a log scale and show the number of fish per hectare.

The suite of allocation species (Table 2) is a representative and diverse group of fishery target species consisting of a snapper, grouper, and hogfish that are consistently observed in high enough numbers to detect change. In 2024, the difference between inside (SPAs) and outside spatially managed areas was analyzed, and one species, mutton snapper, showed a significant difference in the Florida Keys (Table 2).

Table 2. Relative density of fishery target allocation species in the Florida Keys, both inside and outside of the spatially managed areas (i.e., SPAs) in 2024. Densities are reported as the number of individuals per 177 m^2 (± SE) and represent all life stages, and significance was accepted at $p < 0.05$ (*).

	Florida Keys		
Species	*Outside*		*Inside*
Red Grouper	**0.07** (0.01)		**0.06** (0.02)
Black Grouper	**0.04** (0.01)		**0.05** (0.02)
Mutton Snapper	**0.36** (0.04)	*	**0.22** (0.03)
Yellowtail Snapper	**6.75** (0.69)		**6.22** (0.56)
Hogfish	**1.57** (0.10)		**1.53** (0.38)

An NCRMP time series is shown for 2014 to 2024 for four economically important species: hogfish, red grouper, mutton snapper, and yellowtail snapper, and includes statistical comparisons, tested individually for each protected status (i.e., inside and outside of FKNMS protected areas), in relative density between adjacent years (Figure 12). Species-specific densities varied by survey year, and patterns in significant differences between survey years varied among species and protection levels. For the complete time series, yellowtail snapper generally had higher densities inside FKNMS protected areas (SPAs), and hogfish, mutton snapper, and red grouper generally had higher densities outside the smaller SPAs. In most cases, within each species and protection status, the recent 2024 density estimates were similar to the previous 2022 density estimates. Two significant differences were observed between the 2024 and 2022 surveys; yellowtail snapper and hogfish had significantly higher densities outside of the protected FKNMS SPAs (Figure 12). Note: Results for 2020–2021 are not included due to incomplete sampling related to COVID-19 fieldwork limitations.

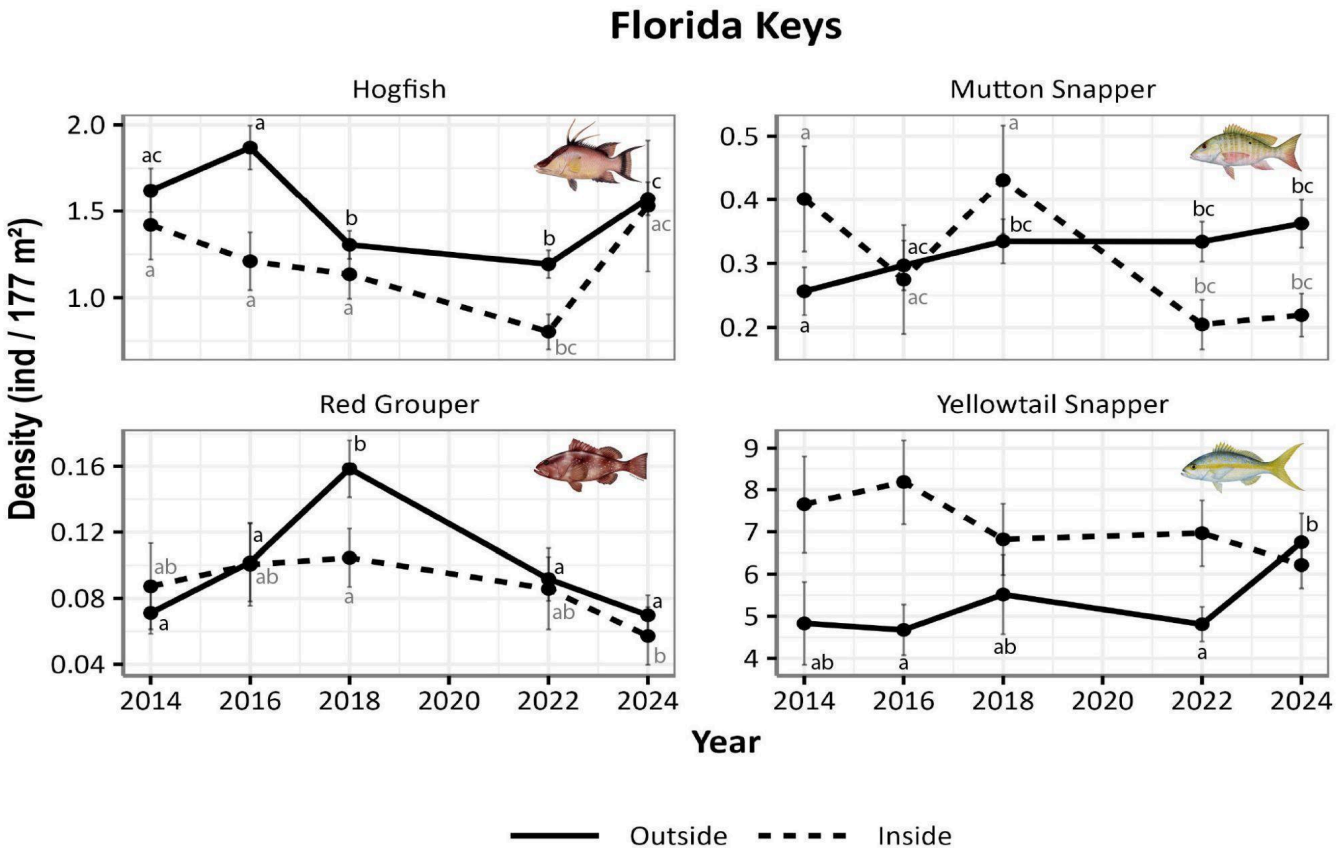


Figure 12. Relative density of hogfish, red grouper, mutton snapper, and yellowtail snapper by NCRMP survey year (2014 to 2024) in the Florida Keys. Densities are reported as the number of individuals in the area of the secondary sampling unit (ind / 177 m^2) ± SE and represent all life stages, and statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., a, b, c) denote a difference between survey years within each protected status. Protected status refers to sites inside (dashed line) or outside (solid line) of the Sanctuary Preservation Areas (SPAs). Note: y-axis varies by species.

Dry Tortugas

In the Dry Tortugas, the 2024 survey data showed that fishery target species, such as yellowtail snapper, and non-target species, such as slippery dick, striped parrotfish, and bluehead wrasse, were common and numerous (Figure 13).

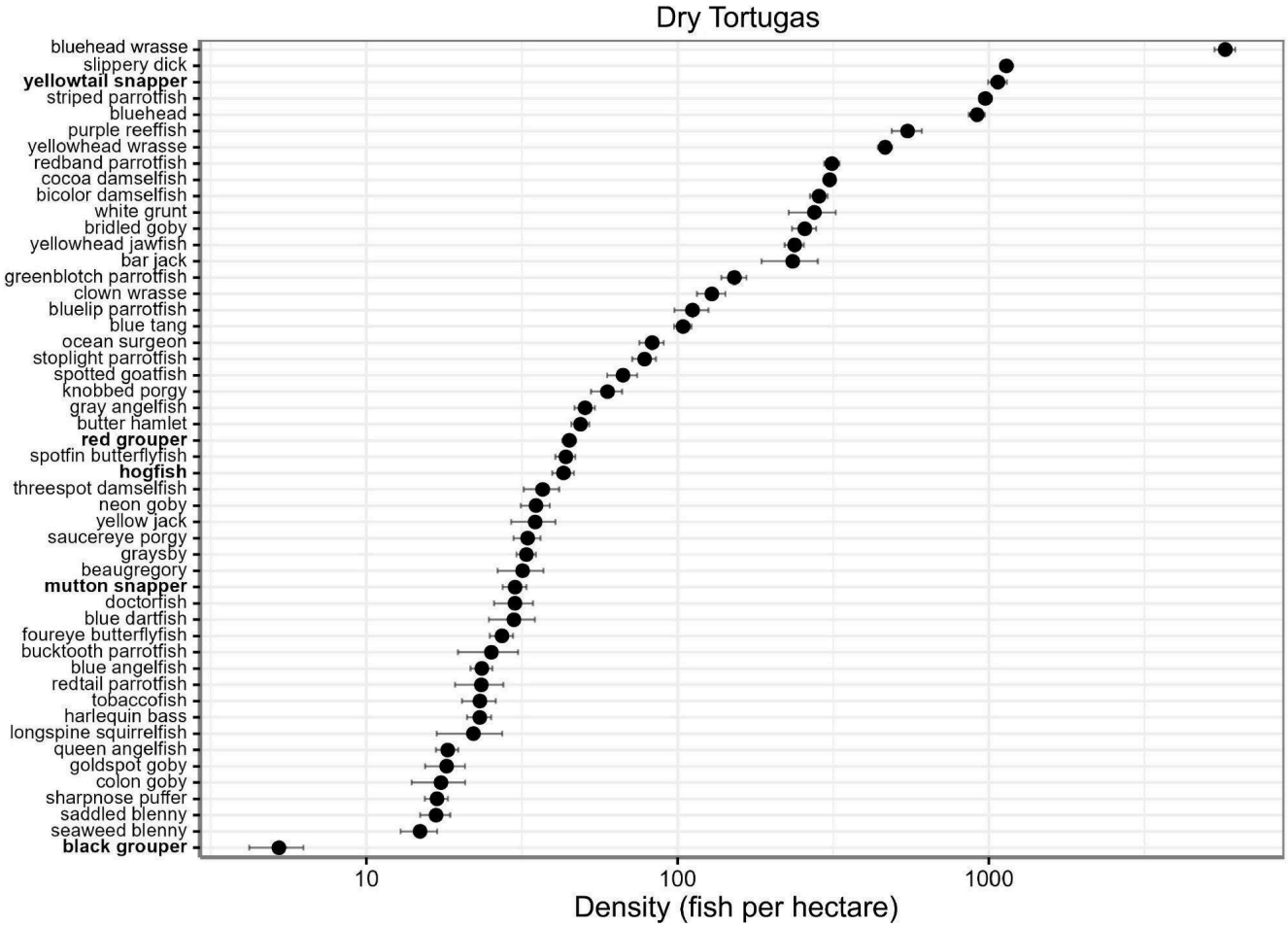


Figure 13. Mean relative density of the most frequently occurring 50 species and allocation species from NCRMP 2024 surveys in the Dry Tortugas. Allocation species are bold, and fish densities (± SE) are presented on a log scale and show the number of fish per hectare.

The suite of allocation species (Table 3) is a representative and diverse group of fishery target species consisting of snapper, grouper, and hogfish that are consistently observed in high enough numbers to detect change. In 2024, the difference between inside (TNCA and DRTO) and outside spatially managed areas was analyzed, and three species, red grouper, black grouper, and mutton snapper, showed a significant difference in the Dry Tortugas (Table 3).

Table 3. Relative density of fishery target allocation species in the Dry Tortugas, both inside and outside of the spatially managed areas (i.e., Tortugas North Conservation Area and Dry Tortugas National Park boundaries) in 2024. Densities are reported as the number of individuals per 177 m^2 (± SE) and represent all life stages, and significance was accepted at $p < 0.05$ (*).

	Dry Tortugas		
Species	*Outside*		*Inside*
Red Grouper	**0.56** (0.09)	*	**0.84** (0.05)
Black Grouper	**0.02** (0.01)	*	**0.11** (0.02)
Mutton Snapper	**0.79** (0.13)	*	**0.47** (0.05)
Yellowtail Snapper	**14.06** (3.91)		**19.80** (1.31)
Hogfish	**0.82** (0.13)		**0.74** (0.07)

Figure 14 shows statistical comparisons, tested individually for each protected status (i.e., inside and outside), in relative density between adjacent years for four economically important species: hogfish, red grouper, mutton snapper, and yellowtail snapper. Species-specific densities varied by survey year, and patterns in significant differences between survey years varied among species and protection levels. For the complete time series, species-specific densities inside and outside of spatial protection have either remained the same or have increased, and all four species generally had higher densities inside the large FKNMS (TNCA) and NPS (DRTO) protected areas. In most cases, within each species and protection status, the recent 2024 density estimates were similar to the previous 2022 density estimates. Two significant differences were observed between the 2024 and 2022 surveys; red grouper had significantly lower densities, and mutton snapper had significantly higher densities outside of the TNCA and DRTO protected areas (Figure 14).

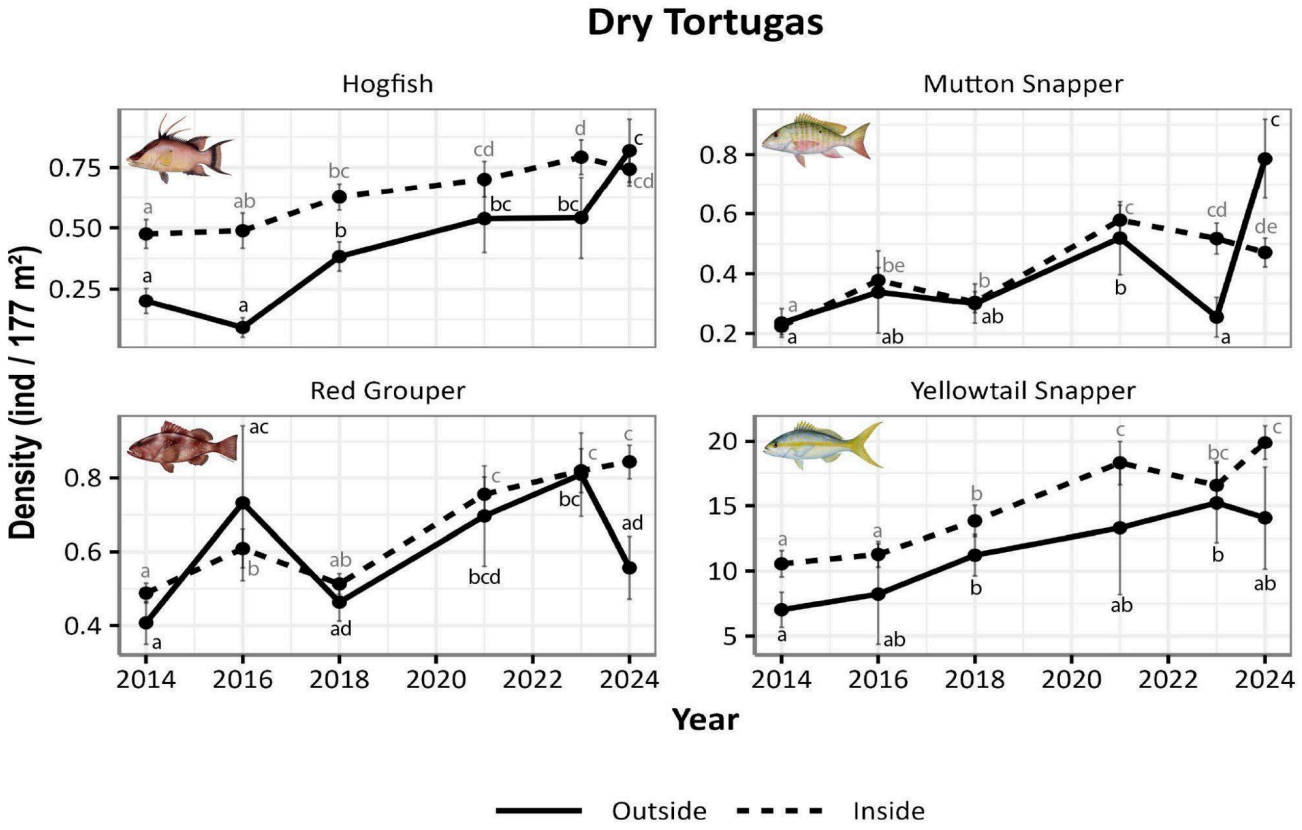


Figure 14. Relative density of hogfish, red grouper, mutton snapper, and yellowtail snapper by NCRMP survey year (2014–2024) in the Dry Tortugas. Densities are reported as the number of individuals in the area of the secondary sampling unit (ind / 177 m^2) ± SE and represent all life stages, and statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., a, b, c, d) denote a difference between survey years within each protected status. Protected status refers to sites inside (dashed line) or outside (solid line) of the Tortugas North Conservation Area and Dry Tortugas National Park boundary. Note: y-axis varies by species.

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 have larger numbers of younger, smaller fish 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 the future of the fishery.

In Florida's state waters, hogfish, mutton snapper, red grouper, and yellowtail snapper are managed by FWC using minimum length regulations. In Figures 15–17, we show FWC's minimum length of capture in fork length: hogfish (41 cm), mutton snapper (42 cm), red grouper (48 cm), and yellowtail snapper (25 cm).

Southeast Florida

Figure 15 shows relative length composition distributions for hogfish, yellowtail snapper, mutton snapper, and red grouper for the three most recent survey years (2020–2021, 2022, and 2024). In 2024, smaller sizes of hogfish (< 30 cm) and mutton snapper (20–35 cm) were frequently observed, and for the past three survey years, there were no observations of hogfish (> 41 cm) and few observations of mutton snapper (> 42 cm) above, their minimum length at captures. In comparison, yellowtail snapper and red grouper were observed both above and below their minimum length at captures (25 cm and 48 cm, respectively), and as expected in fishery target species, larger individuals were observed less frequently (Figure 15).

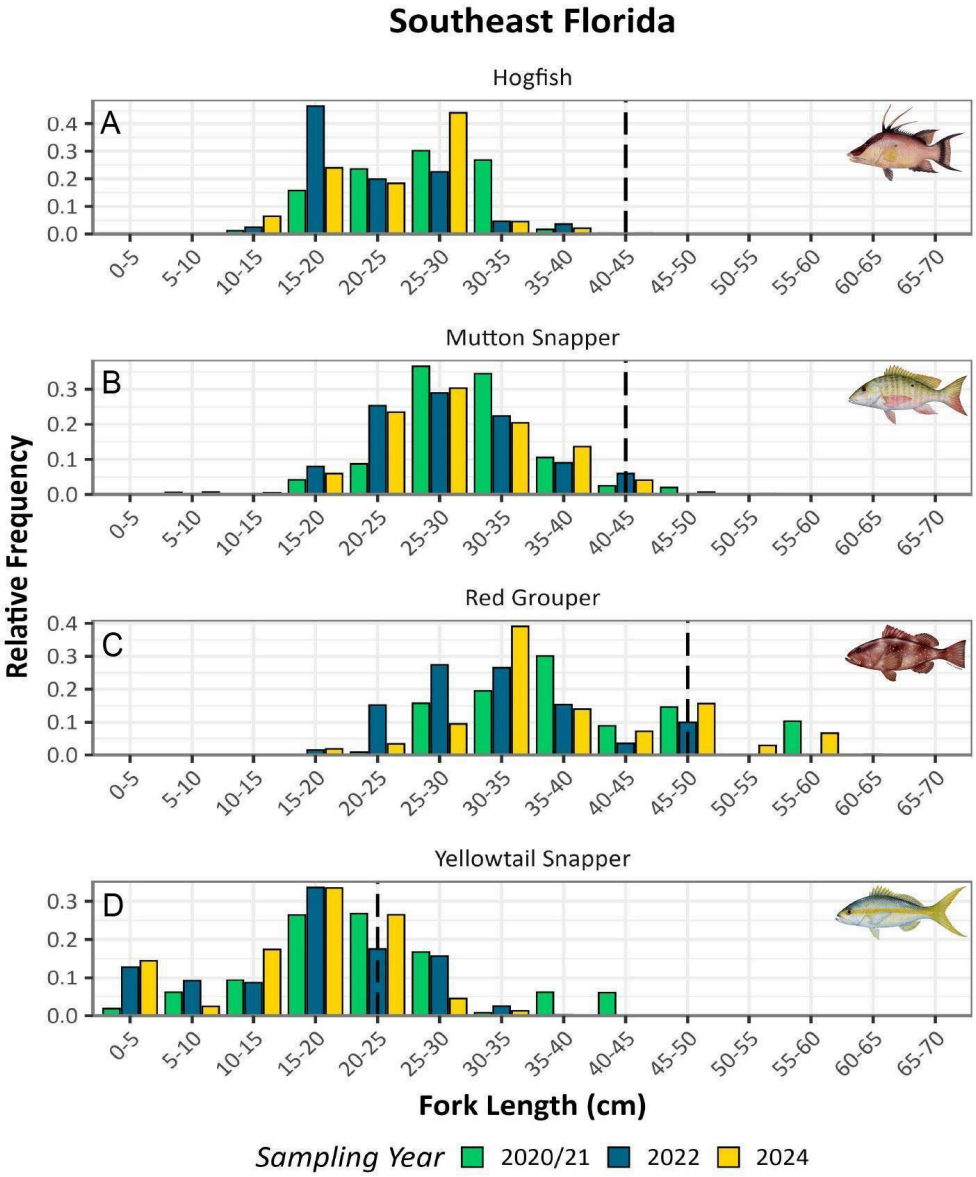


Figure 15. Relative length frequency of selected fishery target species in Southeast Florida for the three most recent NCRMP sample years: A) hogfish, B) mutton snapper, C) red grouper, and D) yellowtail snapper. Dashed vertical line indicates minimum length at capture (fork length) for Florida state waters: hogfish (41 cm), mutton snapper (42 cm), red grouper (48 cm), and yellowtail snapper (25 cm). Note: y-axis varies by species.

Florida Keys

Figure 16 shows relative length composition distributions for hogfish, mutton snapper, red grouper, and yellowtail snapper for the three most recent survey years with complete sampling (2018, 2022, and 2024); results for 2020–2021 are not included due incomplete sampling from COVID-19-related limitations. In 2024, hogfish were frequently observed < 30 cm, and for all three survey years assessed, an inconsequential number of hogfish were observed above their minimum length of capture (41 cm). Smaller sizes of mutton snapper and yellowtail snapper were frequently observed; however, both were also observed above their minimum lengths of capture (42 cm and 25 cm, respectively). In 2024, red grouper were often observed > 25 cm, including above their length at capture (48 cm). Collectively, the NCRMP fish data shows a strong year class of red grouper in 2018 that is observed in subsequent survey years (2022 and 2024) as a progressive increase in the larger size classes, with many larger red grouper (45–70 cm) observed in 2024 (Figure 16).

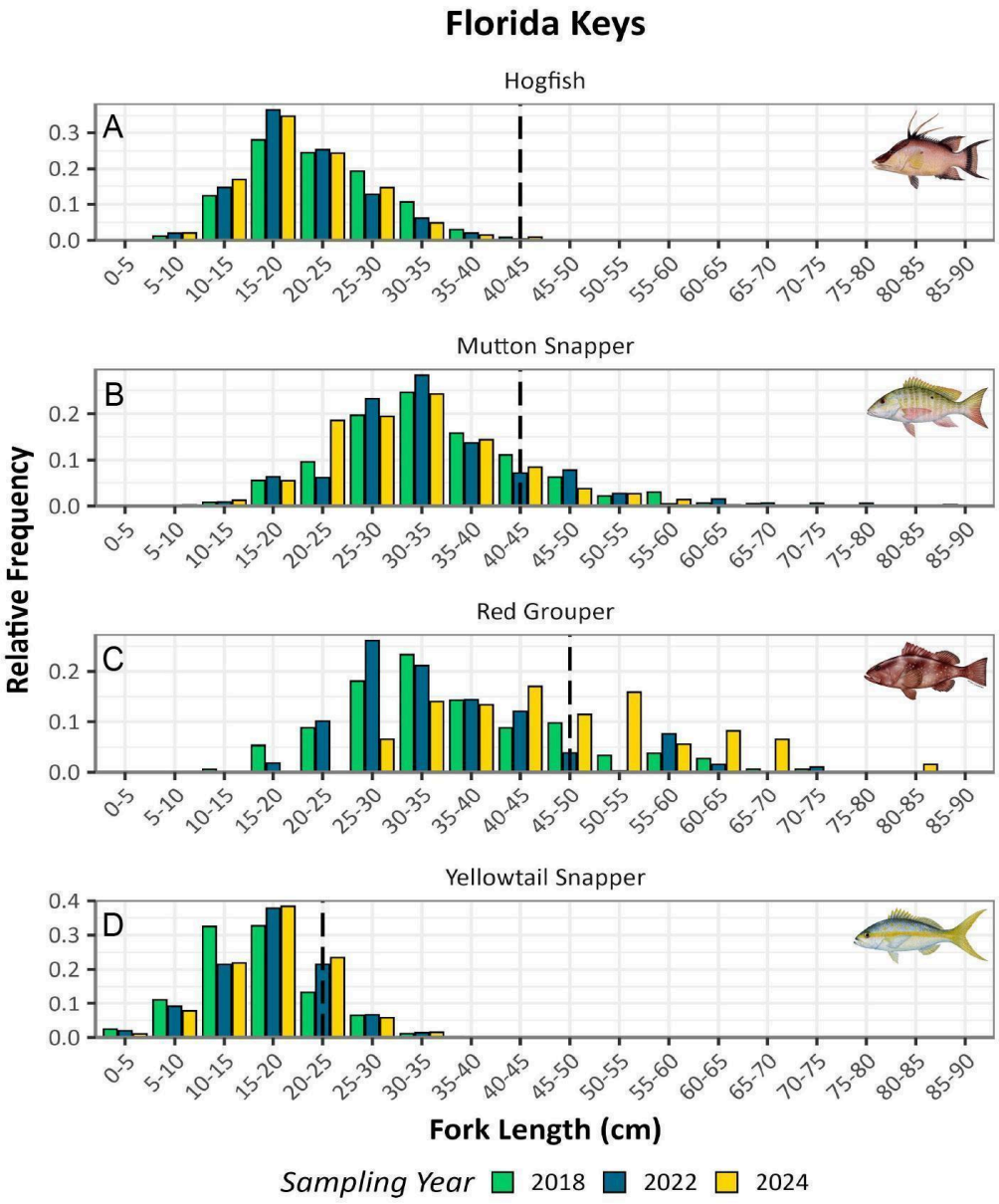


Figure 16. Relative length frequency of selected fishery target species in the Florida Keys for the three most recent NCRMP sample years: A) hogfish, B) mutton snapper, C) red grouper, and D) yellowtail snapper. Dashed vertical line indicates minimum length at capture (fork length) for Florida state waters: hogfish (41 cm), mutton snapper (42 cm), red grouper (48 cm), and yellowtail snapper (25 cm). Note: y-axis varies by species.

Dry Tortugas

Figure 17 shows relative length composition distributions for hogfish, mutton snapper, red grouper, and yellowtail snapper for the most recent three survey years (2020–2021, 2022–2023, and 2024). In 2024, all four species were frequently observed at many size classes (15–50 cm for hogfish, 25–70 cm for mutton snapper, 15–65 cm for red grouper, and 10–30 cm for yellowtail snapper) with additional fishes occasionally observed above and below these ranges. For the three most recent survey years, these fishery target species were regularly observed above their minimum lengths of capture. The larger size classes observed suggest that fish here experience lower fishing mortality relative to the Florida Keys and Southeast Florida (Figure 17).

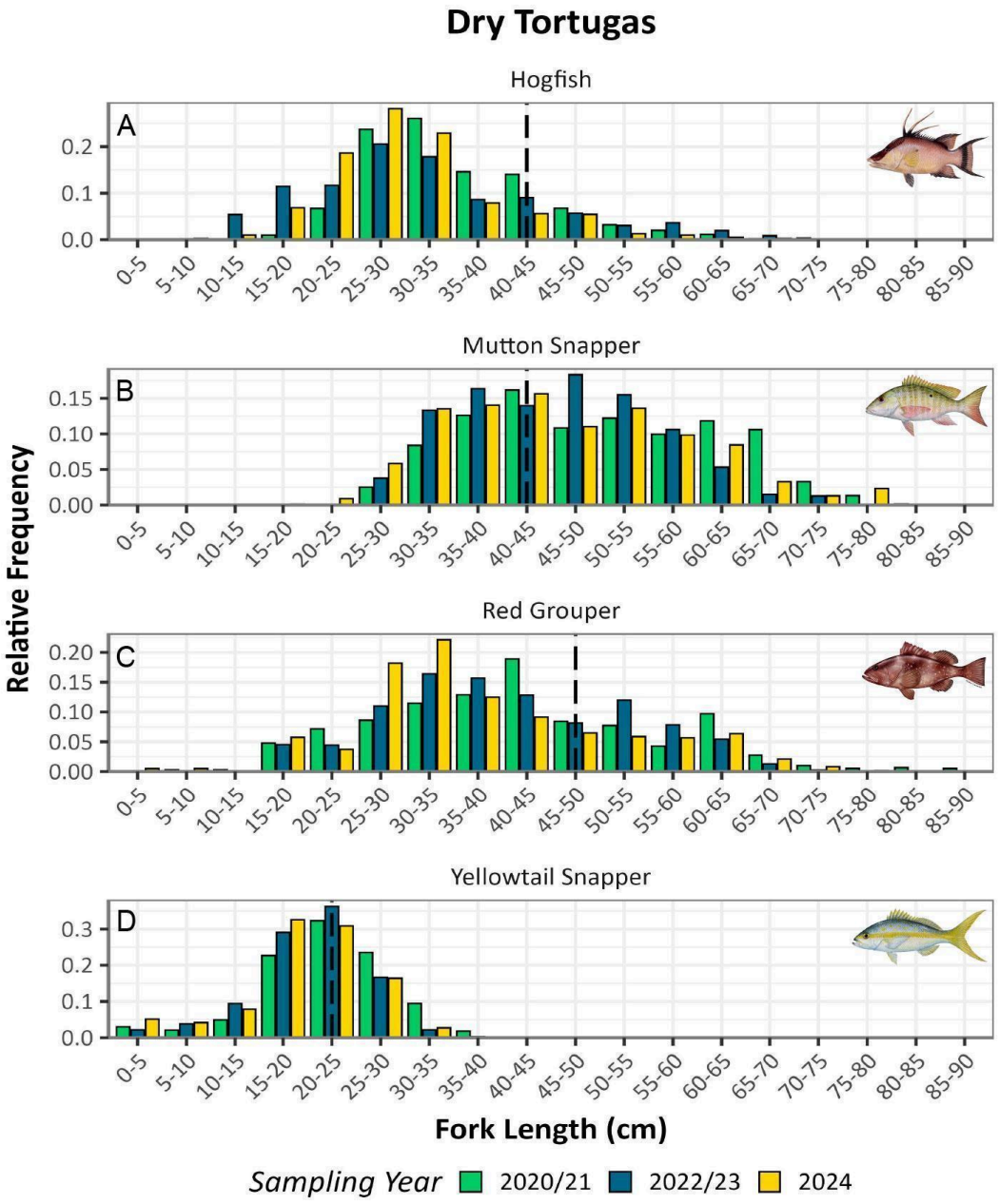


Figure 17. Relative length frequency of selected fishery target species in the Dry Tortugas for the three most recent NCRMP sample years: A) hogfish, B) mutton snapper, C) red grouper, and D) yellowtail snapper. Dashed vertical line indicates minimum length at capture (fork length) for Florida state waters: hogfish (41 cm), mutton snapper (42 cm), red grouper (48 cm), and yellowtail snapper (25 cm). Note: y-axis varies by species.

II. Corals and Benthic Communities

Overall, hard and soft coral cover has declined in each region since 2014, and macroalgal cover has varied across years (Figure 18).

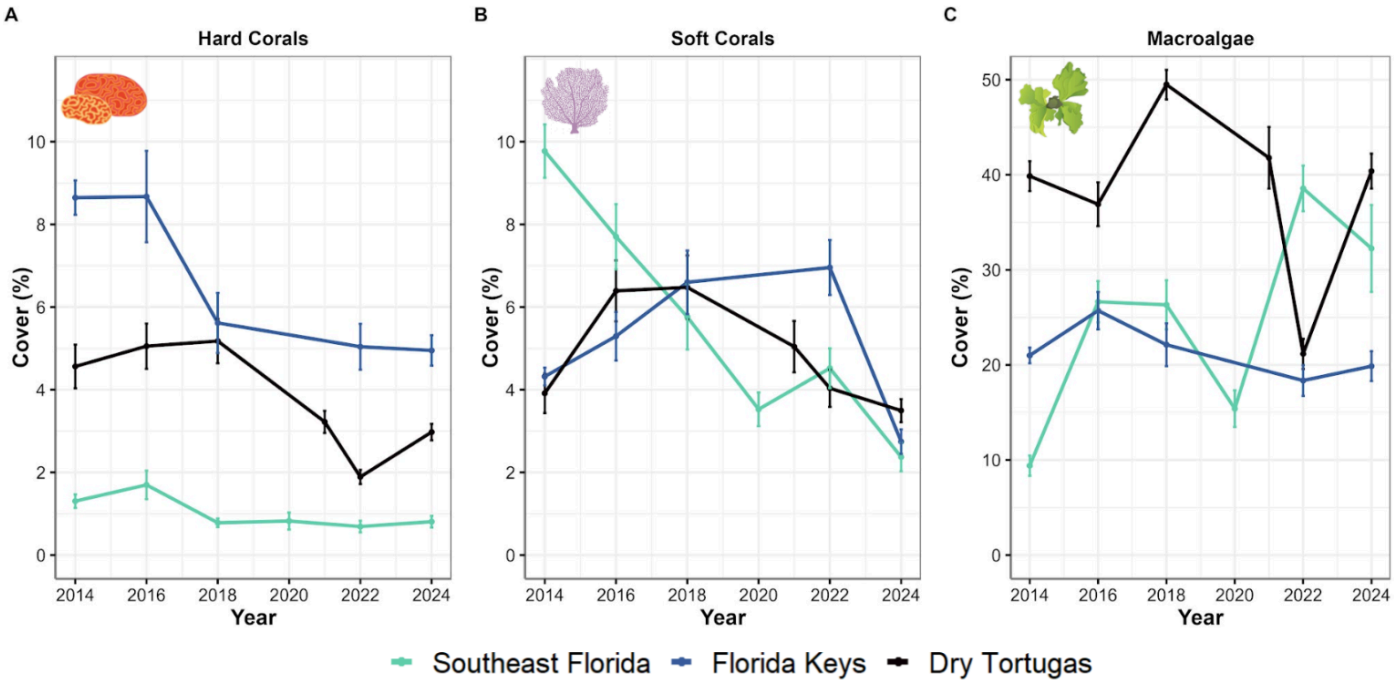


Figure 18. Overall cover (% ± SE) of hard corals (A), soft corals (B), and macroalgae (C) for each Florida region from 2014 to 2024 from NCRMP surveys. Note differences in y-axis scales.

While estimates of disease prevalence (Figure 19) include all coral diseases, the most prevalent and persistent disease across Florida's Coral Reef to date is stony coral tissue loss disease (SCTLD). SCTLD was first detected in Southeast Florida in 2014 (Precht et al., 2016) and continued to spread across the entirety of Florida's Coral Reef, reaching the Florida Keys in 2016 (Muller et al., 2020), and the Dry Tortugas in 2021 (Grove et al., 2022; Dry Tortugas National Park, 2022; Stein and Ruzicka, 2023). This disease has caused extensive mortality since its emergence in 2014, but as of 2023, the entire reef tract has been characterized as an SCTLD-endemic zone, rather than an epidemic zone (Figure 19; Harrell et al. 2024). Figures 19 and 20 present data from both NCRMP and DRM, including DRM only years (indicated with asterisks); to ensure compatibility across years and sampling methodologies, all data are filtered to DRM's 60 ft. max sampling depth.

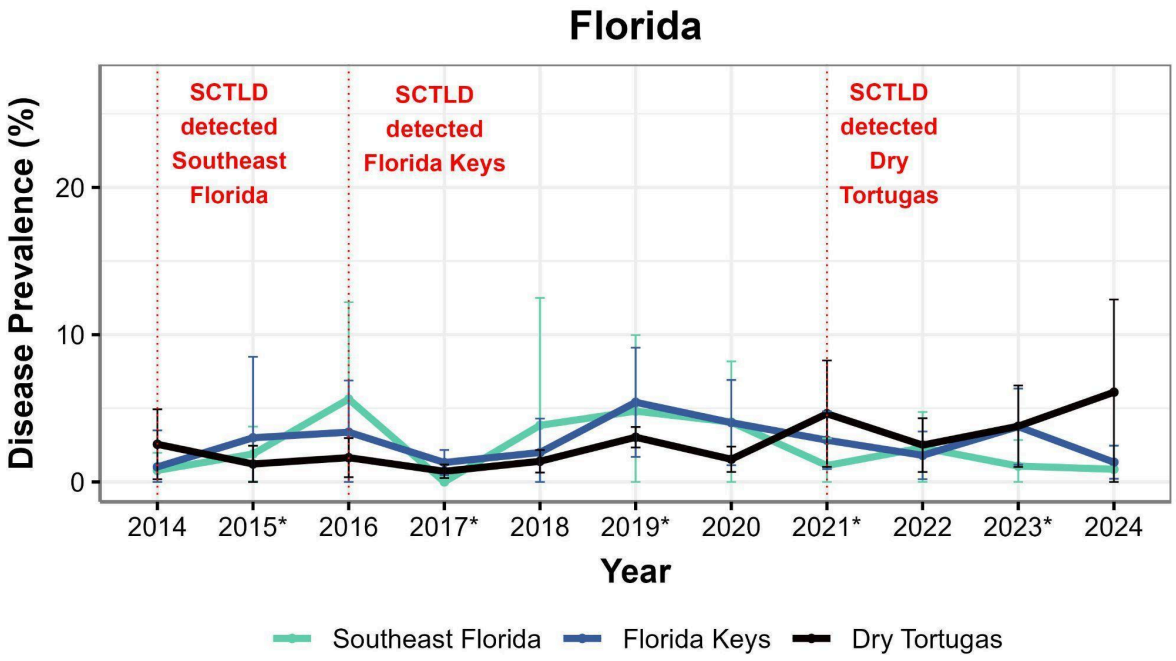


Figure 19. Mean prevalence (% ± SE) of all coral diseases from 2014 to 2024, compiled from both NCRMP and DRM coral demographics data. Asterisks on odd-numbered years denote that data is from DRM only, while other years include data from both NCRMP and DRM. NCRMP data only includes sites shallower than 60 ft. depth, the maximum depth limit of DRM. Red vertical dotted lines indicate when stony coral tissue loss disease (SCTLD) was first detected in each Florida region.

Coral bleaching has also continued to be a significant stressor for coral populations, both globally and on Florida's Coral Reef. In 2023, heat stress reached record-breaking levels in Florida's waters (Manzello et al. 2025). Although NCRMP surveys did not occur in Florida in 2023, DRM surveys coincided with the most severe bleaching event in the program's history. This prompted a post-bleaching assessment, which documented significant declines in coral abundance and live tissue area (Stein et al. 2024). Heat stress levels declined in 2024, and both NCRMP and DRM surveys recorded reduced total bleaching prevalence compared to 2023 (Figure 20).

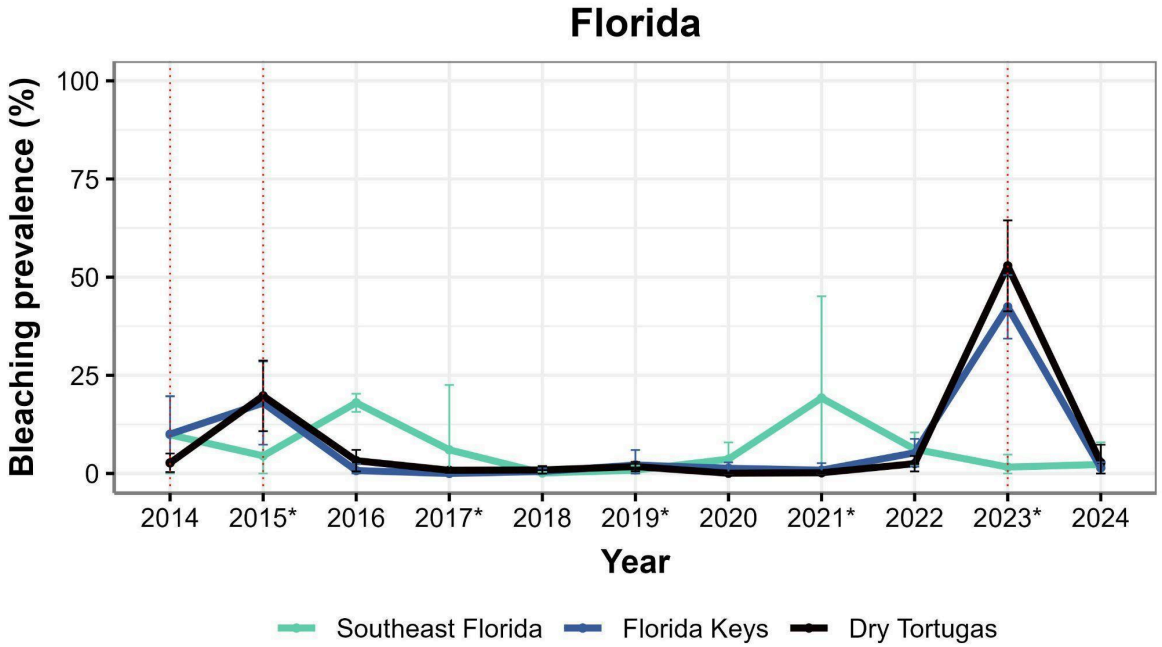


Figure 20. Mean coral total bleaching prevalence (% ± SE) from 2014 to 2024 compiled from both NCRMP and DRM coral demographics data. Red vertical dotted lines indicate years with severe bleaching events across Florida's Coral Reef. NCRMP data only includes sites shallower than 60 ft. depth to match the maximum depth limit of DRM.

Coral and Macroalgal Cover

Southeast Florida

In Southeast Florida, hard coral cover has been consistently low (< 2%) since 2014 and additional declines occurred after 2016 (Figure 21). In 2024, mean coral cover was 0.8% ± 0.1. Soft coral cover has also declined over time, from an average cover of 9.8% ± 0.4 in 2014 to 2.4% ± 0.1 in 2024 (Figure 21). Macroalgae cover was highly variable between years (Figure 21) and was 32.3% ± 4.6 in 2024. However, macroalgae cover is strongly influenced by the timing of the sampling season, the habitat type surveyed, and the specific functional group or species of macroalgae. Increases in macroalgal cover from 2020 were driven by increases across multiple functional groups (especially fleshy macroalgae).

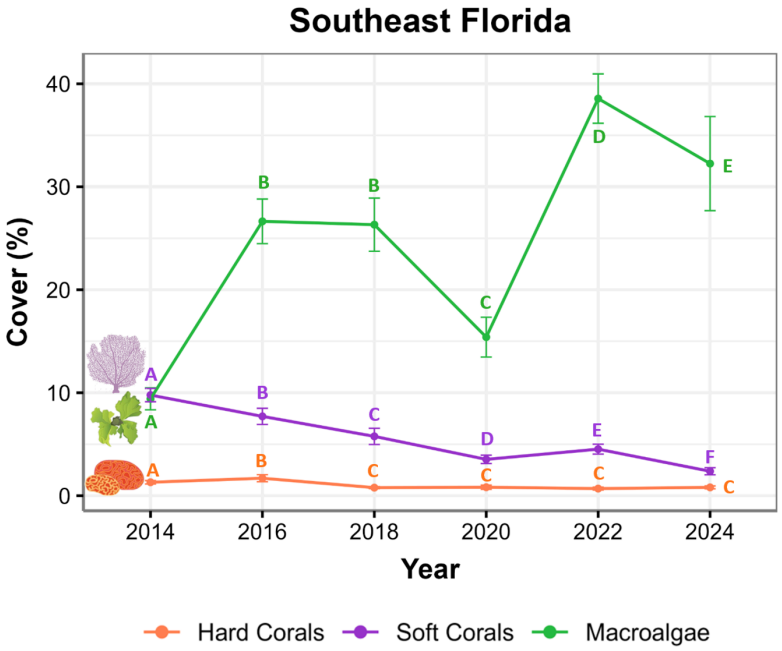


Figure 21. Overall cover (% ± SE) of hard corals, soft corals, and macroalgae in Southeast Florida from 2014 to 2024. Statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., A–F) denote a difference between survey years for hard coral, soft coral, and macroalgal cover, separately.

Florida Keys

In the Florida Keys, hard coral mean cover declined over the 2014 to 2024 survey period (Figure 22). In 2024, cover was approximately 5.0% ± 0.4, a steep decline from 8.6% ± 0.4 in 2014. Soft coral cover increased from 2014 to 2022, peaking at 7.0% ± 0.4; however, 2024 values declined sharply (2.7% ± 0.1), likely a result of an unprecedented thermal stress event in 2023 (Figure 22). Macroalgae did not significantly change between 2014 and 2024; in 2024, macroalgae cover was 19.9% ± 1.6 (Figure 22). Results for 2020–2021 are not included due to the small sample size from COVID-19-related limitations.

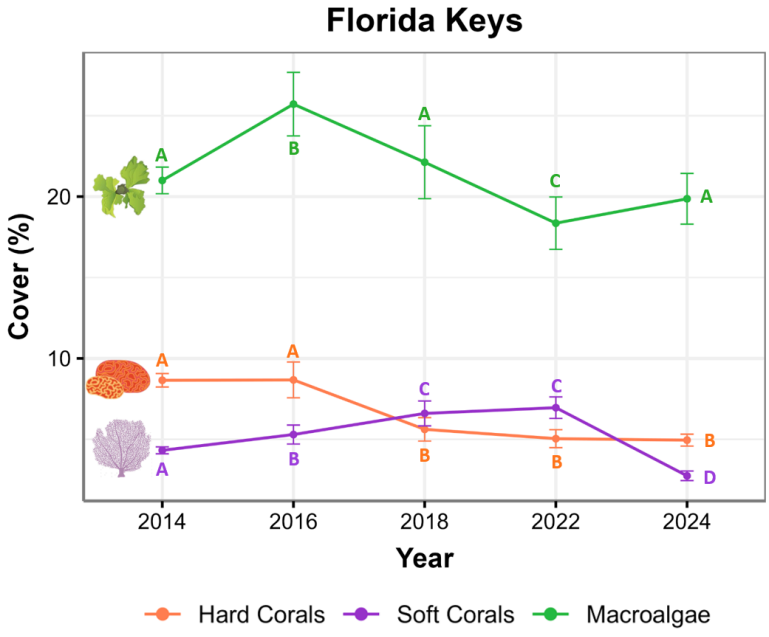


Figure 22. Overall cover (% ± SE) of hard corals, soft corals, and macroalgae in the Florida Keys from 2014 to 2024. Statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., A-D) denote a difference between survey years for hard coral, soft coral, and macroalgal cover, separately.

Dry Tortugas

In the Dry Tortugas, the mean cover of hard corals was consistently 4%–5% from 2014 to 2018, before it declined significantly in 2021, and was approximately 3.0% ± 0.2 in 2024 (Figure 23). Mean cover of soft corals declined from its peak in 2018 at 6.5% ± 0.6 down to 3.5% ± 0.1 (Figure 23). Macroalgae cover was variable(Figure 23). In 2024, macroalgae cover was 40.4% ± 1.8. However, macroalgae cover is strongly influenced by the timing of the sampling season, the habitat type surveyed, and the specific functional group or species of macroalgae.

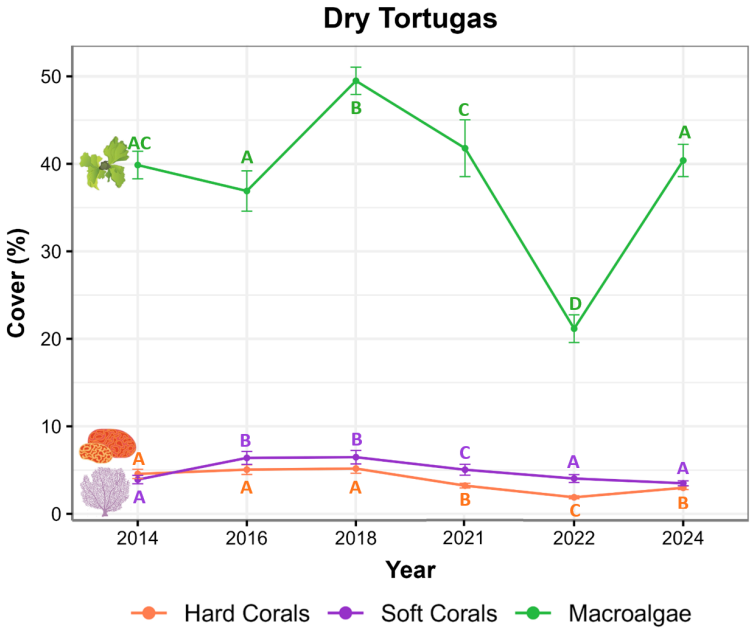


Figure 23. Overall cover (% ± SE) of hard corals, soft corals, and macroalgae in the Dry Tortugas from 2014 to 2024. Statistical significance, if present, is reported at $p < 0.05$, and different letters (i.e., A–D) denote a difference between survey years for hard coral, soft coral, and macroalgal cover, separately.

Species Occurrence

More coral species than the allocation species have CVs of density that are less than 20%. A 20% CV of density can be translated to the ability to statistically detect a 40% change. As coral species continue to decline from threats such as SCTLD and thermal stress, the frequency of occurrence declines, and more surveys are required to achieve a 20% CV.

Southeast Florida

For NCRMP in Southeast Florida in 2024, eight individual species had CVs of 20% or less: *S. siderea*, *Stephanocoenia intersepta, P. astreoides*, *M. cavernosa*, *Siderastrea radians*, *Porites porites*, *Dichocoenia stokesii*, and *M. meandrites* (Figure 24). Of the six coral species used in allocations, four had a CV of 20% or less (*S. siderea, P. astreoides*, *M. cavernosa*, and *M. meandrites*), and two did not meet CV targets (*P. strigosa* and *O. faveolata*). The most commonly encountered coral species were *S. siderea*, *S. intersepta*, *P. astreoides*, and *M. cavernosa* (Figure 24).

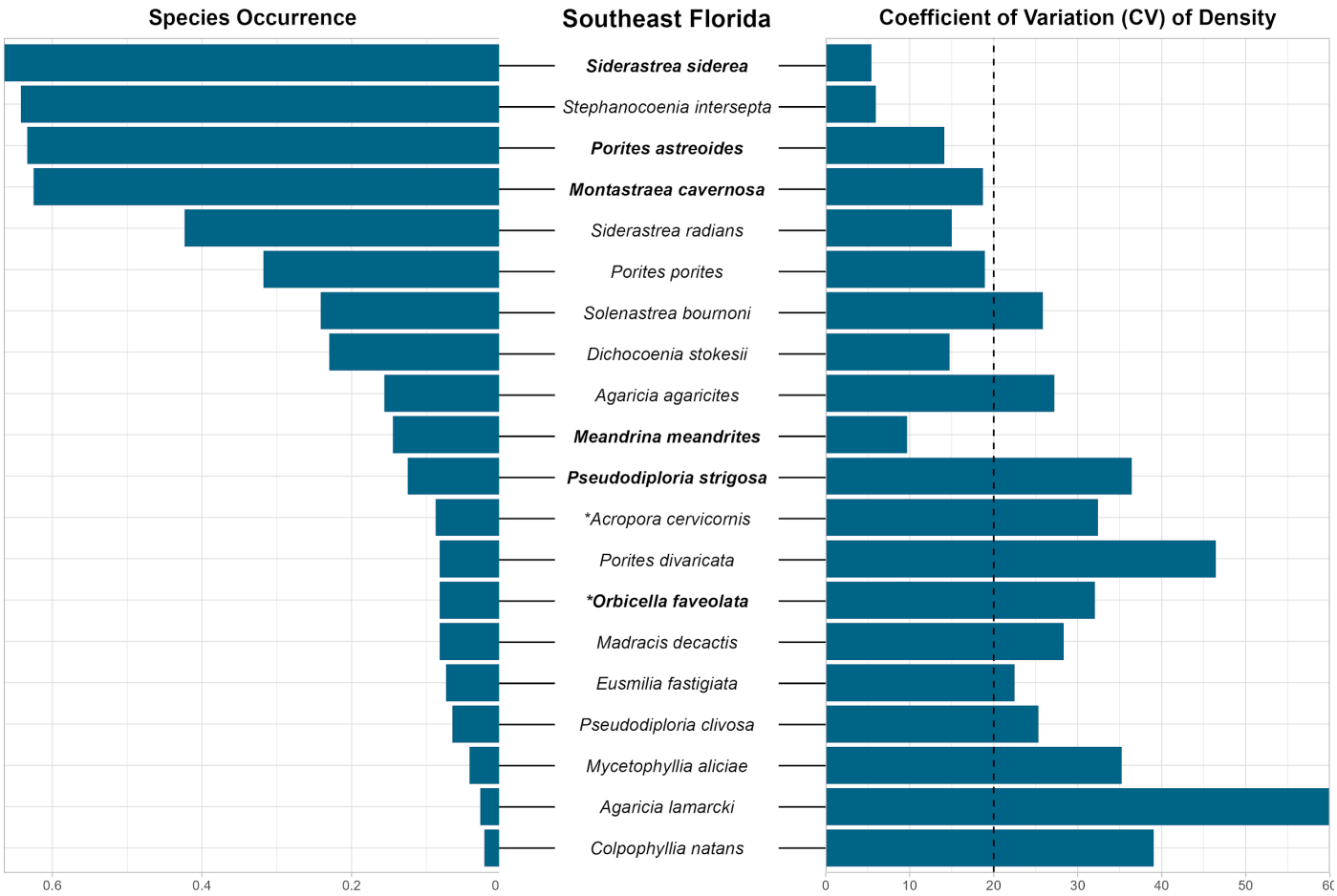


Figure 24. Coral species occurrence and coefficient of variation (CV) of density in coral demographics surveys in Southeast Florida in 2024. Species with an occurrence less than 0.01 are not shown. Bolding indicates the species was used in allocations, and an asterisk (*) indicates ESA-listing. Dashed vertical line on the CV plot indicates the survey's target of a 20% CV of density. NCRMP and DRM data are included. Note: x-axis scale varies by metric.

Florida Keys

For the Florida Keys in 2024, 17 coral species met CV targets of 20% or less (Figure 25). All allocation species, *S. siderea*, *M. cavernosa*, *O. faveolata*, *S. bournoni*, *P. strigosa*, *C. natans*, *O. annularis*, and *P. clivosa*, met the CV targets. The coral species most commonly encountered were *S. siderea*, *P. astreoides*, *S. intersepta*, and *M. cavernosa* (Figure 25).

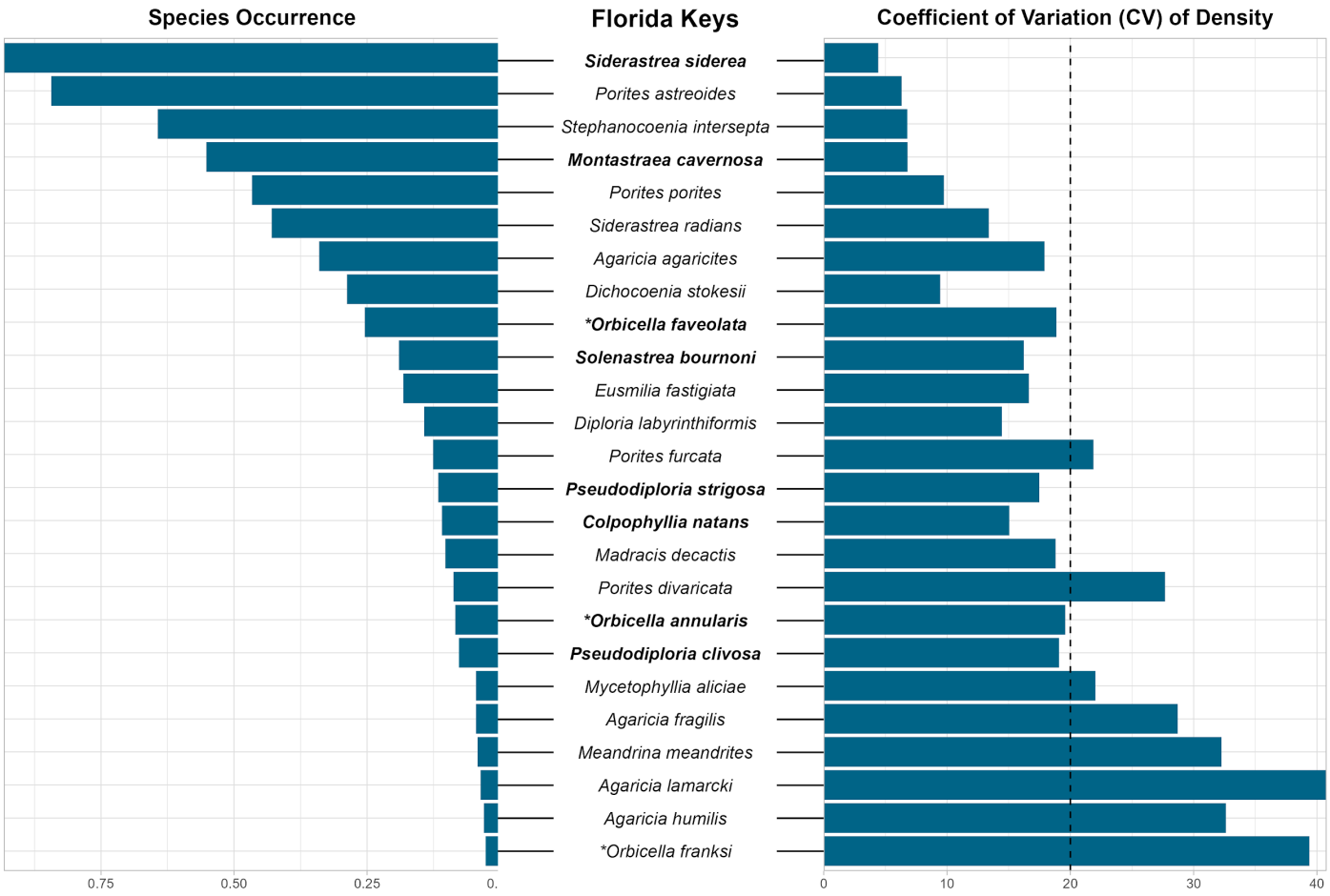


Figure 25. Coral species occurrence and coefficient of variation (CV) of density in coral demographics surveys in the Florida Keys in 2024. Species with an occurrence less than 0.01 are not shown. Bolding indicates the species was used in allocations, and an asterisk (*) indicates ESA-listing. Dashed vertical line on the CV plot indicates the survey's target of a 20% CV of density. NCRMP and DRM data are included. Note: x-axis scale varies by metric.

Dry Tortugas

In the Dry Tortugas in 2024, 15 coral species had CVs of 20% or less (Figure 26). Five of the eight allocation species had a CV of 20% or less: *S. siderea*, *M. cavernosa*, *O. faveolata*, *O. franksi*, and *M. meandrites.* Among the allocation species, *Orbicella annularis* had the most limited occurrence and is not shown in the below figure, as only two colonies were recorded. As with Florida Keys and Southeast Florida, the coral species most commonly encountered were *S. siderea*, *P. astreoides*, *S. intersepta*, and *M. cavernosa* (Figure 26).

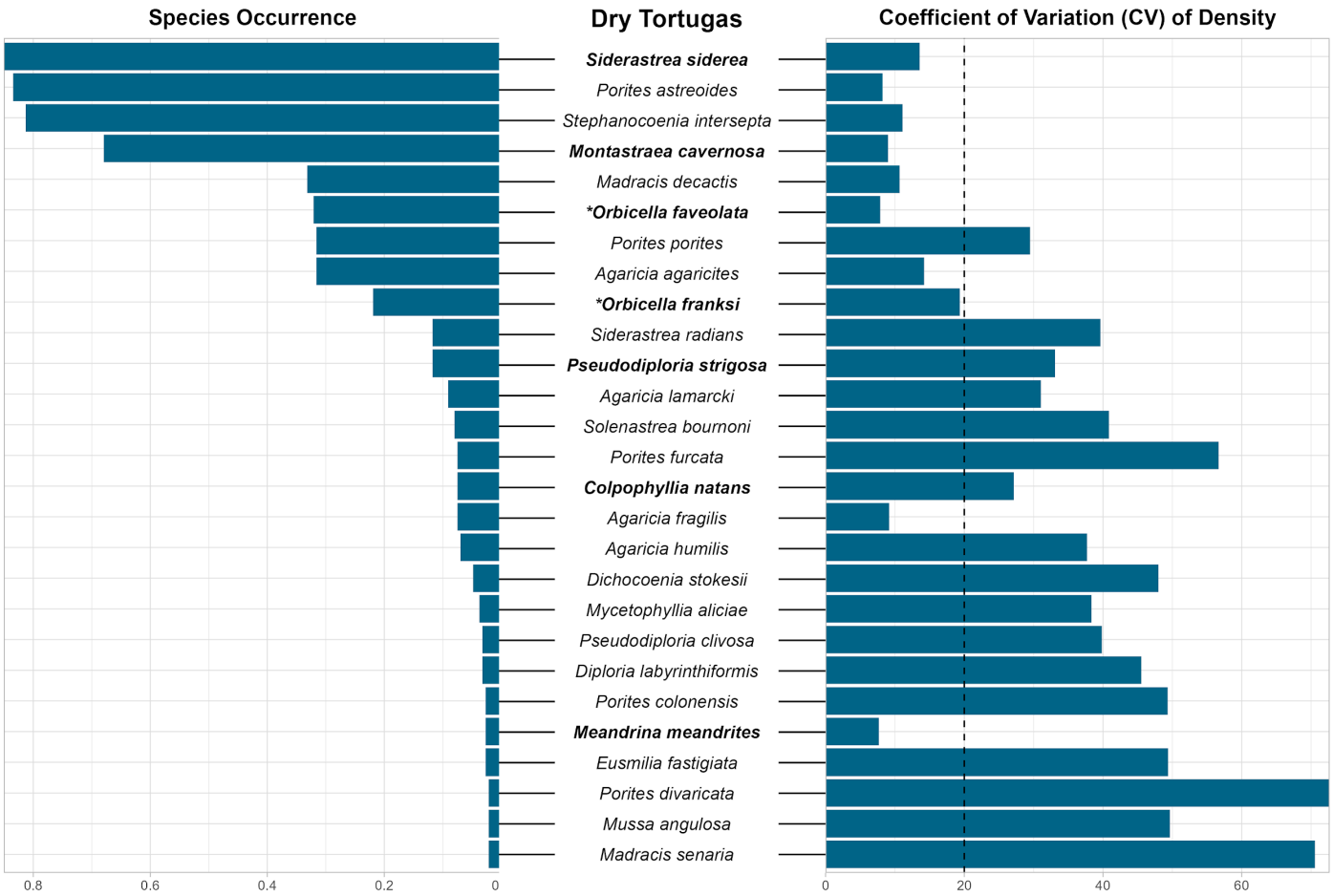


Figure 26. Coral species occurrence and coefficient of variation (CV) of density in coral demographics surveys in the Dry Tortugas in 2024. Species with an occurrence less than 0.01 are not shown. Bolding indicates the species was used in allocations, and an asterisk (*) indicates ESA-listing. Dashed vertical line on the CV plot indicates the survey's target of a 20% CV of density. NCRMP and DRM data are included. Note: x-axis scale varies by metric.

Density and Size Composition

Colony size and mortality are important components of colony density. When partial mortality (either recent or old) increases on a coral colony to full mortality (100%), the completely dead coral colony is no longer part of the population and, as such, is not included in NCRMP surveys. Coral mortality is a primary cause of declining coral density.

The subset of species shown in size composition figures was selected based on CV of density, ESA status, SCTLD susceptibility, and ecological value (e.g., reef-building capability) for each region. Size composition figures are relative length frequency distributions based on the maximum skeletal diameter of surveyed colonies. Size compositions provide a detailed description of the population structure of a selected coral species and reflect the combination of demographic processes of recruitment, growth, and survival. Over time, coral colonies can remain in the same skeletal size class (due to partial mortality of coral tissue or lack of growth), grow to a larger size (tissue survival and skeletal growth), shrink to a smaller size (from colony skeletal fragmentation), or suffer total mortality over time (no longer surveyed). Thus, size frequency figures can show juvenile input (growth and survival) to the adult length classes ($\geq$ 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-sized length classes could signify a decrease in juvenile input into smaller size classes, a previous (episodic) recruitment event that resulted in large juvenile input into the population, or mortality in smaller or larger sized corals. 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.

Southeast Florida

In Southeast Florida, the mean density of corals has declined significantly since 2014 (Figure 27), and was 0.5 ± 0.04 corals/m^2 in 2024. Old mortality was slightly variable between years, but for the past four survey years (2018–2024), it has remained steady around 10%.

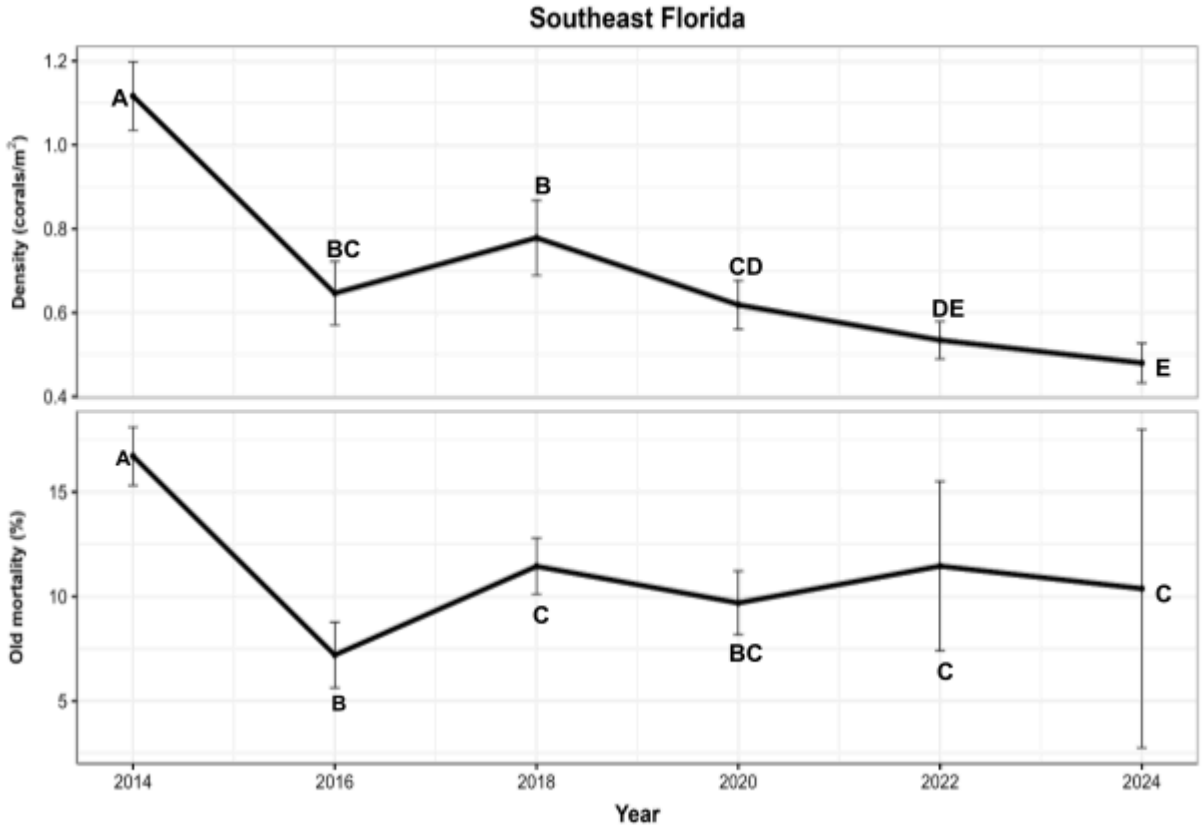


Figure 27. Mean coral density (corals/m^2; top) and old mortality (%; bottom) ± SE from 2014 to 2024 in Southeast Florida. Statistical significance, if present, is reported at $p < 0.05$, and different letters (e.g., A, B) denote a difference between survey years. Note differences in y-axis scales.

In Southeast Florida in 2024, coral density was dominated by *P. astreoides*, followed by *M. cavernosa*, *S. siderea*, *S. intersepta*, and *S. radians* (Figure 28). The largest coral species by maximum skeletal dimension were *O. faveolata*, *Acropora cervicornis*, and *P. clivosa* (all between approximately 25–50 cm), and colonies of these species also had a relatively high percentage (approximately 11–36%) of old mortality, as did *P. strigosa* and *Porites divaricata. Diploria labyrinthiformis* had a relatively high percentage (approximately 2.4% ± 2.4) of recent mortality.

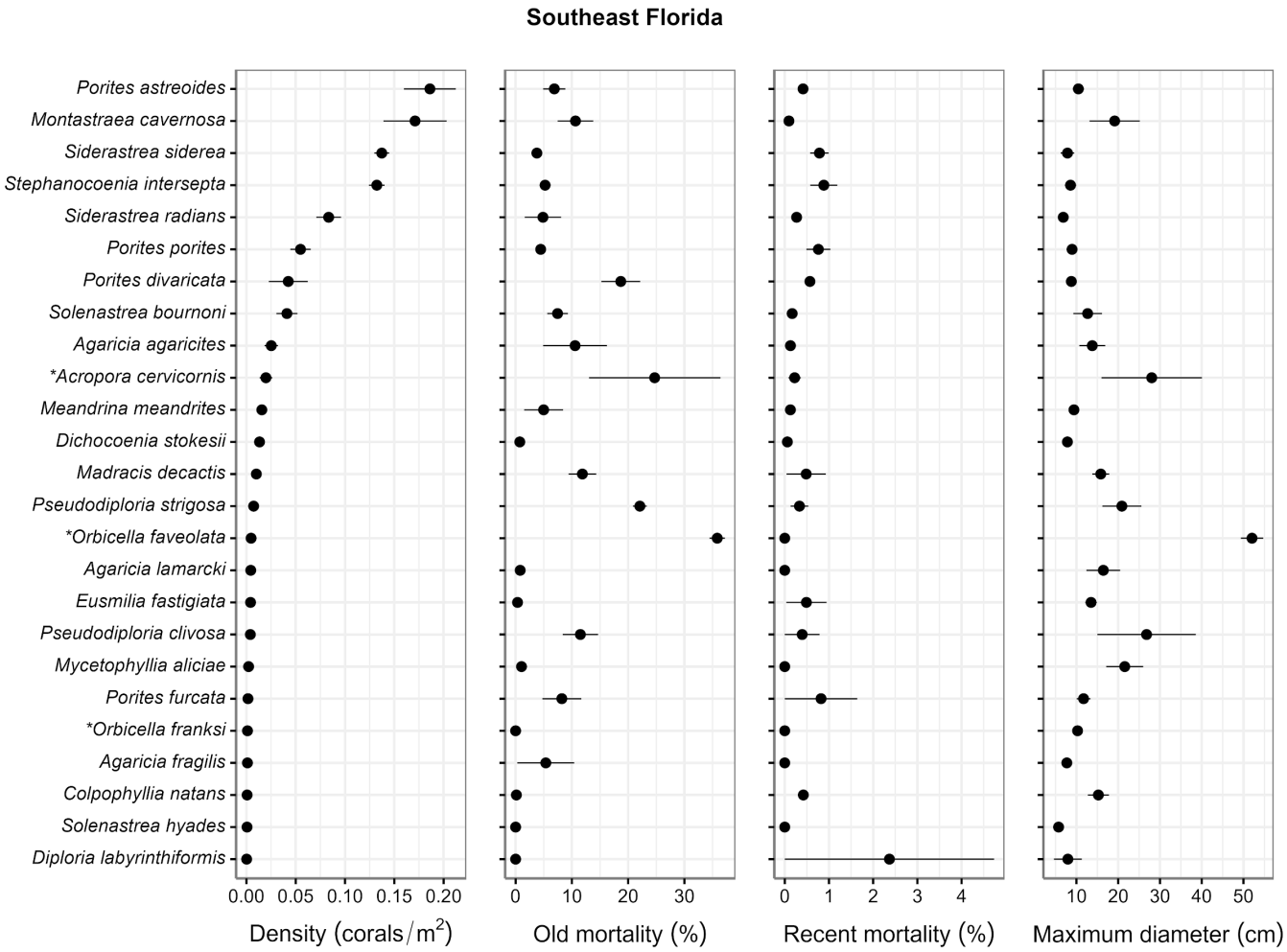
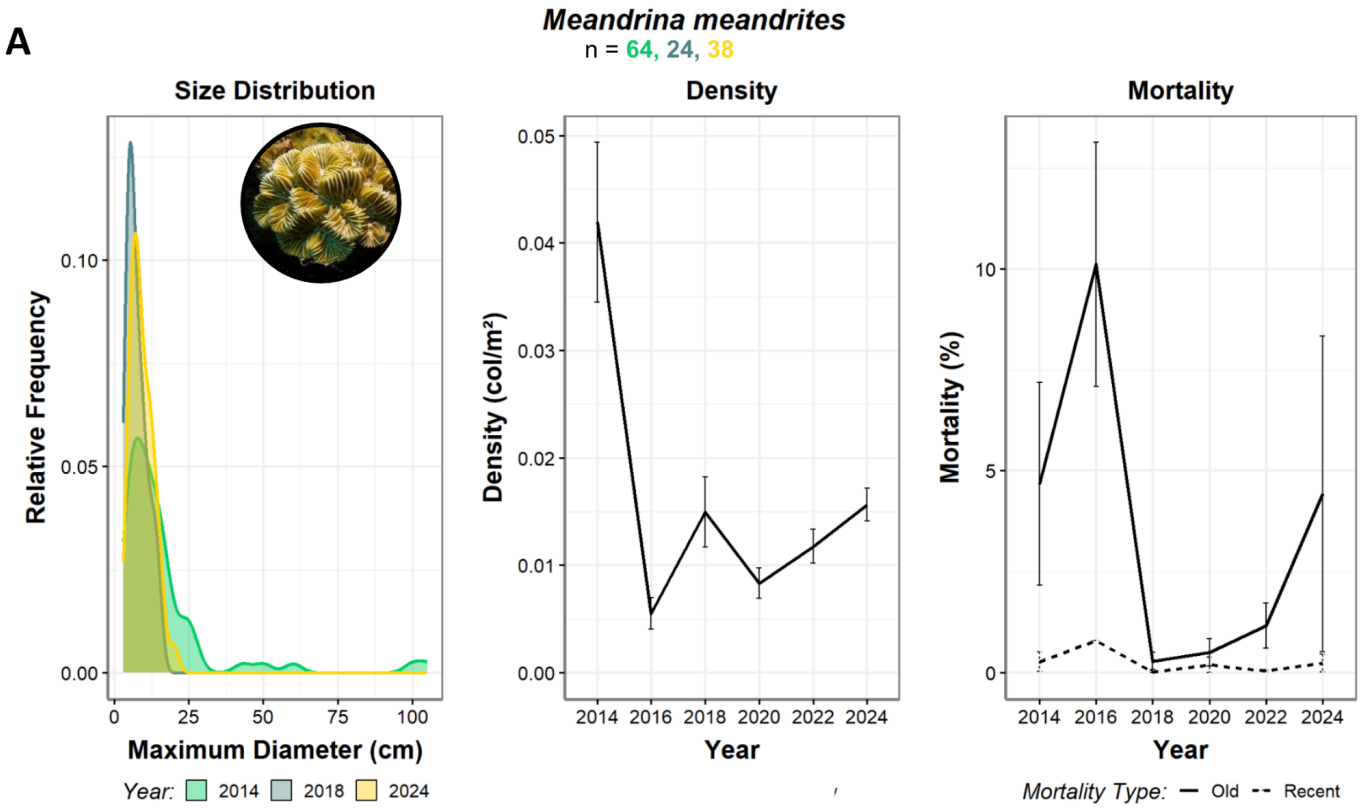
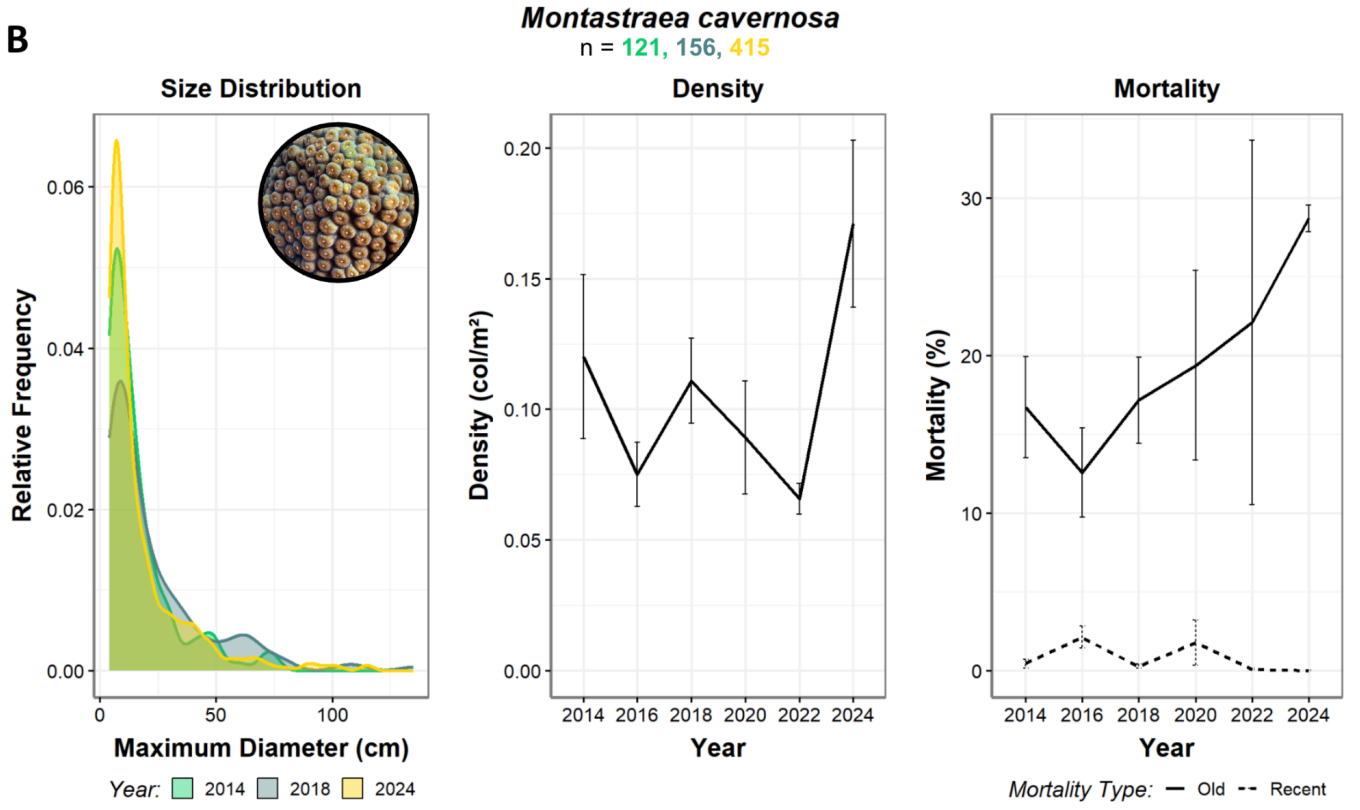


Figure 28. Mean (± SE) density of corals (colonies/m^2), extent of old mortality (%), extent of recent mortality (%), and maximum diameter (cm) by coral species in Southeast Florida in 2024. Species are ordered in terms of decreasing density, and only species with densities above 0.01 are included. NCRMP and DRM data are included. ESA-listed species are denoted with an asterisk (*).

Figure 29 shows the relative size frequency distribution, percent mortality, and densities for *M. meandrites*, *M. cavernosa*, *O. faveolata*, and *S. siderea* in 2014, 2018, and 2024. Generally, coral populations have shifted over time towards smaller-sized colonies. That shift is strongest for species that are highly susceptible to SCTLD, such as *M. meandrites*, which had no colonies greater than 25 cm in 2024. Species-specific density patterns were variable. In *M. meandrites*, density rapidly declined between 2014 and 2016, but has shown slight increases in density since 2020. This, in conjunction with the small average colony size, suggests successful recruitment and/or survival. Similarly for *M. cavernosa*, colony density is currently at its highest point in the ten-year survey period, but, overall, the population size structure has shifted towards smaller colonies, suggesting successful recruitment events. *Siderastrea siderea* is generally considered to be a more stress-tolerant coral species, and its size structure remained relatively stable. However, *S. siderea* population density has decreased over time.


A
Meandrina meandrites
n = 64, 24, 38
Size Distribution
Density
Mortality
Relative Frequency
Maximum Diameter (cm)
Density (col/m²)
Mortality (%)
Year
Year: 2014 2018 2024
Mortality Type: Old Recent


B
Montastraea cavernosa
n = 121, 156, 415
Size Distribution
Density
Mortality
Relative Frequency
Maximum Diameter (cm)
Density (col/m²)
Mortality (%)
Year
Year: 2014 2018 2024
Mortality Type: Old Recent

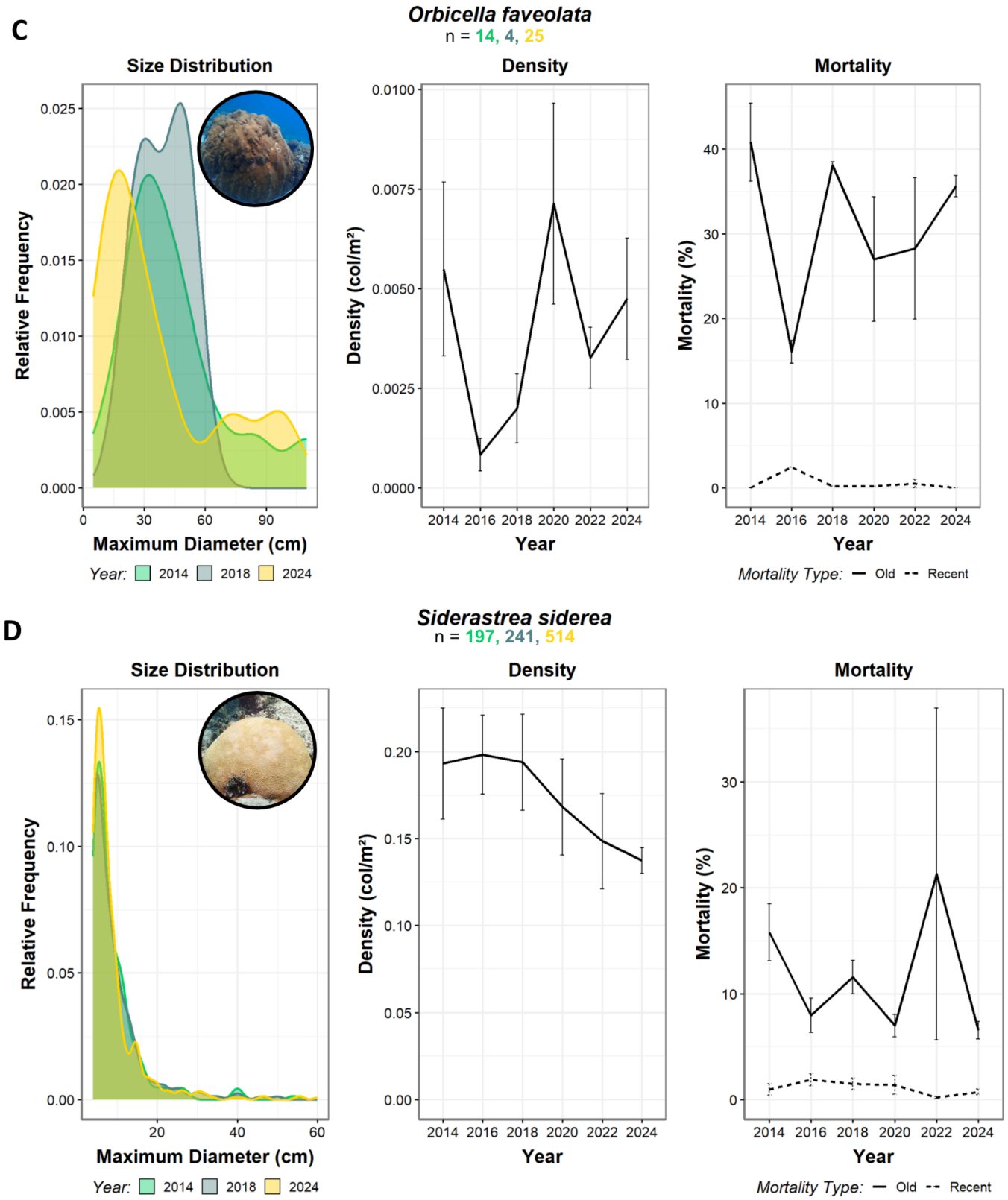


Figure 29. Summary of Southeast Florida NCRMP and DRM results for A) *Meandrina meandrites*, B) *Montastraea cavernosa*, C) *Orbicella faveolata*, and D) *Siderastrea siderea*. The number of colonies observed (n) is reported for each species in a given survey year. The left panel is the size distribution scaled by the observed frequency of maximum diameter; the middle panel is the mean colony density (colonies per m^2) across survey years with standard error; the right panel is the percent mortality (old and recent) across survey years with standard error. The Southeast Florida survey sizes for 2014, 2018, and 2024 are 90, 127, and 352, respectively.

Florida Keys

Overall coral density in the Florida Keys declined from 2014 to 2024. The mean coral density in 2024 (2.8 ± 0.2 corals/m^2) was less than half of 2014 values (5.9 ± 0.2 corals/m^2; Figure 30). The prevalence of old mortality on colonies trended downwards over time, generally consistent with the decline in coral density; these decreases suggest many colonies with partial old mortality succumbed to full mortality and disappeared from subsequent surveys (Figure 30).

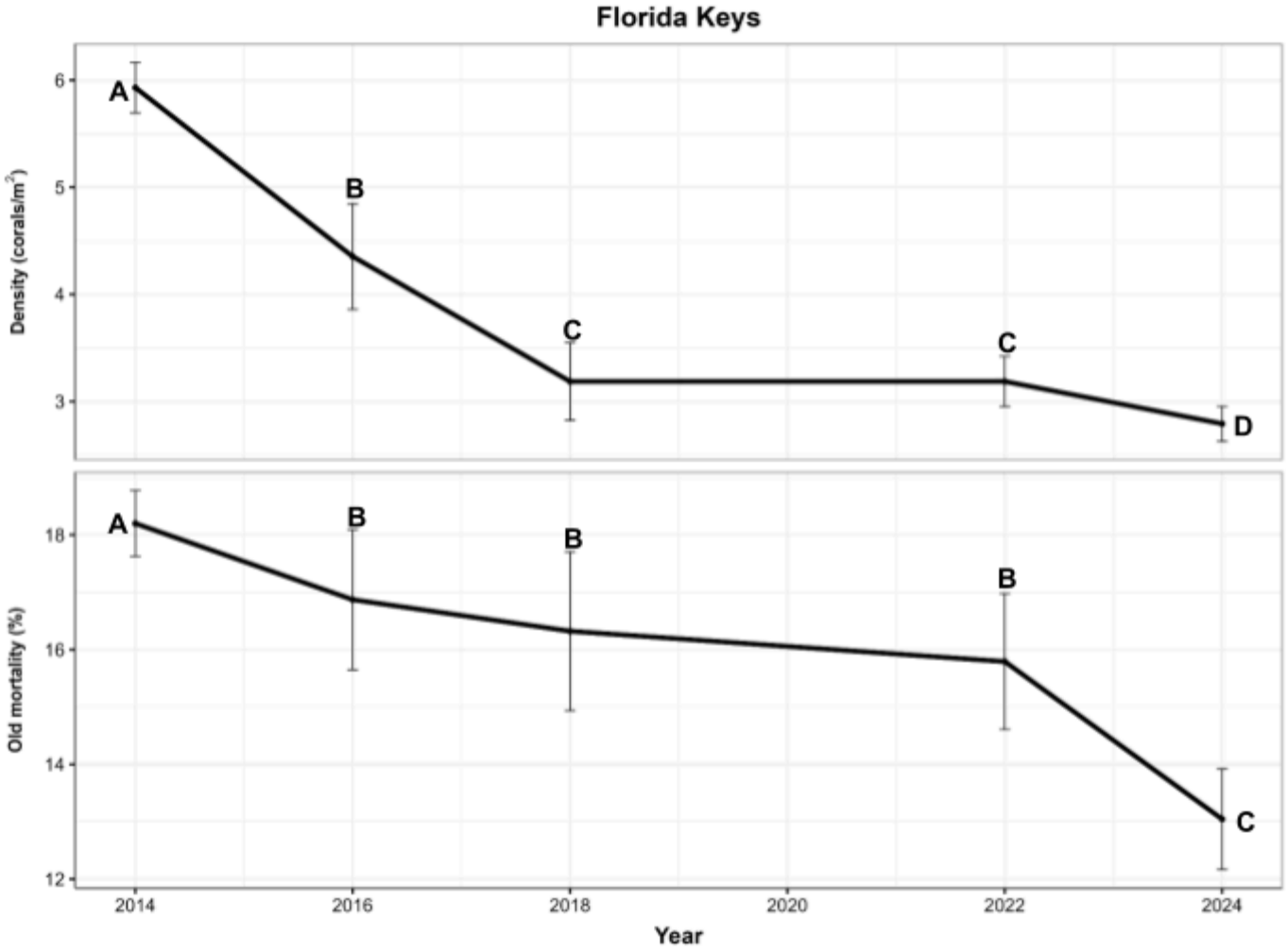


Figure 30. Mean coral density (corals per m^2; top) and old mortality prevalence (%; bottom) ± SE from 2014 to 2024 in the Florida Keys (note that no surveys were conducted in 2020). Statistical significance, if present, is reported at $p < 0.05$, and different letters (e.g., A, B) denote a difference between survey years. Note differences in y-axis scales.

The mean density of corals in the Florida Keys in 2024 was dominated by the following species: *S. siderea*, *S. intersepta, P. astreoides*, *Agaricia agaricites*, and *M. cavernosa* (Figure 31), and all species had less than one colony/m^2. The three orbicellids (*O. annularis*, *O. faveolata*, *O. franksi*) had the largest mean size in terms of maximum skeletal diameter (> 30 cm). Old mortality was highest in branching *Porites* species (ranging 25%–40%) and *Orbicella* species (31%–34%). Recent mortality by species was low (< 2%), with the highest prevalence observed on *P. porites* and *P. furcata*.

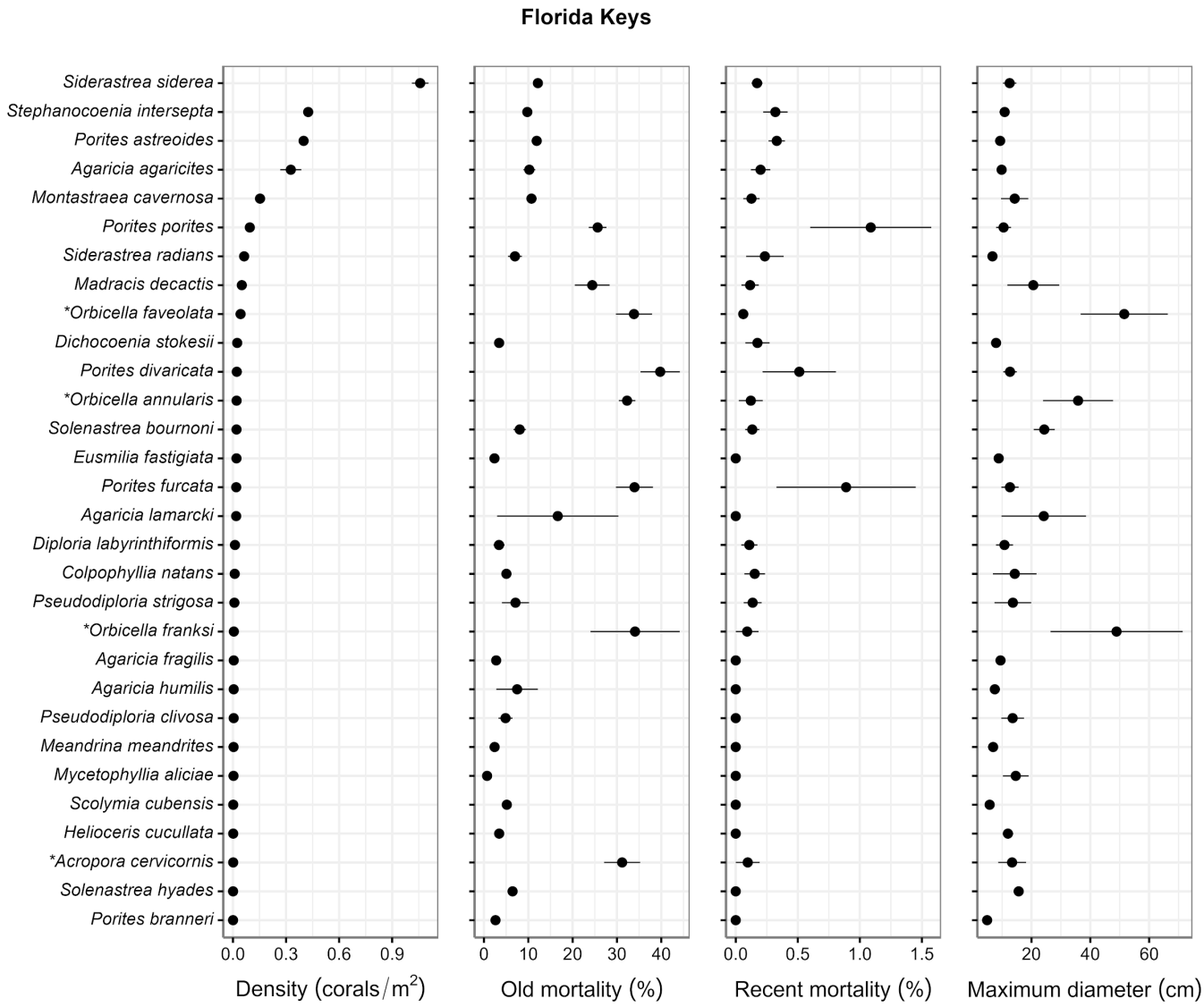
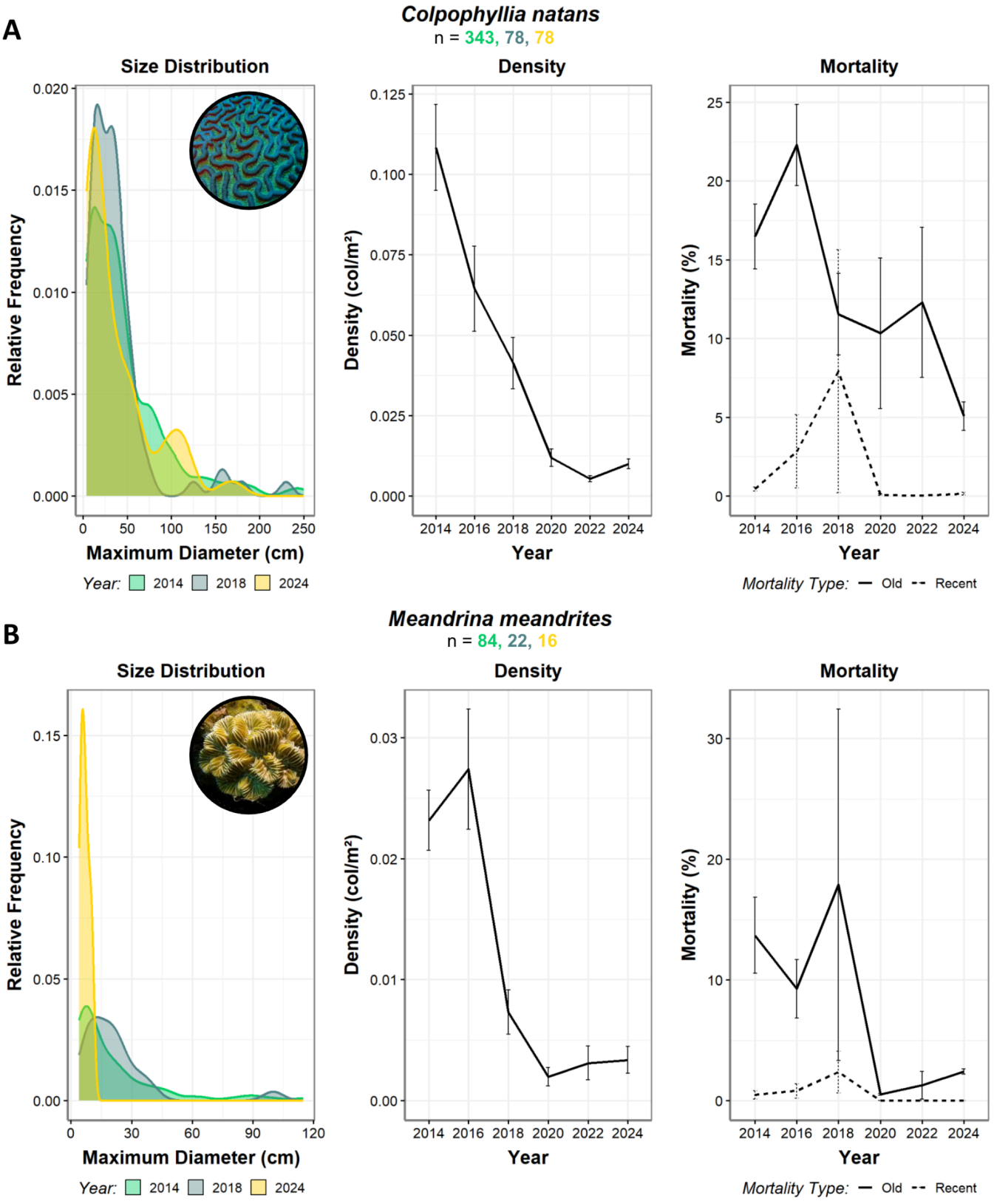


Figure 31. Mean (± SE) density of corals (colonies/m^2), extent of old mortality (%), extent of recent mortality (%), and maximum diameter (cm) by coral species in the Florida Keys in 2024. Species are ordered in terms of decreasing density, and only species with densities above 0.01 are included. NCRMP and DRM data are included. ESA-listed species are denoted with an asterisk (*).

Length frequency distributions for *C. natans*, *M. meandrites*, *M. cavernosa*, and *O. faveolata* in 2014, 2018, and 2024 generally show populations that have become more right-skewed with time, indicating shifts towards smaller-sized colonies (Figure 32). This pattern is particularly clear for highly SCTLD-susceptible species like *C. natans* and *M. meandrites*. Overall, the extent of old mortality declined over time, suggesting either tissue regrowth over previously dead skeletons or a progressive degradation of distinct colony boundaries. There is a general trend of declining density over time for all four focal species, with density bottoming out in 2020 or 2022 and slight increases or stabilization in 2024.


A
Colpophyllia natans
n = 343, 78, 78
Size Distribution
Relative Frequency
Maximum Diameter (cm)
Year: 2014 2018 2024
Density
Density (col/m²)
Year
Mortality
Mortality (%)
Year
Mortality Type: Old Recent
B
Meandrina meandrites
n = 84, 22, 16
Size Distribution
Relative Frequency
Maximum Diameter (cm)
Year: 2014 2018 2024
Density
Density (col/m²)
Year
Mortality
Mortality (%)
Year
Mortality Type: Old Recent

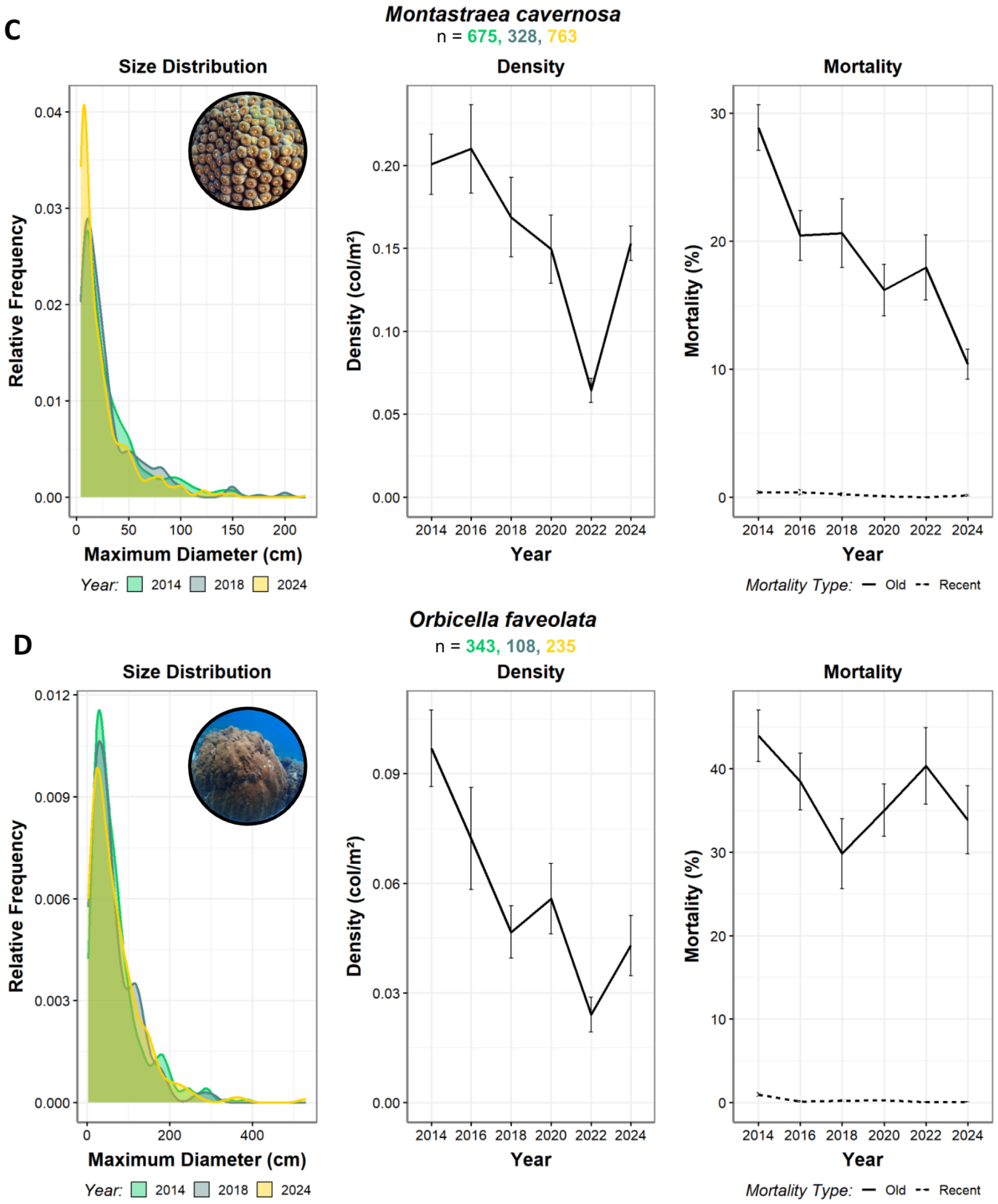


Figure 32. Summary of Florida Keys NCRMP and DRM results for A) *Colpophyllia natans*, B) *Meandrina meandrites*, C) *Montastraea cavernosa*, and D) *Orbicella faveolata*. The number of colonies observed (n) is reported for each species in a given survey year. The left panel is the size distribution scaled by the observed frequency of maximum diameter; the middle panel is the mean colony density (colonies per m^2) across survey years with standard error; the right panel is the percent mortality (old and recent) across survey years with standard error. The Florida Keys demographic survey sizes for 2014, 2018, and 2024 are 409, 188, and 594, respectively.

Dry Tortugas

Overall coral density in the Dry Tortugas declined significantly since 2018 (Figure 33), with mean coral density falling to 1.5 ± 0.1 corals/m^2 in 2024. Colony size and mortality are important components of colony density. Old mortality was highest in 2016 and in 2024, reaching 18.5% ± 1.2 and 13.8% ± 1.5, respectively (Figure 33).

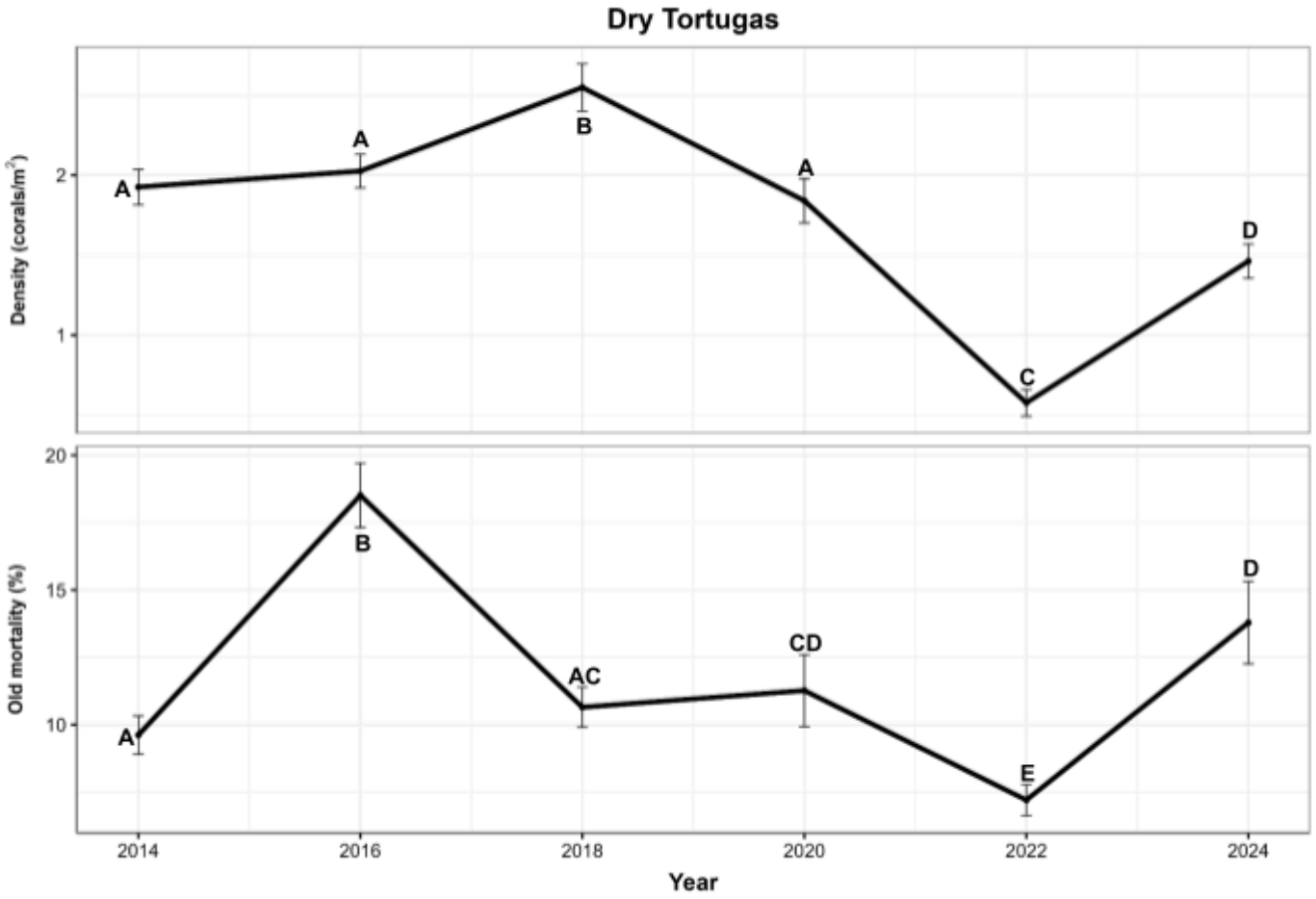


Figure 33. Mean coral density (corals/m^2) and old mortality (%) ± SE from 2014 to 2024 in the Dry Tortugas. Statistical significance, if present, is reported at $p < 0.05$, and different letters (e.g., A, B) denote a difference between survey years. Note: y-axis scale varies by metric.

In 2024, the mean coral density in the Dry Tortugas was highest for *S. siderea* and *P. astreoides* (Figure 34). The coral species with the largest maximum skeletal dimension (> 40 cm) were *O. faveolata, O. franksi*, and *Agaricia lamarcki.* Old mortality was highest (40–50%) in *O. franksi*, *P. furcata*, *A. cervicornis*, and *P. divaricata*. Recent mortality was very low (<1%), except in *D. stokesii* (1.7%) and *A. cervicornis* (18.8%).

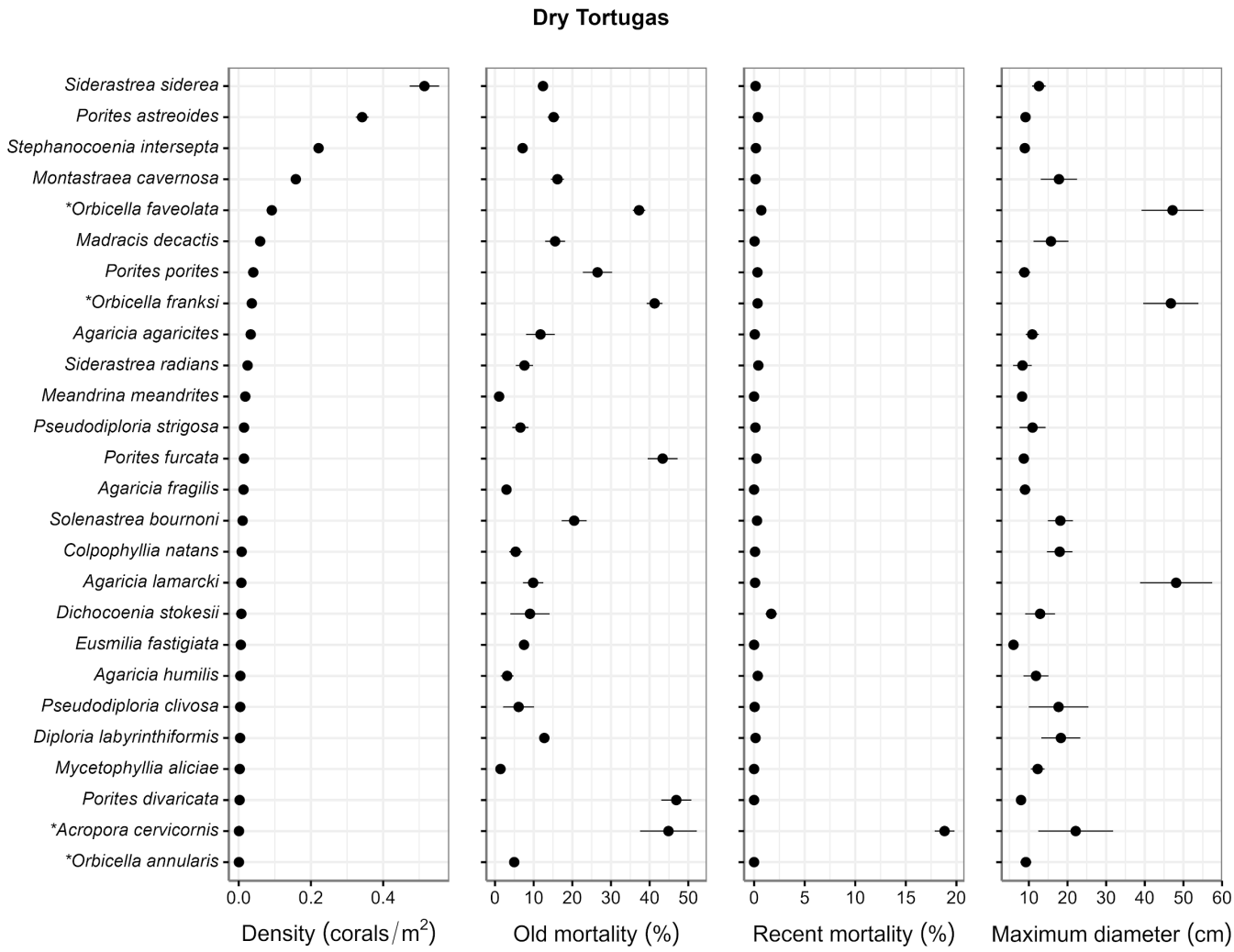
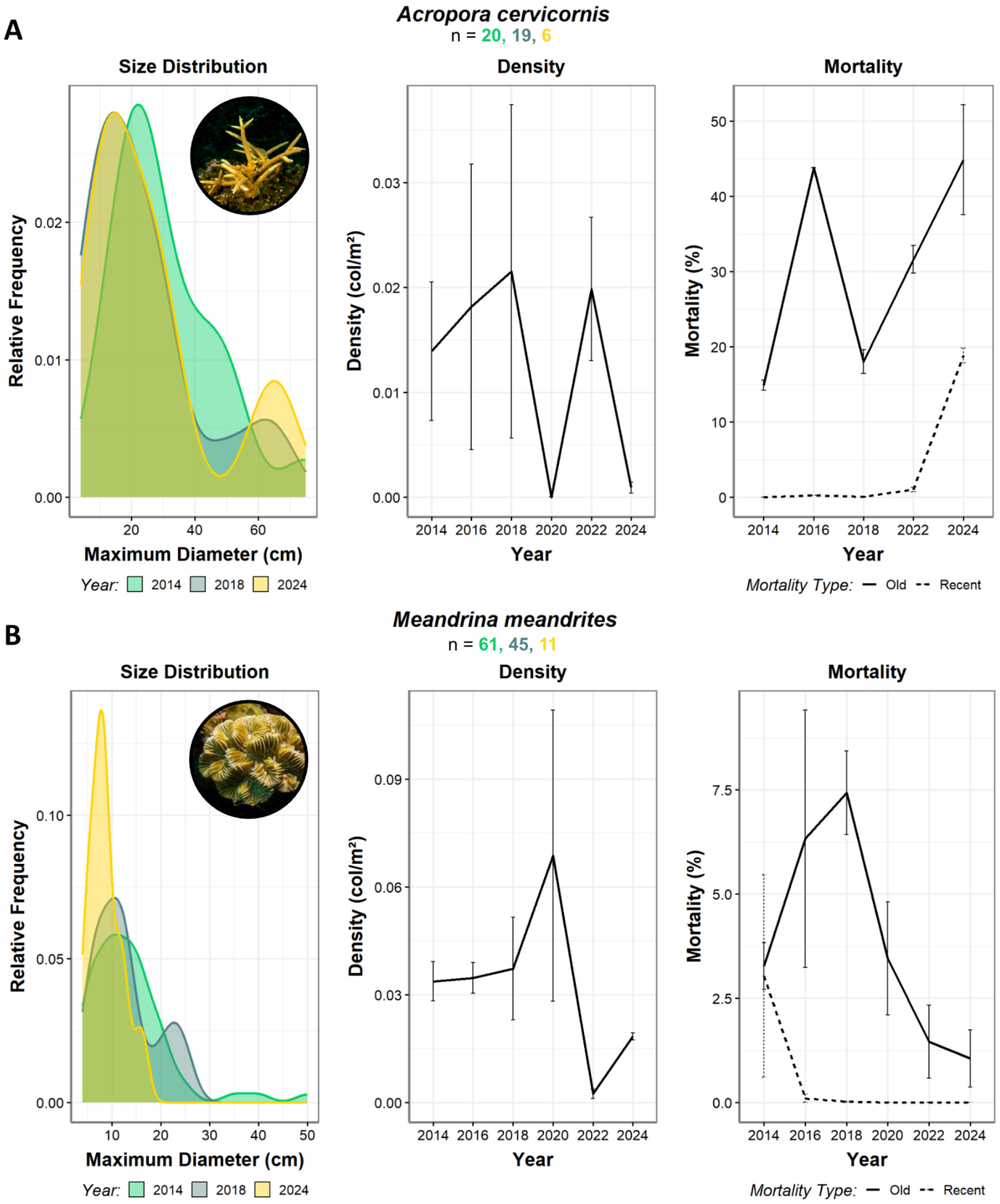


Figure 34. Mean (± SE) density of corals (colonies/m^2), extent of old mortality (%), extent of recent mortality (%), and maximum diameter (cm) by coral species in the Dry Tortugas in 2024. Species are ordered in terms of decreasing density, and only species with densities above 0.01 are included. NCRMP and DRM data are included. ESA-listed species are denoted with an asterisk (*).

Figure 35 shows the length frequency distributions for *A. cervicornis*, *M. meandrites*, *M. cavernosa*, and *O. franksi* in 2014, 2018, and 2024. *Acropora cervicornis* continues to be a rare species, and its clumped distribution contributes to variability in its density over time. In 2018 and 2024, *A. cervicornis'* bimodal size structure distribution reflects that the species persists both in small colonies and, more rarely, in larger thickets. Similar to Southeast Florida and the Florida Keys, *M. meandrites* in the Dry Tortugas had a significant shift in population size structures towards smaller colonies; additionally, colony density in 2024 showed a small but significant increase from its minimum in 2022, which may reflect a successful recruitment event of *M. meandrites* following its precipitous, SCTLD-driven decline. Contrary to *M. meandrites*, *O. franksi*'s population size structure shifted towards larger colonies. This suggests that there has primarily been a loss of smaller size classes of *O. franksi* in the Dry Tortugas over the past decade. With these larger, bouldering colonies, however, there is often higher partial old mortality. Additionally, the density of *O. franksi* declined precipitously between 2018 and 2020, although it has since stabilized.


A
Acropora cervicornis
n = 20, 19, 6
Size Distribution
Density
Mortality
Relative Frequency
Maximum Diameter (cm)
Density (col/m²)
Year
Mortality (%)
Year: 2014 2018 2024
Mortality Type: Old Recent
B
Meandrina meandrites
n = 61, 45, 11
Size Distribution
Density
Mortality
Relative Frequency
Maximum Diameter (cm)
Density (col/m²)
Year
Mortality (%)
Year: 2014 2018 2024
Mortality Type: Old Recent

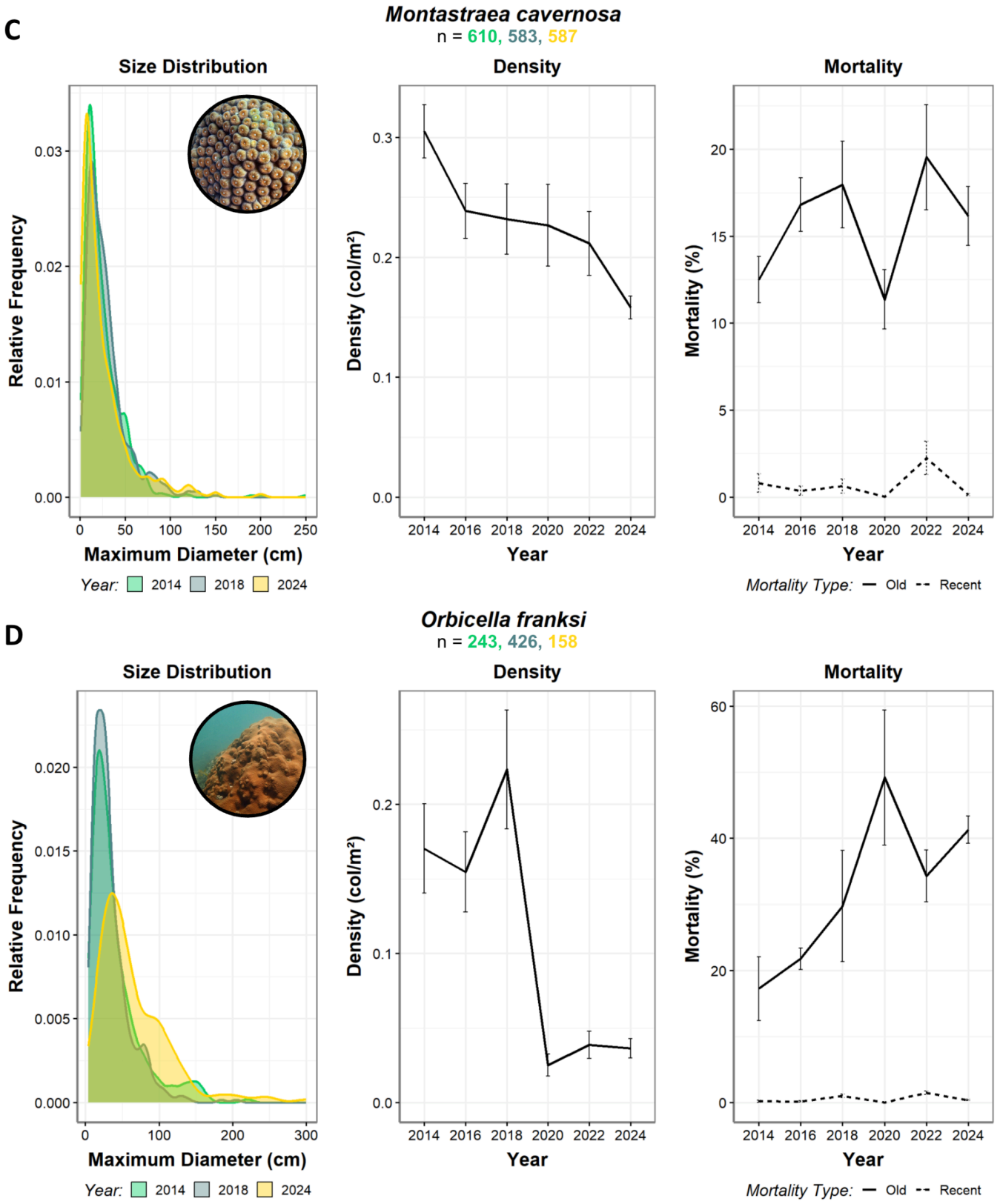


Figure 35. Summary of Southeast Florida NCRMP and DRM results for A) *Acropora cervicornis*, B) *Meandrina meandrites*, C) *Montastraea cavernosa*, and D) *Orbicella franksi*. The number of colonies observed (n) is reported for each species in a given survey year. The left panel is the size distribution scaled by the observed frequency of maximum diameter; the middle panel is the mean colony density (colonies per m^2) across survey years with standard error; the right panel is the percent mortality (old and recent) across survey years with standard error. Dry Tortugas demographic survey sizes for 2014, 2018, and 2024 are 135, 139, and 340, respectively.

Coral Bleaching and Disease

Southeast Florida

In Southeast Florida in 2024, coral paling and bleaching had an overall prevalence of 14.6% ± 6.0, with species-specific bleaching prevalences shown below (Figure 36). In more commonly surveyed coral species (> 10 colonies), coral bleaching was most prevalent across *S. radians*, *S. siderea*, and *O. faveolata*. Other species had a higher observed bleaching prevalence, but very low numbers surveyed (e.g., *Agaricia fragilis*). In Southeast Florida, NCRMP surveys were conducted between June and November of 2024, while DRM surveys occurred between August and November of 2024 (Harrell et al., 2024).

In Southeast Florida in 2024, coral disease prevalence was relatively low at 1.5% ± 1.6 based on data from both NCRMP and DRM surveys. The highest species-specific prevalence of disease was on *A. agaricites*, *P. astreoides*, and *S. bournoni* (Figure 36).

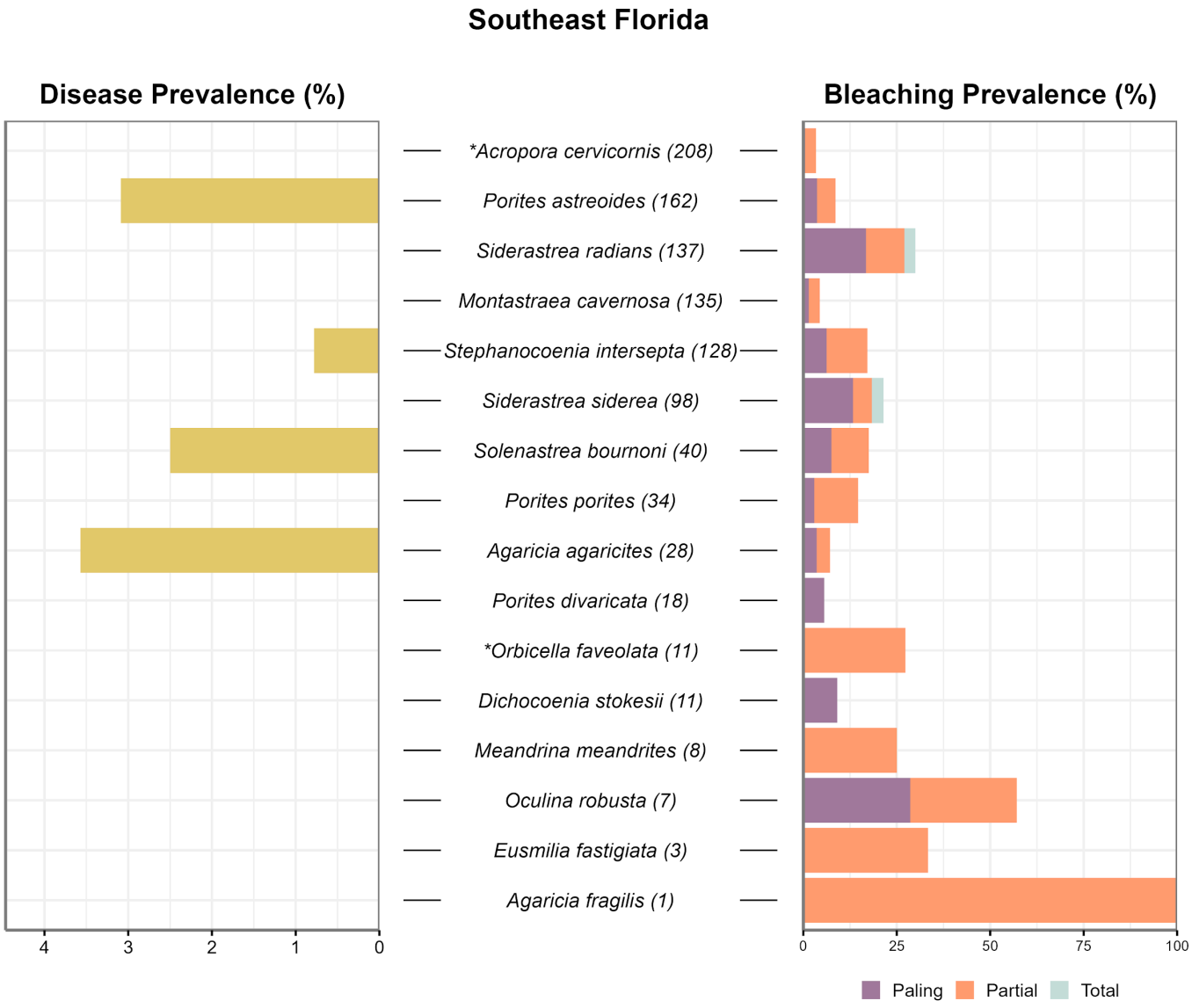


Figure 36. Disease prevalence (left) and bleaching prevalence (right) by coral species for Southeast Florida in 2024. The number of coral colonies observed by species is in parentheses. Only species with disease or bleaching observed in the 2024 NCRMP and 2024 DRM coral demographics surveys are included. Note: species are sorted in order of decreasing number of observations, and x-axis scale varies by metric. ESA-listed species are denoted with an asterisk (*).

Florida Keys

In the Florida Keys in 2024, coral paling and bleaching had an overall prevalence of 24.3% ± 8.5. Multiple coral species had a high bleaching prevalence (40–60%). Across more common species (> 10 colonies), bleaching prevalence was highest in *Eusmilia fastigiata*, *P. strigosa*, and *P. porites* (Figure 37). NCRMP surveys in the Florida Keys extended from June to October in 2024, and DRM surveys were largely from August to November 2024 (Harrell et al., 2024).

In 2024, overall coral disease prevalence was relatively low at 1.1% ± 0.9, with less than 3% by individual species. The species with the highest disease prevalence were *D. stokesii*, *S. intersepta*, *S. radians*, and *S. siderea* (Figure 37).

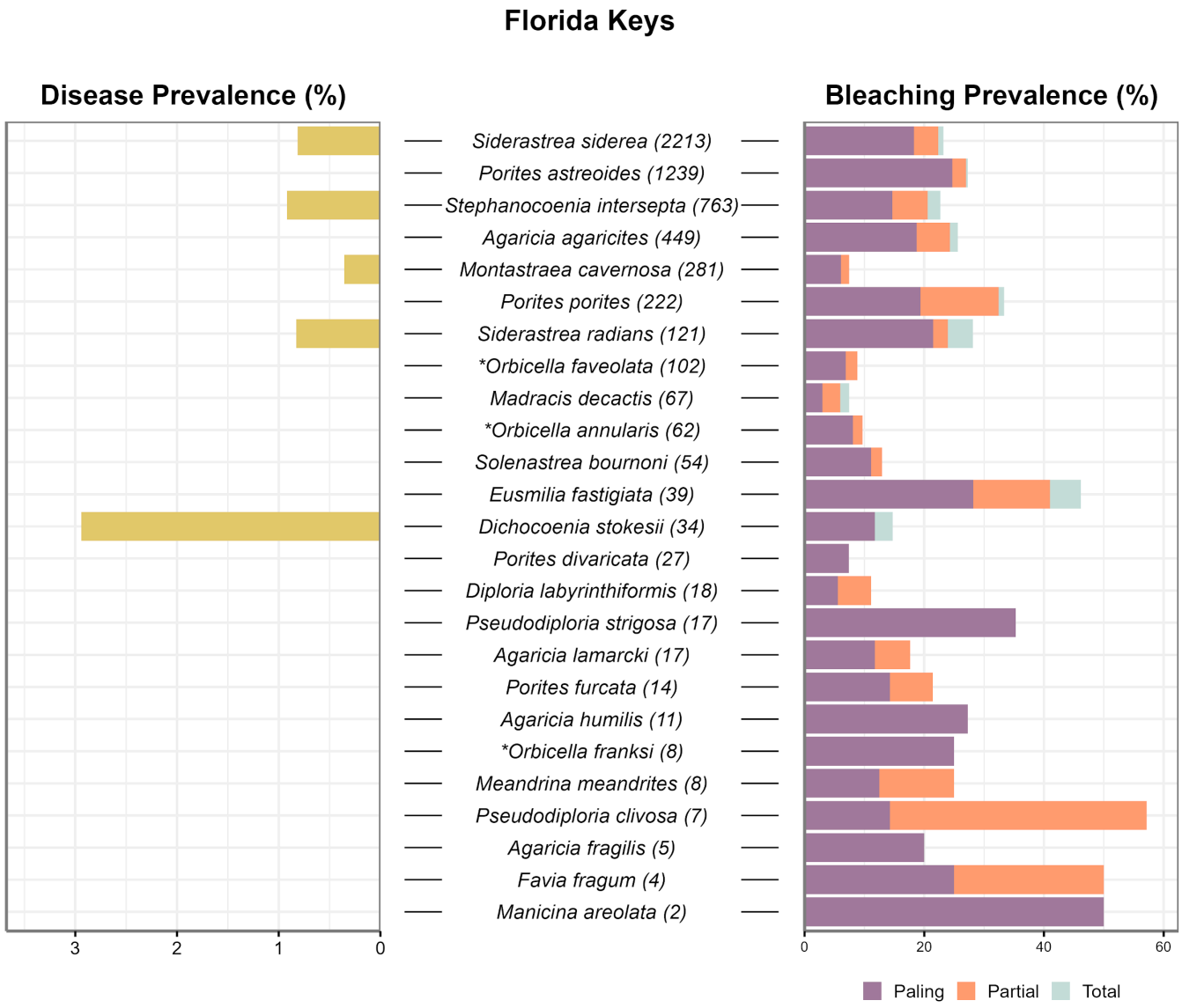


Figure 37. Disease prevalence (left) and bleaching prevalence (right) by coral species for the Florida Keys in 2024. The number of coral colonies observed by species is in parentheses. Only species with disease or bleaching observed in the 2024 NCRMP and 2024 DRM coral demographics surveys are included. Note: species are sorted in order of decreasing number of observations, and x-axis scale varies by metric. ESA-listed species are denoted with an asterisk (*).

Dry Tortugas

NCRMP surveys in the Dry Tortugas occurred in September 2024, and DRM surveys occurred from August to November 2024. Bleaching was highly prevalent at 35.2% ± 9.4. The more common coral species (> 10 colonies) that observed the highest bleaching prevalence were *P. strigosa*, *P. furcata*, and *P. porites* (Figure 38).

In the Dry Tortugas in 2024, coral disease was relatively prevalent, at 4.6% ± 4.3. The highest prevalence of coral disease in more commonly observed species (> 10 colonies) was in *S. radians*, *S. bournoni*, and *O. franksi* (Figure 38).

Figure 38. Disease prevalence (left) and bleaching prevalence (right) by coral species for the Dry Tortugas in 2024. The number of coral colonies observed by species is in parentheses. Only species with disease or bleaching observed in the 2024 NCRMP and 2024 DRM coral demographics surveys are included. Note: species are sorted in order of decreasing number of observations, and x-axis scale varies by metric. ESA-listed species are denoted with an asterisk (*).

Summary

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, Florida's Coral Reef continued to be dominated by many smaller, often schooling species, and generally, fishes were more commonly observed smaller than their minimum length of capture by the fishery in all regions (i.e., hogfish, mutton snapper, red grouper, and yellowtail snapper). The data emphasized 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 larger economically valuable reef fish species evaluated, black grouper density was notably low in all regions, and the 2024 surveys suggest that the large Dry Tortugas protected areas may be important for this species. In the Florida Keys, none of the five fishery target species evaluated had significantly higher densities in the small protected areas. This could be related to a number of factors including, but not limited to, differences in habitat type and quality, size of the protected areas, and lack of effective enforcement. As a fishery-independent survey, NCRMP collects numbers and lengths on all observed fishes to the nearest cm. Unfortunately, length composition data showed that larger hogfish are rare in Southeast Florida and the Florida Keys; a stock assessment (SEDAR94) is underway in 2025–2026. 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. NCRMP length composition data suggests lower fishing mortality for hogfish, mutton snapper, red grouper, and yellowtail snapper in the Dry Tortugas region. This may be due to the region's multiple, larger, no-take marine reserves, remoteness, or a combination of region-specific factors.

NCRMP corals and benthic community data showed that coral cover in Florida continued to decline, particularly where impacts of the severe coral bleaching in 2023 were most apparent. This bleaching event, part of the 2023–2024 global coral bleaching event, exacerbated the already persistently low coral cover across all Florida regions and contributed to further declines in coral colony density. In every Florida region, coral demographics (combined NCRMP and DRM data) showed that species that are highly susceptible to SCTLD, such as *M. meandrites* and *C. natans*, have become increasingly rare and, as large colonies have died, population size distributions have shifted to a higher proportion of smaller colonies. This may also indicate an influx (i.e., through recruitment, survival, and growth) into the adult ($\geq$ 4 cm) colony size surveyed by NCRMP. For multiple coral species, coefficients of variation (CVs) for density estimates were below 20% across Florida regions. The ability to achieve lower CVs can be attributed to the combined sampling effort of NCRMP and DRM, which increases sample sizes and spatial coverage in Florida. These complementary programs emphasize the benefits of federal-state collaboration to produce statistically robust population estimates. As corals continue to decline due to severe stressors, such as stony coral tissue loss disease (SCTLD) and bleaching, expanding survey efforts may be necessary to maintain low CVs and detect meaningful changes over time. As restoration efforts continue to scale amid increasingly frequent and severe stressors, NCRMP surveys are critical to collect data on coral populations, benthic communities, and fish populations and communities at restoration sites to enable comparisons with regional populations and inform adaptive restoration practices.

References

Ault, J. S., Smith, S. G., Bohnsack, J., Luo, J., Zurcher, N., McClellan, D., Ziegler, T., Hallac, D., Patterson, M., Feeley, M., Ruttenberg, B., Hunt, J., Kimball, D., and Causey, B. (2013). Assessing coral reef fish population and community changes in response to marine reserves in the Dry Tortugas, Florida, USA. *Fisheries Research*, *144*, 28–37. https://doi.org/10.1016/j.fishres.2012.10.007

Ault, J. S., Smith, S. G., Luo, J., Grove, L. J., Johnson, M. W., and Blondeau, J. (2021). Refinement of the southern Florida Reef Tract benthic habitat map with habitat use patterns of reef fish species. (NCEI Accession 0224176). NOAA National Centers for Environmental Information. Dataset. https://www.ncei.noaa.gov/archive/accession/0224176

Bak, R. P. M. and Meesters, E. H. (1998). Coral population structure: the hidden information of colony size-frequency distributions. *Marine Ecology Progress Series*, *162*, 301–306. https://doi.org/10.3354/meps162301

Bohnsack, J., and Bannerot, S. (1986). A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. NOAA National Marine Fisheries Service. NOAA Technical Report NMFS 41.

Bryan, D. R., Smith, S. G., and Ault, J. S. (2016). Feasibility of a regionwide probability survey for coral reef fish in Puerto Rico and the U.S. Virgin Islands. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, *8*, 135–146. https://doi.org/10.1080/19425120.2015.1082520

Dry Tortugas National Park. (2022, February 15). *Stony Coral Tissue Loss on Florida's Coral Reef*. https://www.nps.gov/drto/learn/nature/stony-coral-tissue-loss-on-florida-s-coral-reef.htm

Feeley, M. W., Brandt, M. E., Bryan, D. R., Zurcher, N., Acosta, A., Ault, J. S., Blondeau, J., Bohnsack, J. A., Grove, L. J. W., Keller, J. A., McDonough, V., Richter, L., Smith, S. G., and Swanson, D. S. (2025). A cooperative multiagency reef fish monitoring protocol for the Florida and US Virgin Islands coral reef ecosystems: Protocol narrative version—2.0. Science Report NPS/SR—2025/327. National Park Service, Fort Collins, Colorado. https://doi.org/10.36967/2310167

Ganz, H., and Blondeau, J. (2015). Reef Visual Census statistical package in R (website). R package version 1.0.0. Available online: https://github.com/jeremiaheb/rvc

Grove, L. J. W., Blondeau, J., and Ault, J. S. (2021). National Coral Reef Monitoring Program's Reef Fish Visual Census metadata for the U.S. Caribbean. SEDAR80-WP-02. SEDAR80, North Charleston, SC.

Grove, L. J. W., Blondeau, J., Cain, E., Davis, I. M., Edwards, K. F., Groves, S. H., Hile, S. D., Langwiser, C., Siceloff, L., Swanson, D. W., Towle, E. K., Viehman, T. S., and Williams, B. (2022). National Coral Reef Monitoring Program biological monitoring summary Florida: 2020–2021. Coral Reef Conservation Program, National Centers for Coastal Ocean Science, Southeast Fisheries Science Center. https://doi.org/10.25923/9jns-v916

Groves, S., Mateski, J., Krampitz, N., Sturm, A. M., and Viehman, T. S. (2025). NCRMP benthics statistical package in R (website). R package version 1.0.0. https://github.com/MSE-NCCOS-NOAA/NCRMP_benthics

Harrell, C., Stein, J., and Ruzicka, R. (2024). Disturbance Response Monitoring 2024 Summer Quick Look Report. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL. 39 pp. https://ocean.floridamarine.org/FRRP/Home/About

Hughes, T., and Tanner, J. (2000). Recruitment failure, life histories, and long-term decline of Caribbean corals. *Ecology*, *81*(8), 2250–2263. https://doi.org/10.2307/177112

Knowlton, N. (2001). The future of coral reefs. *Proceedings of the National Academy of Sciences*, *98*(10), 5419–5425. https://doi.org/10.1073/pnas.091092998

Manzello D.P., Cunning R., Karp R.F., Baker A.C., Bartels E., Bonhag R,. Borreil A., Bourque A., Brown K.T., Bruckner A.W., and Corbett B. (2025). Heat-driven functional extinction of Caribbean *Acropora* corals from Florida's Coral Reef. *Science*, *390*(6771), 361-366. https://www.science.org/doi/10.1126/science.adx7825

Meesters, E. H., Hilterman, M., Kardinaal, E., Keetman, M., deVries, M., and Bak, R. P. M. (2001). Colony size-frequency distributions of scleractinian coral populations: spatial and interspecific variation. *Marine Ecology Progress Series*, *209*, 43–54. https://doi.org/10.3354/meps209043

Muller E. M., Sartor, C., Alcaraz, N. L., and van Woesik, R. (2020). Spatial epidemiology of the stony-coral-tissue-loss disease in Florida. *Frontiers in Marine Science*, *7*, 163. https://doi.org/10.3389/fmars.2020.00163

NOAA Coral Program (NOAA CRCP). (2021). National Coral Reef Monitoring Plan. Silver Spring, MD, NOAA Coral Reef Conservation Program. 40pp. https://doi.org/10.25923/fqkq-w497

NOAA Coral Reef Conservation Program (CRCP). (2024a). National Coral Reef Monitoring Program (NCRMP) Reef Visual Census (RVC) Fish Survey Protocols U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands. NOAA Coral Reef Conservation Program. 22 pp. https://doi.org/10.25923/1y7h-cf65

NOAA Coral Reef Conservation Program (CRCP). (2024b). National Coral Reef Monitoring Program (NCRMP) Benthic Community Assessment Survey Field Protocols for U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands. NOAA Coral Reef Conservation Program. 29 pp. https://doi.org/10.25923/e3gf-vk84

NOAA Coral Reef Conservation Program (CRCP). (2024c). National Coral Reef Monitoring Program (NCRMP) Coral Demographics Survey Field Protocols for U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, U.S. Virgin Islands. NOAA Coral Reef Conservation Program. 28 pp. https://doi.org/10.25923/hgpr-jm80

NOAA National Marine Fisheries Service. (2014). Final rule. Endangered and threatened wildlife and plants: Final listing determinations on proposal to list 66 reef-building coral species and to reclassify elkhorn and staghorn corals. *Federal Register*, *79*(175), 53851–54123.

NOAA National Marine Fisheries Service. (2024). Final rule. Endangered and Threatened Wildlife and Plants: Reclassification of Pillar Coral (*Dendrogyra cylindrus*) From Threatened to Endangered. *Federal Register*, *89*(242), 101993–102000.

Precht, W., Gintert, B., Robbart, M., Fura, R., and van Woesik, R. (2016). Unprecedented disease-related coral mortality in Southeastern Florida. *Scientific Reports*, *6*, 31374. https://doi.org/10.1038/srep31374

SEDAR. 2006. SEDAR 12 – Gulf of Mexico Red Grouper Stock Assessment Report 1. SEDAR, North Charleston, SC. 358 pp.

SEDAR. 2024. SEDAR 79 – Southeastern US Mutton Snapper Stock Assessment Report. SEDAR, North Charleston, SC. 526 pp.

SEDAR. 2025. SEDAR 96 – Southeastern US Yellowtail Snapper Stock Assessment Report. SEDAR, North Charleston, SC. 194 pp.

Smith, S. G., Ault, J. S., Bohnsack, J.A., Harper, D. E., Luo, J., and McClellan, D. B. (2011a). Multispecies survey design for assessing reef-fish stocks, spatially explicit management performance, and ecosystem condition. Fisheries Research, 1099(1), 25-41. https://doi.org/10.1016/j.fishres.2011.01.012

Smith, S. G., Swanson, D. W., Chiappone, M., Miller, S. L., and Ault, J. S. (2011b). Probability sampling of stony coral population in the Florida Keys. Environmental Monitoring and Assessment, 183(1-4), 121-138. https://doi.org/10.1007/s10661-011-1912-2

Stein, J. and Ruzicka, R. (2023). Florida Reef resilience program disturbance response monitoring 2022 Quick Look Report. Florida Fish and Wildlife Research Institute. https://ocean.floridamarine.org/FRRP/Home/About

Stein, J., Huebner, L.K., Colella, M., Harrell, C., and Ruzicka, R. (2024). Florida's Coral Reef 2023-2024 Post-Bleaching Assessment Quick Look Report. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL. 23 pp. https://ocean.floridamarine.org/FRRP/Home/About

Towle, E. K. (2021). How can the National Coral Reef Monitoring Program help inform stony coral tissue loss disease monitoring? 2021 Featured Stories: June [website]. NOAA Coral Reef Conservation Program. Online: https://coralreef.noaa.gov/aboutcrcp/news/featuredstories/june21/stony-coral.html

Towle, E. K., Donovan, E. C., Kelsey, H., Allen, M. E., Barkley, H., Blondeau, J., Brainard, R. E., Carew, A., Couch, C. S., Dillard, M. K., Eakin, C. M., Edwards, K., Edwards, P. E. T., Enochs, I. C., Fleming, C. S., Fries, A. S., Geiger, E. F., Grove, L. J., Groves, S. H., Gorstein, M., Heenan, A., Johnson, M. W., Kimball, J., Koss, J. L., Kindinger, T., Levine, A., Manzello, D. P., Miller, N., Oliver, T., Samson, J. C., Swanson, D., Vargas-Angel, B., Viehman, T. S., and Williams, I. D. (2022). A national status report on United States coral reefs based on 2012–2018 data from National Oceanic and Atmospheric Administration's National Coral Reef Monitoring Program. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.812216

Underwood, A. J., and Keough, M. J. (2001). Supply-side ecology. The nature of consequences and variations in recruitment of intertidal organisms. In Bertness, M. D., Gaines, S. D., and Hay, M. E. (eds). *Marine Community Ecology*. Sinauer Associates, Inc. 183–200.

Viehman, T. S., Grove, J. G., Blondeau, J., Cain, E., Edwards, K. F., Groves, S. H., Krampitz, N., Langwiser, C. Siceloff, L. Swanson, D., Towle, E. K., and Williams, B. (2023). National Coral Reef Monitoring Program, Biological Monitoring Summary – Florida: 2022. NOAA Technical Memorandum NOS CRCP 48. https://doi.org/10.25923/e6xg-1989

Viehman, T. S.*, Groves, S. H.*, Grove, L. J., Smith, S. G., Mudge, L., Donovan, C., Edwards, K. F., and Towle E. K. (2024). A quantitative assessment of the status of benthic communities on US Atlantic coral reefs using a novel standardized approach. *Bulletin of Marine Science 100* (2), 283–306. *equal authorship. https://doi.org/10.5343/bms.2022.0025

Appendix: Supplemental Information

NCEI Data Package References:

- **Florida 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 Florida [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. doi: 10.7289/v5xw4h4z

- **2024 Florida Benthic Data:**

  National Centers for Coastal Ocean Science (NCCOS); NOAA Southeast Fisheries Science Center (SEFSC) (2024). National Coral Reef Monitoring Program: Assessment of coral reef benthic communities in Florida Reef Tract from 2024-06-05 to 2024-11-15 (NCEI Accession 0306238). [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. https://www.ncei.noaa.gov/archive/accession/0306238

- **Florida Fish 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 fish communities in Florida. [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. doi: 10.7289/v52n50ks

- **2024 Florida Fish Data:**

  National Centers for Coastal Ocean Science (NCCOS); NOAA Southeast Fisheries Science Center (SEFSC) (2024). National Coral Reef Monitoring Program: Assessment of fish communities in the Florida Reef Tract from 2024-05-29 to 2024-11-26 (NCEI Accession 0306184). [indicate subset used]. NOAA National Centers for Environmental Information. Dataset. https://www.ncei.noaa.gov/archive/accession/0306184

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) collecting additional NCRMP samples in the Florida region, see:
Florida Keys National Marine Sanctuary, Mission: Iconic Reefs
Biscayne National Park and Florida Fish and Wildlife Conservation Commission
For NCRMP's partnership with a state-led benthic monitoring program, see:
Disturbance Response Monitoring