

**South Atlantic MPAs and *Oculina* HAPC:
Characterization of Fish Communities, Benthic Habitat, and Benthic Macrobiota**

Final Report for 2015-2017 NOAA Ship *Pisces* Cruises (15-02, 16-20, 17-02)

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EXECUTIVE SUMMARY

In 2009, the South Atlantic Fishery Management Council (SAFMC) established eight deepwater Marine Protected Areas (MPAs) along the outer continental shelf off the southeastern U.S. from south Florida to North Carolina. This report summarizes three research cruises that were conducted from 2015 to 2017 in support of this NOAA Coral Reef Conservation Program (CRCP) and SAFMC grant. Seven MPA sites were surveyed in this 3-yr project and included St. Lucie Hump MPA, North Florida MPA, Georgia MPA, Edisto MPA, Charleston Deep Artificial MPA, Northern South Carolina MPA, and Snowy Wreck MPA. Also the Devil's Hole Special Management Zone (SMZ) which was added in July 2017, and the *Oculina* HAPC and OECA were surveyed.

The cruises reported herein include: NOAA Ship *Pisces* Cruise 15-02, June 18-29, 2015; NOAA Ship *Pisces* 16-02, July 7-16, 2016; and NOAA Ship *Pisces* 17-02, June 19- July 5, 2017. Remotely Operated Vehicle (ROV) surveys, CTD casts, and multibeam sonar mapping were used to document and characterize the benthic habitats, benthic macrobiota, and fish populations within and adjacent to the MPA protected areas which are within the jurisdiction of the SAFMC. The Flower Garden Banks National Marine Sanctuary (FGBNMS) *Mohawk* ROV (operated by the Undersea Vehicles Program at the University of North Carolina at Wilmington) was used all three years.

Individual cruise reports for each of the three years were submitted previously (Harter et al. 2016; 2017; 2018) and provide detailed quantitative characterization of the benthic habitat, benthic macrobiota, and fish populations for each of the ROV dives conducted during each cruise. During the three cruises, a total of 79 ROV dives surveyed 50 sites within the MPAs and 29 sites to reefs adjacent to the MPAs. The total dive time was 115 hr, covering 84 km, and 15,178 digital images documented bottom habitat, macrobiota and fish. A total of 40 CTD casts were made. Twenty-two multibeam sonar surveys provided new maps covering a total area of 422 km² at depths ranging from 22 to 368 m. These sites had never been surveyed previously with multibeam sonar. Georeferenced maps were made for each site and were ground-truthed with the ROV dives. A total of 150 species of macrobiota were documented along with 163 species of fish.

These three cruises provide valuable data for these MPAs which may be referenced and compared to past and future research cruises to identify the long-term health and status of these important ecosystems. This report is submitted to the SAFMC, NOAA Fisheries, NOAA DSCRTP, NOAA CRCP, NOAA Mesophotic Reef Ecosystem Program, and NOAA Marine Sanctuaries to assist management on these habitats and key species.

ACKNOWLEDGEMENTS

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Technology Program (DSCRTP), and the NOAA Office of Marine and Aviation Operations (OMAO) which provided support for ship time. We thank the NOAA Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) at Harbor Branch Oceanographic Institute, Florida Atlantic University (HBOI-FAU). We especially thank the crew of the NOAA Ship *Pisces*, and the ROV operators (Lance Horn, Jason White, Eric Glidden) of the Undersea Vehicles Program at UNCW for their support and efforts which made these cruises a success.

DELIVERABLES AND DATA MANAGEMENT

This Final Report and the previous three Cruise Reports are the deliverables for this NOAA CRCP/SAFMC grant. To date, all data have been archived as required; these data include shipboard data, raw and processed multibeam sonar data, CTD, ROV navigation data, ROV video and digital images, ROV dive annotations, and HBOI Microsoft Access at-Sea Database (Table 1). A complete set of original data are archived by the Principal Investigators at NOAA Fisheries, Panama City (Stacey Harter) and HBOI-FAU (John Reed).

Table 1. Data archives for 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Principal Investigators- Stacey Harter, Andrew David, NOAA NMFS, Panama Lab; John Reed, HBOI-FAU.

Source	Description	Format
Ship	Multibeam (MB) sonar- raw	PDS
Ship	MB- processed files (corrected for tides and sound velocity)	CARIS, HDCS,XYZ (ASCII)
Ship	MB- GeoTIFF	TIFF
Ship	CTD	CSV
ROV	ROV video- digital copies of all ROV dives	External hard drives, DVD
ROV	ROV digital still images	JPEG; External hard drives
ROV	Event log	CSV
Science	ROV dive track polygons	ArcGIS shapefile
Science	Cruise database	Access MDB

CIOERT/NOAA COLLABORATION

The primary focus of this research cruise is to advance NOAA OER goals while complementing the management objectives of NOAA CRCP, NOAA DSCRTP, NOAA Mesophotic Reef Ecosystem Program, NOAA CIOERT, and the South Atlantic Fishery Management Council.

For these three cruises, science personnel included NOAA NMFS, Panama City Lab (Stacey Harter, Andrew David, , Heather Moe, Felicia Drummond), NOAA CIOERT at HBOI-FAU (John Reed, Stephanie Farrington), UNCW Undersea Vehicles Program (Lance Horn, Jason White, Eric Glidden), College of Charleston (Matthew Platt, Caroline Cooper, Mallory McCormack), Boston University (Marta Ribera), University of Miami (Alex Nyburg), and Savannah State (Sean Yeckley).

PROJECT OVERVIEW

The South Atlantic Fishery Management Council (SAFMC) and Department of Commerce through the Magnuson-Stevens Fishery Management Act have established eight deepwater Marine Protected Areas (MPAs), five deepwater Coral Habitat Areas of Particular Concern (CHAPCs), and the *Oculina* Coral HAPC along the outer continental shelf off the southeastern U.S. This project proposes to document and characterize the benthic habitat, benthic sessile biota, and fish populations within some of these protected areas and within the jurisdiction of the SAFMC.

In February 2009, the SAFMC implemented eight Type II MPAs between Cape Hatteras, NC and the Florida Keys to protect seven species of the deepwater snapper-grouper complex. The closures, however, will provide ecosystem-level benefits to the entire complex as well as protect the shelf-edge reef habitat they utilize. These consist of five species of grouper: snowy grouper (*Hyporhodus niveatus*), yellowedge grouper (*H. flavolimbatus*), warsaw grouper (*H. nigritus*), misty grouper (*H. mystacinus*) and speckled hind (*Epinephelus drummondhayi*), and two species of tilefish: golden tilefish (*Lopholatilus chamaeleonticeps*) and blueline tilefish (*Caulolatilus microps*). The shelf-edge MPAs are known to contain reef habitat exploited by these five species of grouper as well as deepwater soft bottom habitat used by the two tilefish species. These species are considered to be at risk due to currently low stock densities and to life history characteristics which subject them to substantial fishing mortality.

Bottom-tending fishing gear has been shown to have deleterious effects upon reefs and is now prohibited in the MPAs. These sites were designated by the Council to protect spawning grounds of reef fish. As such, decisions to create future area closures will be based upon the efficacy of these areas and the lessons learned during their implementation. Additionally, the MPAs contain extensive areas infested with the invasive lionfish, whose population continues to rapidly expand. Future monitoring will assist in evaluating the effects of this invasion on the ecosystem. Area closures constitute a politically charged issue that is unlikely to retain support without evidence indicating increases in the target species. This project will benefit coral reef ecosystems directly by improving our understanding of the impact of fishing activities on both fish and invertebrate species. In addition, five Spawning Special Management Zones (SMZx) were established to identify and protect spawning sites/aggregations for snapper grouper species. We surveyed one of them (Devil's Hole SMZ) in 2017.

The proposed monitoring program for the MPAs will ensure the Council remains well informed of changes within reef fish populations and coral habitats associated with these MPAs. NOAA NMFS conducted preliminary examinations of five of these potential MPA sites in 2004, 2006, 2007 and 2008. Post-closure data were also collected in 2009, 2010, and 2012 – 2017. The MPAs afforded the opportunity to obviate the criticisms of comparing MPAs with adjacent open-to fishing areas by examining the MPAs for four years prior to the closures. Since monitoring began in 2004, this project has produced population density estimates of targeted reef fish species within the boundaries of five of the eight MPAs and adjacent control areas, before and after closure.

GOALS

The primary goal of the cruise is to gather additional data on habitat and fish assemblages in the South Atlantic MPAs as part of a long term sampling program to document changes in these areas before and after implementation of fishing restrictions. Efficacy testing of this management tool will aid fishery managers in future use of area restrictions for the protection of valuable habitat and fishery resources.

This project is in direct support of Fishery Management Council activities associated with the characterization of protected shelf-edge and deepwater coral ecosystems and the efficacy testing of existing MPAs. It directly addresses the following CRCP National Goals and Objectives: obtain ecological information for coral reef fishes and spawning aggregations. Activities may include: a) studies that identify, map and characterize fisheries habitat (including essential fish habitat, habitat areas of particular concern, and spawning aggregation sites) in U.S. coral reef ecosystems, and assess the condition of the habitat; b) studies associated with coral reef areas that are currently, permanently, or seasonally closed to fishing, or that may merit inclusion in an expanded network of no-take ecological reserves; and c) multibeam sonar mapping and ground-truthing, habitat characterization, and monitoring of such areas, including deepwater coral reefs and hard bottom habitat.

Ultimately the primary benefits of these data are to characterize and document the habitat, benthic and fish communities within the shelf-edge MPAs along the southeastern U.S. from south Florida to North Carolina. These data may then be compared to previous and future research cruises and to areas adjacent to the protected areas to better understand the long-term health and status of these important deepwater coral/sponge ecosystems. These data will be of value to the SAFMC, NOAA Fisheries, NOAA DSCRTP, NOAA CRCP, NOAA Mesophotic Reef Ecosystem Program, and NOAA Sanctuaries for management decisions on these habitats and managed key species.

OBJECTIVES

The primary objective of the three research cruises (2015, 2016, and 2017) were to gather additional data on habitat and fish assemblages in seven of the newly designated shelf-edge, South Atlantic Grouper/Tilefish Marine Protected Areas (MPAs) and the *Oculina* HAPC and OECA. The data from these cruises are part of a long-term sampling/monitoring program to document changes in these areas before and after fishing restrictions were implemented. Efficacy of this management tool will aid fishery managers in future use of area restrictions for the conservation of valuable habitat and fishery resources. Specific objectives include:

- Conduct remotely operated vehicle (ROV) transect surveys of benthic habitat and fish populations
- Collect bathymetric data with the ME-70 multibeam mapping system on the ship to locate hard-bottom features and potential ROV dive sites
- Conduct total water column Conductivity-Temperature-Depth (CTD) profiles.

METHODS

Multibeam Sonar Mapping

NOAA acoustic surveys using Simrad ME-70 multibeam sonar were conducted at ROV dive sites where multibeam maps were not available. The main objective of the sonar surveys was to provide background maps to guide ROV exploration at dive sites. Data was processed using CARIS and converted to GeoTIFF images.

CTD Operations

Shipboard CTD and XBT casts were conducted at the multibeam sonar sites during the three cruises. A temperature recorder was also attached to the ROV that measured temperature and depth throughout the dives.

ROV Operations

In 2015-2017, the Flower Garden Banks National Marine Sanctuary (FGBNMS) *Mohawk* ROV (operated by UNCW Undersea Vehicles Program) was used on these cruises. ROV transect locations were selected by four methods:

- analysis of the limited multibeam bathymetric and acoustic backscatter maps produced within the preceding decade
- reef locations provided by colleagues
- sites found during previous years of this survey
- analysis of areas mapped on the current cruise.

ROV dives ranged from <1 to 3 hours in length, covering an average length of 1.06 km. The *Mohawk* ROV was equipped with a high-definition digital video camera (using fiber optic cable) mounted on tilt bar, a fixed digital still camera, and a temperature/depth recorder. The ROV was not outfitted with a manipulator and no samples were collected.

ROV Video Camera (*Mohawk*)

Video was recorded continuously throughout each dive from surface to surface with a high-definition video camera (Insite Pacific Mini Zeus Plus CMOS color zoom camera with 2,380,000 effective pixels). The camera was typically angled down ~30° to view both near and far to the horizon for fish aggregations and habitat, and had 10-cm parallel lasers for scale. High-definition video was recorded to external hard drives and used as the primary data source for viewing by the science team and quantitative analysis of the fish populations. A second standard definition copy was also recorded to a hard drive as well as to DVD for backup and easy viewing on any computer's DVD drive. The standard definition format had an On-Screen Display (OSD) video overlay which recorded time, date, ROV heading, and ROV depth, and was used as the "pilot" view. A microphone was used for continuous audio annotations by the PIs describing events, habitat, and biota which were recorded onto the video recordings and transcribed into a Microsoft Access 2010 database.

ROV Digital Still Camera (*Mohawk*)

Still images were taken for quantitative analysis of habitat and benthic macrobiota. A Kongsberg OE14-408 high-definition digital still camera, with resolution of 3648x2736 (10 Mp) pixels, was pointed down 90° from horizontal and had 10-cm parallel lasers for scale. Still images were

captured approximately every 2 minutes throughout the dive at a height of 1.3 m to provide relatively consistent area for each image (~1.5 m²). Each photo filename was coded with corresponding EDST time and date code (using Stamp 2.8 by Tempest Solutions[©]) which was imported into MS Access and linked to the ROV navigation data for site specific data of coordinates and depth and then imported into ArcGIS[™] 10.3.

ROV Navigation

In 2017, the *Mohawk* ROV used an integrated navigation system consisting of Hypack 2017 software on a 64-bit, 3.4 GHz, rack-mounted computer running Windows 7. Data from an LinkQuest Tracklink 1500HA USBL Acoustic Tracking System, POS-MV, along with the *Mohawk* ROV data fed into this computer. In 2015 and 2016, ORE Offshore 4410C Trackpoint II USBL Acoustic Tracking System was used. The Tracklink system communicates acoustically to an LinkQuest TN1505b transponder on the ROV to provide slant range, bearing, and depth from the support vessel. This system allows the ROV to assign latitude and longitude while in operation. The integrated navigation system provides real time tracking and orientation of the ROV and the ship to the ROV pilot and the ship's bridge for navigation. Georeferenced TIFF files obtained with multibeam sonar can be entered into Hypack as background files to display target sites and features of interest to aid in ROV and ship navigation. Hypack can also export ROV position data in real time as a NMEA data string. Ship and ROV positions in addition to the ROV depth, heading and altimeter data, are logged and processed after each dive day and provided to the scientist in an Excel spreadsheet file. All data documentation (digital images, HD video, dive annotations, and specimen collections) are georeferenced to ROV position by matching the time and date to the ROV navigation files.

ROV Survey Protocol

The primary objectives of each dive were to document benthic habitat, benthic macrobiota, and fish populations, and to conduct photo/video transects which were used for quantitative analyses of the habitat and biota. The general protocol included:

1. Video transects were used for analysis of fish population densities. Video transects kept the ROV as close to the bottom as possible (<0.5 m) with a speed over ground of ~1/4 knot. The camera was typically angled down ~30° to view both near and far to the horizon for fish counts.
2. Digital still images were used to quantify the percent cover of benthic macrobiota and benthic substrate. Images were captured approximately every 2 minutes throughout the dive during which the ROV hovered at a depth of ~1.3 m to provide similar field of view area for each image (~1.5 m²). The camera was pointed down 90° from horizontal and had 10-cm parallel lasers for scale.
3. Still images captured from the photo transects were analyzed using CPCe[©] software to determine relative percent cover of benthic macrobiota and habitat types. Non-transect photos, such as to record a specific species, were not included in the quantitative analyses. Poor and unusable photos (blurred, black, off bottom) or overlapping photos were removed from the quantitative analyses.
4. Underwater video was viewed in real time on the support vessel by investigators familiar with the local deep-water fauna; audio annotations describing habitat, benthic biota, and fish were recorded onto the video and transcribed into a Microsoft Access database.

5. Field notes and video images were reviewed and summarized to identify habitats and biota. These summaries were compiled in ArcGIS format and used to produce habitat maps.
6. All data documentation (digital images, video, and dive annotations) were georeferenced to ROV position after the cruise by matching the date and time to the ROV navigation files in our CIOERT At-Sea Access Database.

Benthic Analyses

Percent cover of substrate type and benthic macrobiota was determined by analyzing the quantitative transect images with Coral Point Count with Excel extensions (CPCe 4.1[©], Kohler and Gill 2006), and following protocols established in part by Vinick et al. (2012) for offshore, deepwater surveys in this region. Random points (50) overlaid on each image were identified as substrate type and benthic taxa. Substrate categories included: soft bottom (unconsolidated sand, mud) and hard bottom which was subdivided into rock (pavement, boulder, ledge), rock rubble/cobble (generally, 5-20 cm), and framework coral (standing coral colonies). All benthic macrobiota (usually >3 cm) were identified to the lowest taxa level possible.

For this report we used the following terminology: hard bottom is sometimes referred to as live bottom due to the amount of living organisms attached to these substrates (SAFMC 1998). Hard bottom provides anchorage for sessile or semi-sessile organisms (e.g., corals, octocorals, anemones, hydroids, sponges, algae). Coral is defined as hard corals (stony corals- Scleractinia) and other taxa with solid calcareous skeletons (e.g., Stylasteridae), as well as non-accreting taxa such as Octocorallia (Alcyonacea- “gorgonacea”) and black corals (Antipatharia) (Lumsden et al. 2007).

Prior to point count analysis, all images were reviewed and a species list was made in a Taxonomic Photo Album using Microsoft Access (Reed and Farrington 2014). We included benthic algae and sessile macroinvertebrates including Porifera, Scleractinia, Octocorallia (Gorgonacea), Antipatharia, Corallimorpharia, Alcyoniina soft corals, other non-coral Cnidaria (hydroids), and Ascidiacea; and all mobile benthic macroinvertebrates including: echinoderms, mollusks, arthropods, and annelids. The following taxonomists have helped with some of the species identifications:

Sponges- S. Pomponi, C. Diaz, P. Cardenas, J. Reed

Cnidaria- S. Cairns, P. Etnoyer, C. Messing, J. Voss, M. Nuttall, D. Opresko, C. Moura, J. Reed

Algae- D. Hanisak, S. Reed, M. and D. Littler

Echinoderms- D. Pawson, C. Messing

Fish- A. David, S. Harter, F. Drummond, H. Moe

Some common taxa could be identified to genus or species level but many could only be identified to a higher level such as family, class, order or even phylum. Sponges, octocorals (gorgonians), and black coral are especially difficult to identify without a specimen in hand. In some cases, a general descriptive taxa was used, e.g., “brown lobate sponge” or “unidentified Demospongiae”, which could consist of numerous species. These designations should not be considered equivalent to species level and should not be used for diversity (H’) indices

calculations. Many deepwater species in this region look nearly identical, such as fan sponges which are polyphyletic and actually may include different orders or classes.

Protocol for Benthic Habitat Characterization

This protocol defines the habitat categories that were used to define and characterize the benthic habitats for the shelf-edge reefs and MPAs off southeastern U.S. within the jurisdiction of the SAFMC. The habitat categories were entered into the HBOI Microsoft Access at-Sea Database for each ROV dive site and used for PRIMER statistical analyses of the fish populations and benthic communities.

1. [*On/Off Reef*]: “On Reef” or “Off Reef”- Simple designation of when the dive is on Hard Bottom (=On Reef) vs Soft Bottom (=Off Reef). This designation is not for any individual photo, but for a zonation within the dive.
2. [*Habitat Zone= Geomorphology*]: This describes the geological feature; e.g., Ridge-West Slope, Ridge- East Slope, Ridge-Top, Soft Bottom. This category is used to plot the distribution of biota for each habitat zone at each dive site and to plot the dive track overlay on multibeam sonar maps in ArcGIS.
3. [*MPA Status*]: Dive site or transect is within a marine protected area (MPA) or is not within any MPA.
4. [*Depth*]: Depth range (m) of the dive.
5. [*Relief*]: LR= Low Relief (0- <1.0 m), MR= Moderate Relief (1-3 m), HR= High Relief (>3 m). This is modified from the SEAMAP designations of outer continental shelf benthic habitat. This category is dependent on the distance over which the depth change occurs. Relief is defined as the relative height of rock ledges, boulders, or rock outcrops. It can also indicate a region where a drop-off or slope of a mound or ridge occurs over a relatively short distance. This distance is generally in the range of 10-20 m, which is typically within the field of view of the ROV for observing fish schools.
6. [*Rugosity*]: LRu= Low Rugosity, HRu= High Rugosity. Rugosity here is defined as a degree of ruggedness of the rock bottom. This will be relative to the size of rock ledges, holes, crevices, which tend to provide the greatest fish habitat. High Rugosity on these shelf-edge reefs occurs primarily along the edges of the rock ridges where there are zones of fractured rock slabs, or zones of boulders or rock outcrops. Low Rugosity is the flat rock pavement typically found top of the ridges or at the base of the mounds and ridges. Low Rugosity also defines the rounded rock mounds and knolls found at some sites that are devoid of ledges and loose boulders. For the present, this will be a non-quantified relative term. Most of the multibeam sonar maps collected are of relatively low resolution (5-10 m) and cannot be used to quantify rugosity at this scale; high resolution (<0.5 m) contour multibeam maps would be needed to quantify this characteristic in the future.

7. [*Substrate*]: Table 2 is a modified subset of SEADESC Habitat Categories which was developed by the NOAA Deep-Sea Coral Program for use in analysis of deep-sea coral surveys (Partyka et al. 2007). The categories which are useful for characterizing deep coral habitat were modified to make them useful for the shelf-edge habitats. The presence of fauna was not included as it is quantified in the Point Count analyses. In the region of this survey, the habitat types included: rock pavement, pavement with ledges, pavement with sediment veneer, rock ledges and boulders, rubble/cobble, and soft bottom. This category is also used to plot the dive track overlay on the multibeam sonar maps in ArcGIS.

Table 2. Benthic habitat category codes (modified SEADESC).

Code	Habitat Name	Habitat Description
S	Soft Substrate	Unconsolidated sand/mud, unlithified
SR	Soft Substrate/Rubble/Rock	Soft substrate (>50% cover) with rubble and/or rock
R	Rubble	Rubble/cobble (~5-20 cm sized rock or coral)
RL	Rock/Ledges	Rocks, boulders, and/or ledges
P	Pavement	Rock pavement
C	Hard Corals	Live and/or dead colonial scleractinian coral; standing individual colonies, bushes, or thickets.
TH	Tilefish (blueline or golden; not sand tile)	Soft bottom with visually identifiable burrows
A	Artificial Substrate	Any artificial structure that provides habitat for fishes and/or invertebrates

Fish Population Analyses

Each dive was divided into transects based on benthic habitat characterization (see Protocol for Benthic Habitat Characterization above) so that each transect consisted of only a single habitat type. All fish were identified for each transect down to the lowest taxonomic level and counted. Transect area (m²) was calculated by multiplying the transect length (m) by the estimated field of view of the transect width (m). Transect length was determined by using the ROV tracking system and transect width was estimated for each dive using the paired lasers on the video camera. This varied with the visibility of each dive. Transect area was then used to calculate the density (# of individuals 1000 m⁻²) of each fish species.

Statistical Analyses

Multivariate analyses were used to determine differences in benthic macrobiota and fish assemblages among dives. All analyses were conducted in PRIMER 6 and based on guidelines of Clarke and Warwick (2001) and Clarke and Gorley (2006). The dive sites were compared by their Management Status (Inside MPA vs Outside MPA). For the benthic and fish analysis, CPCe percent cover data of the macrobiota and fish densities (# individuals 1000 m⁻²) were averaged by location inside and outside the MPAs (e.g., Inside Snowy Wreck MPA and Outside Snowy Wreck MPA). Then these data were square-root transformed to reduce the dominate influences of copious species to the similarity matrix.

Similarities between sites for both fish and benthic biota were then calculated using the S17 Bray-Curtis similarity index. A non-metric multidimensional scaling ordination (MDS) plot and a dendrogram with group-average linking were created showing the results of a concurrently run Similarities Profile (SIMPROF). Similarity Percentages (SIMPER) was utilized where possible to determine which species contributed to the dissimilarities among group pairs.

The DIVERSE routine in PRIMER 6 was also used on fish densities to examine differences in species diversity of fish assemblages among dives. Data that was gathered from this routine include total number of speices (S), evenness (J' = Pielou's evenness), and species diversity ($H'(\log_e)$ = Shannon-Weiner index).

RESULTS AND DISCUSSION

Study Areas

The three cruises in 2015, 2016, and 2017 took place on the continental shelf-edge of the South Atlantic Bight from central Florida to North Carolina, and within the jurisdiction of the SAFMC. Seven shelf-edge MPAs along with the *Oculina* HAPC and the newly designated Devil's Hole SMZ were surveyed (Figs. 1-6, Table 3). In addition, ROV surveys were also made on hard-bottom habitat of adjacent areas outside of some of the MPAs to provide comparative baseline data, inside vs outside of the MPAs. The Florida sites included the St. Lucie Hump MPA, North Florida MPA, and the *Oculina* OECA and HAPC. Dives off Georgia were made outside the Georgia MPA; no dives were made within the Georgia MPA which is primarily soft bottom and tilefish habitat. South Carolina sites included the Charleston Deep Artificial Reef MPA (twin barges artificial reefs), Edisto MPA, Northern South Carolina MPA, and the Devil's Hole SMZ. The North Carolina sites included the Snowy Grouper Wreck MPA, which includes both reef habitat on the western portion of the MPA and the Snowy Grouper ship wreck.

Table 3. List of ROV dive sites by state and MPA status (Inside MPA or Outside MPA) conducted during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02).

Site	# of Dives	Depth Range (m)
Florida	25	31.9-97
St. Lucie Hump MPA	1	72-97
Oculina Experimental Closed Area (OECA)	4	49-93
Oculina HAPC	7	54-96
North Florida MPA	7	31.9-66.1
Outside North Florida MPA	6	48-65.4
Georgia	7	59.5-75
Outside Georgia MPA	7	59.5-75
South Carolina	38	39.1-197.3
Charleston Deep Artificial Reef MPA (Barge 1)	2	76-88
Charleston Deep Artificial Reef MPA (Barge 2)	3	91-102
Edisto MPA	10	39.1-66.3
Outside Edisto MPA	8	41-56.1
Devil's Hole SMZ	3	68.3-137.8
Northern S. Carolina MPA	4	47.4-67
Outside Northern S. Carolina MPA	3	49-166
Northern S. Carolina MPA (iceberg scar site)	3	148.1-167.4
Outside Northern S. Carolina MPA (iceberg scar site)	2	167.1-197.3
North Carolina	9	56-260
Snowy Wreck MPA	5	56-105
Outside Snowy Wreck MPA	3	68.3-93.5
Snowy Wreck MPA (wreck site)	1	238-260
Grand Total	79	31.9-260

Cruise Summary

During the three cruises, a total of 79 ROV dives were conducted; 50 dives surveyed sites within the shelf-edge MPAs and 29 were conducted at adjacent non-protected sites. The total dive time was 115 hr, covering 84 km, and 15,178 digital images documented bottom habitat, macrobiota and fish.

CTD Operations

A total of 40 shipboard CTD casts were conducted at the multibeam sites during the three cruises (Figures 2-6). A recorder was also attached to the ROV on almost all dives between 2015 and 2017 that measured temperature and depth throughout the dives. CTD data are presented in the individual cruise reports (Harter et al. 2016; 2017; 2018).

Multibeam Sonar

Twenty-two multibeam sonar surveys provided new maps covering a total area of 422 km² at depths ranging from 22 to 368 m. (Table 4; Figs. 2-6). These sites had never been surveyed previously with multibeam sonar. Georeferenced maps were made for each of the sites and were ground-truthed with the ROV dives.

Table 4. Multibeam sonar surveys conducted during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02).

State/Name	No. Sites	Area (mi²)	Area (km²)	Min Depth (m)	Max Depth (m)
Florida	8	121.2	314.0	35.3	192.3
St. Lucie Hump MPA	1	9.7	25.0	47.7	128.9
Oculina Experimental Closed Area (OECA)	4	87.5	226.6	72.2	192.3
Oculina HAPC	2	17.8	46.0	60.2	113.2
Outside North Florida MPA	1	6.3	16.4	35.3	64.3
Georgia	2	5.3	13.8	49.5	82.3
Outside Georgia MPA	2	5.3	13.8	49.5	82.3
South Carolina	9	26.9	69.7	22.2	207.0
Charleston Deep Artificial Reef MPA (Barge 1)	1	0.7	1.7	93.2	105.3
Charleston Deep Artificial Reef MPA (Barge 2)	2	0.7	1.9	79.0	96.1
Edisto MPA	4	14.4	37.4	22.2	73.5
Northern S. Carolina MPA	1	9.3	24.0	34.0	64.2
Northern S. Carolina MPA (iceberg scar site)	1	1.8	4.7	147.4	207.0
North Carolina	3	9.6	24.9	57.8	368.8
Snowy Wreck MPA	2	9.4	24.4	57.8	135.5
Snowy Wreck MPA (wreck site)	1	0.2	0.5	175.2	368.8
Grand Total	22	163.1	422.3	22.2	368.8

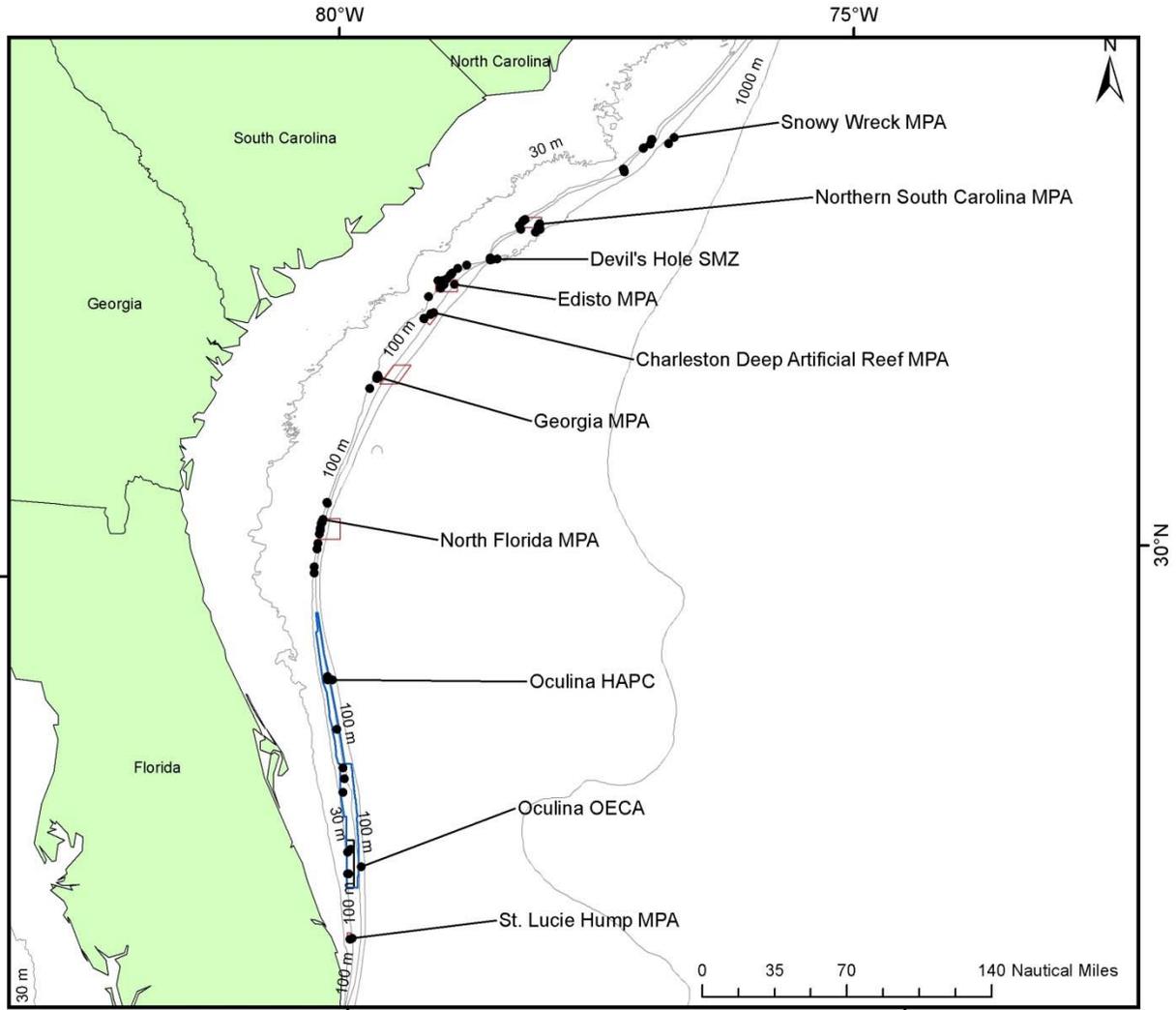


Figure 1. Locations of shelf-edge MPA sites and ROV dive sites off southeastern U.S. during 2015 - 2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Red polygons = SAFMC MPA sites; blue polygon = *Oculina* HAPC/OECA; solid dots = ROV dives.

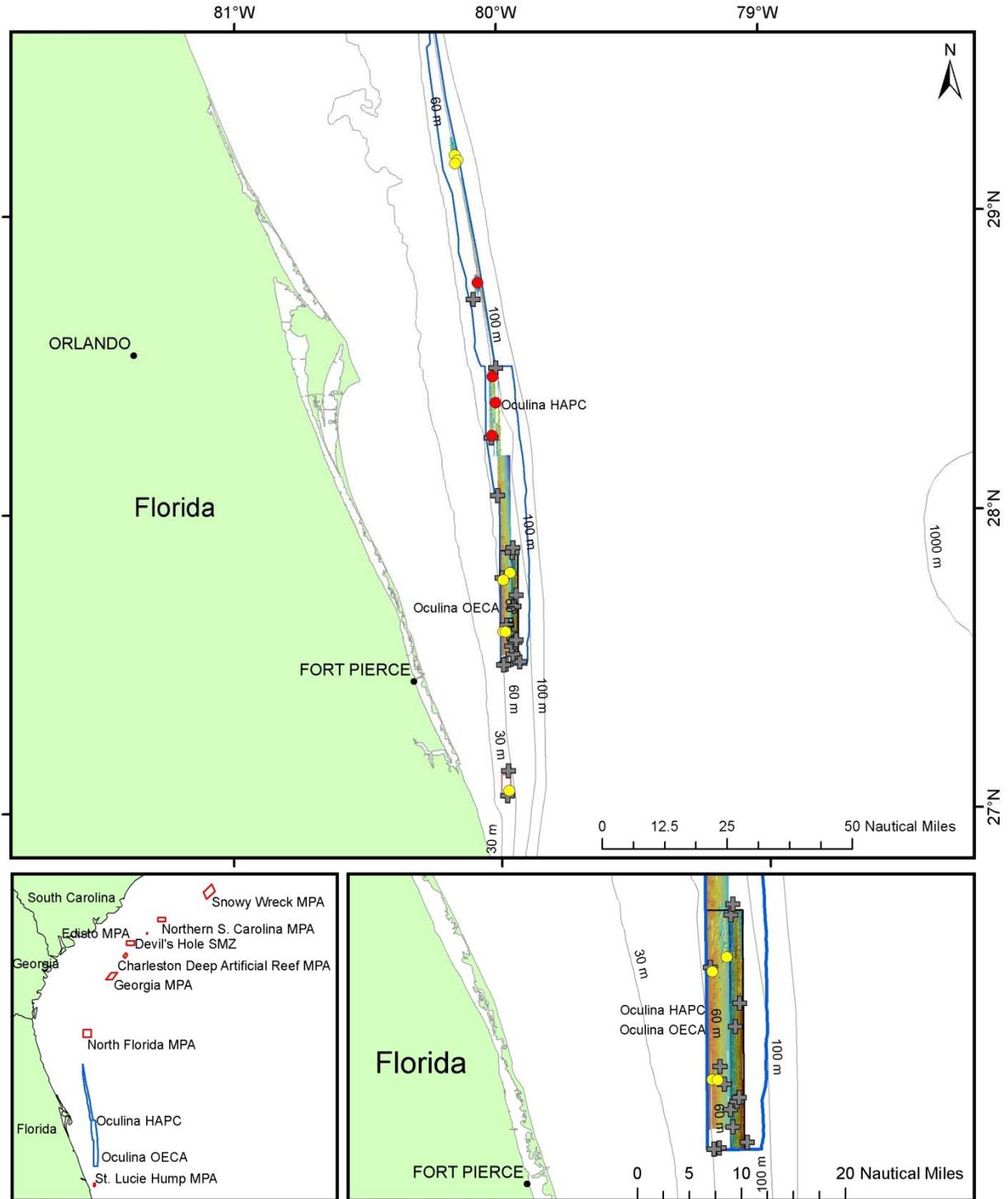


Figure 2. Locations of shelf-edge MPA sites and ROV dive sites off central Florida during 2015 - 2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Red polygons = SAFMC MPA sites; blue Polygon = *Oculina* HAPC, solid dots = ROV dives (red- 2015, yellow- 2016, green- 2017); crosses (+) = CTD casts.

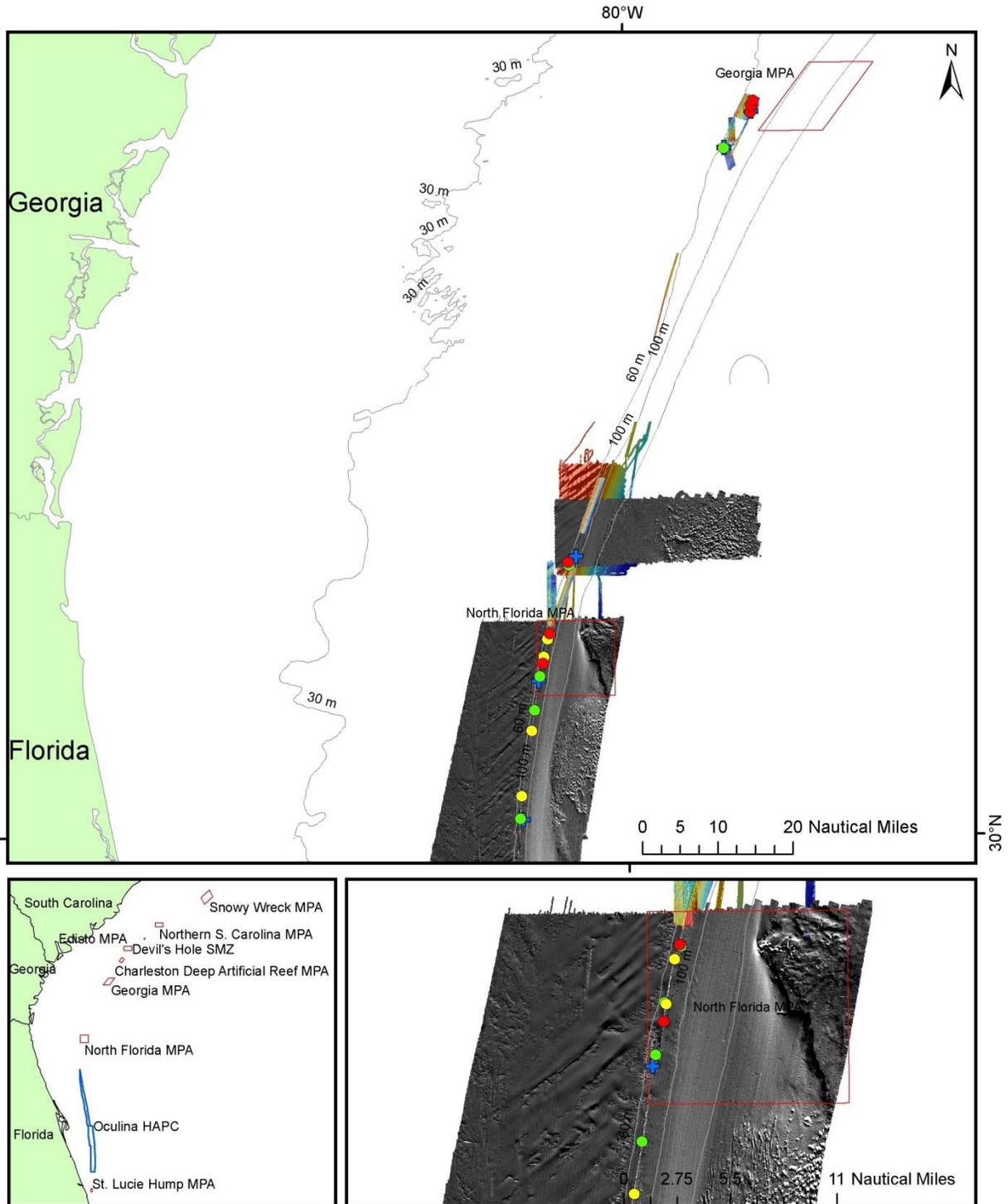


Figure 3. Locations of shelf-edge MPA sites and ROV dive sites off north Florida and Georgia during 2015 and 2017 NOAA Ship *Piscis* cruises (15-02, 16-02, 17-02). Red polygons = SAFMC MPA sites; blue polygon = *Oculina* HAPC, solid dots = ROV dives (red- 2015, yellow- 2016, green- 2017); crosses (+) = CTD casts.

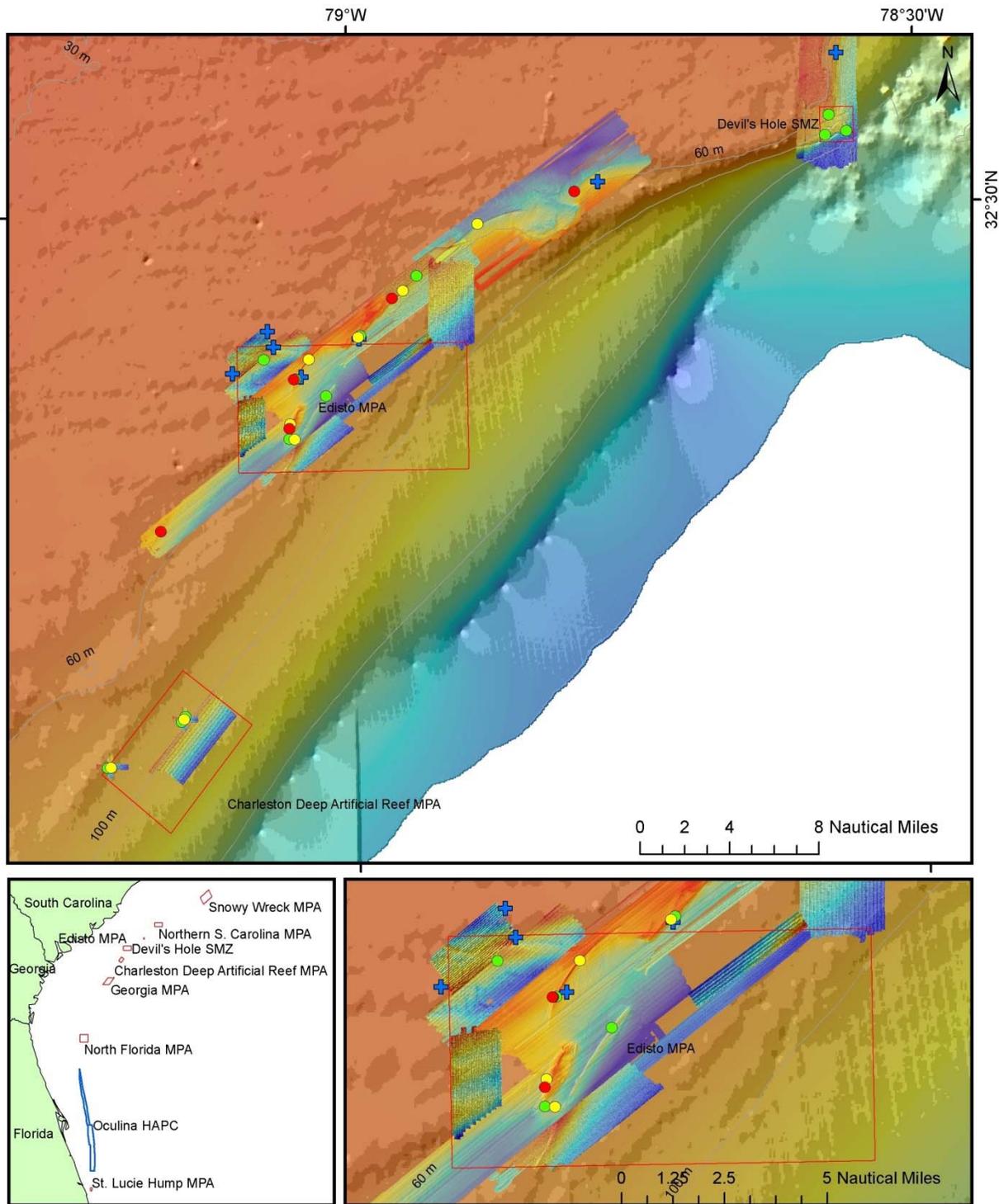


Figure 4. Locations of shelf-edge MPA sites and ROV dive sites off South Carolina during 2015 - 2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Red polygons = SAFMC MPA sites; blue polygon = *Oculina* HAPC, solid dots = ROV dives (red- 2015, yellow- 2016, green- 2017); crosses (+) = CTD casts.

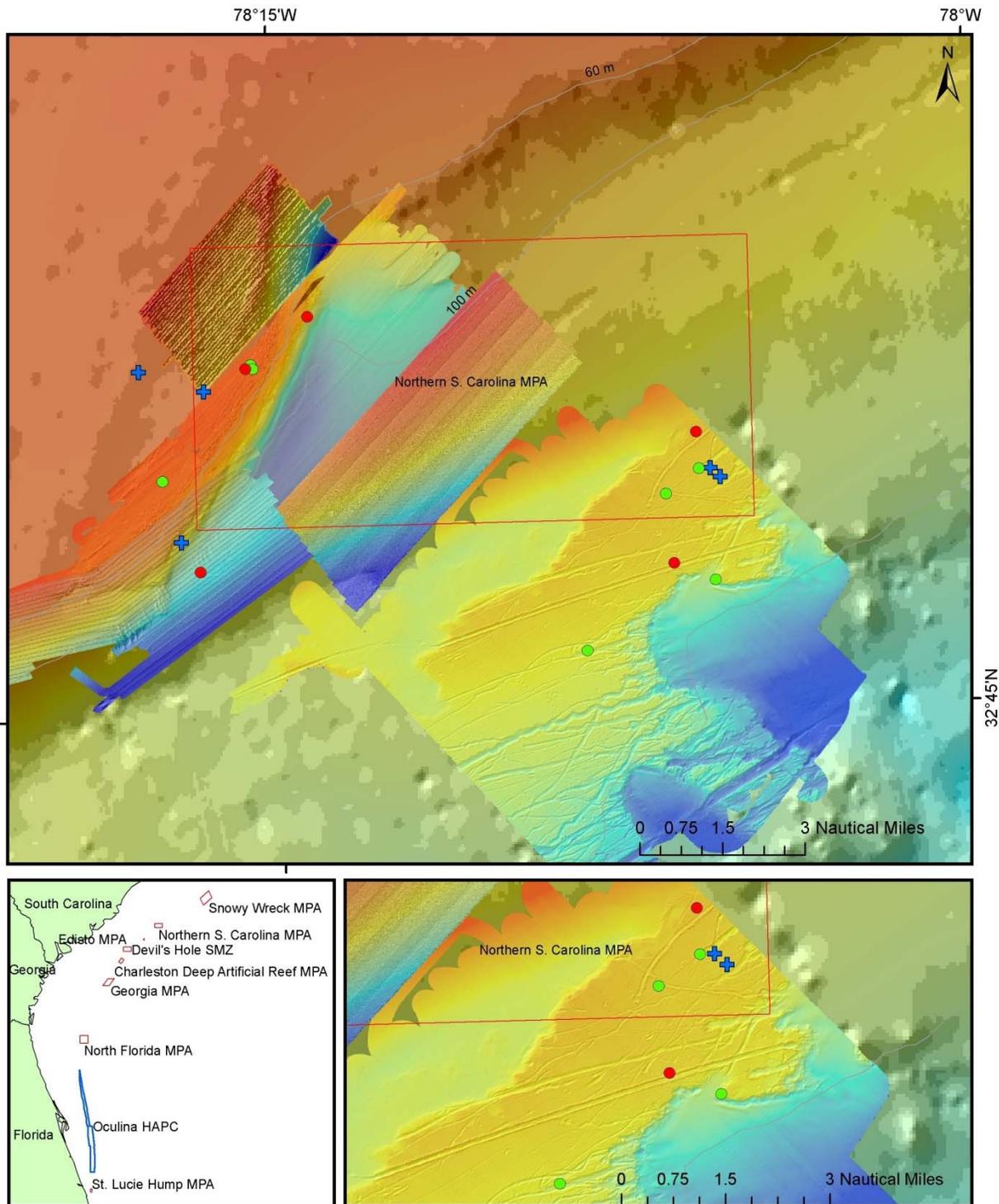


Figure 5. Locations of shelf-edge MPA sites and ROV dive sites off northern South Carolina during 2015 - 2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Red polygons = SAFMCA MPA sites; blue polygon = *Oculina* HAPC, solid dots = ROV dives (red- 2015, yellow- 2016, green- 2017); crosses (+) = CTD casts.

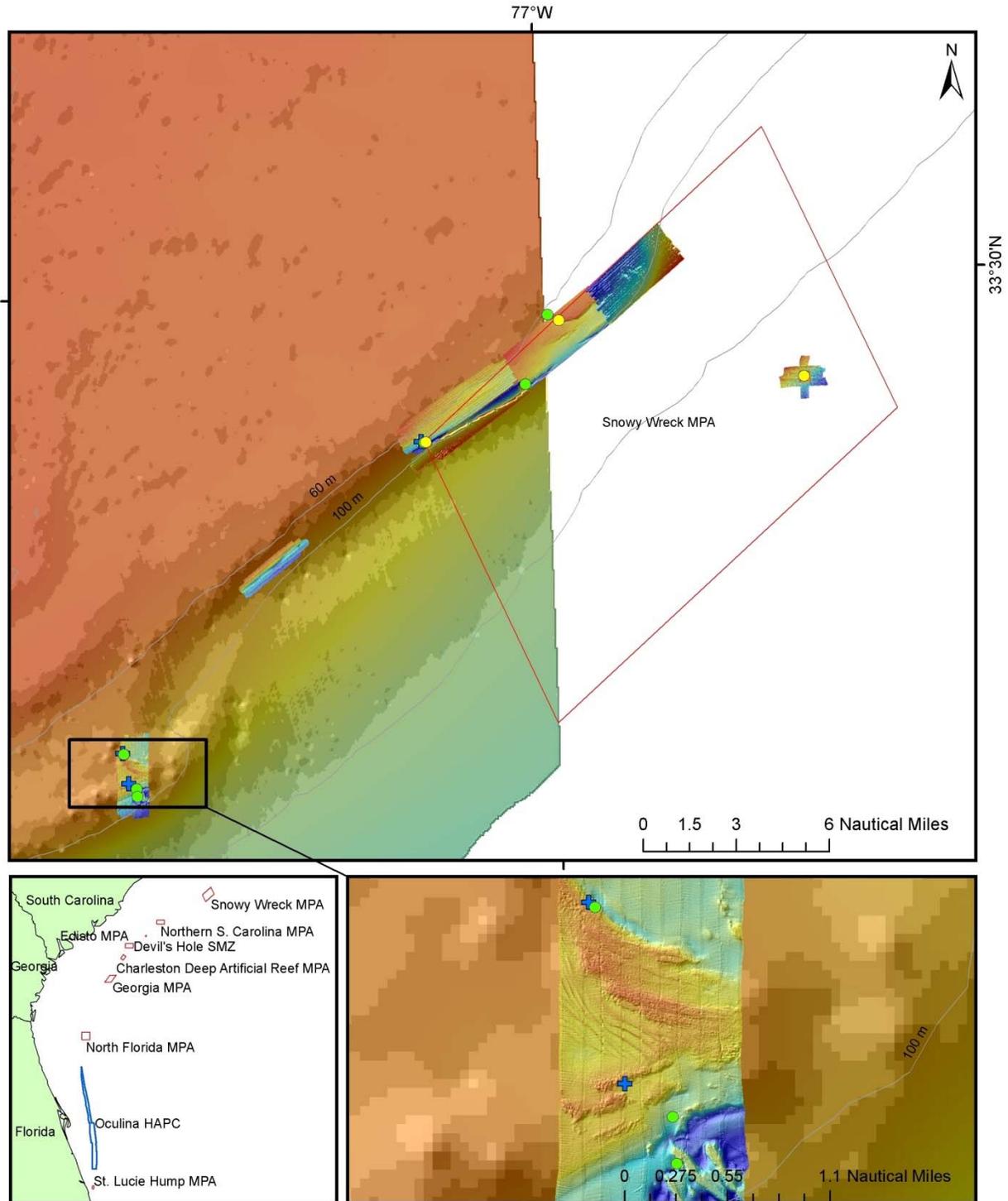


Figure 6. Locations of shelf-edge MPA sites and ROV dive sites off North Carolina during 2015 - 2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Red polygons = SAFMC MPA sites; blue polygon = *Oculina* HAPC, solid dots = ROV dives (red- 2015, yellow- 2016, green- 2017); crosses (+) = CTD casts.

MPA Site Descriptions

These are the first insitu observations of some of these newly designated shelf-edge MPA sites. The following are short descriptions of the geomorphology and benthos of each MPA site based on the ROV dives (from excerpts of the individual Cruise Reports; Harter et al. 2016, 2017, 2018).

St Lucie MPA

The multibeam (MB) sonar for the St Lucie Hump MPA shows a N-S escarpment along the southeast side of the MPA; one dive was made along this escarpment (Figs. 2, 7, 8, 9, 10). [Pisces_2016_St_Lucie_MPA_Grid- (Harter et al. 2017)]

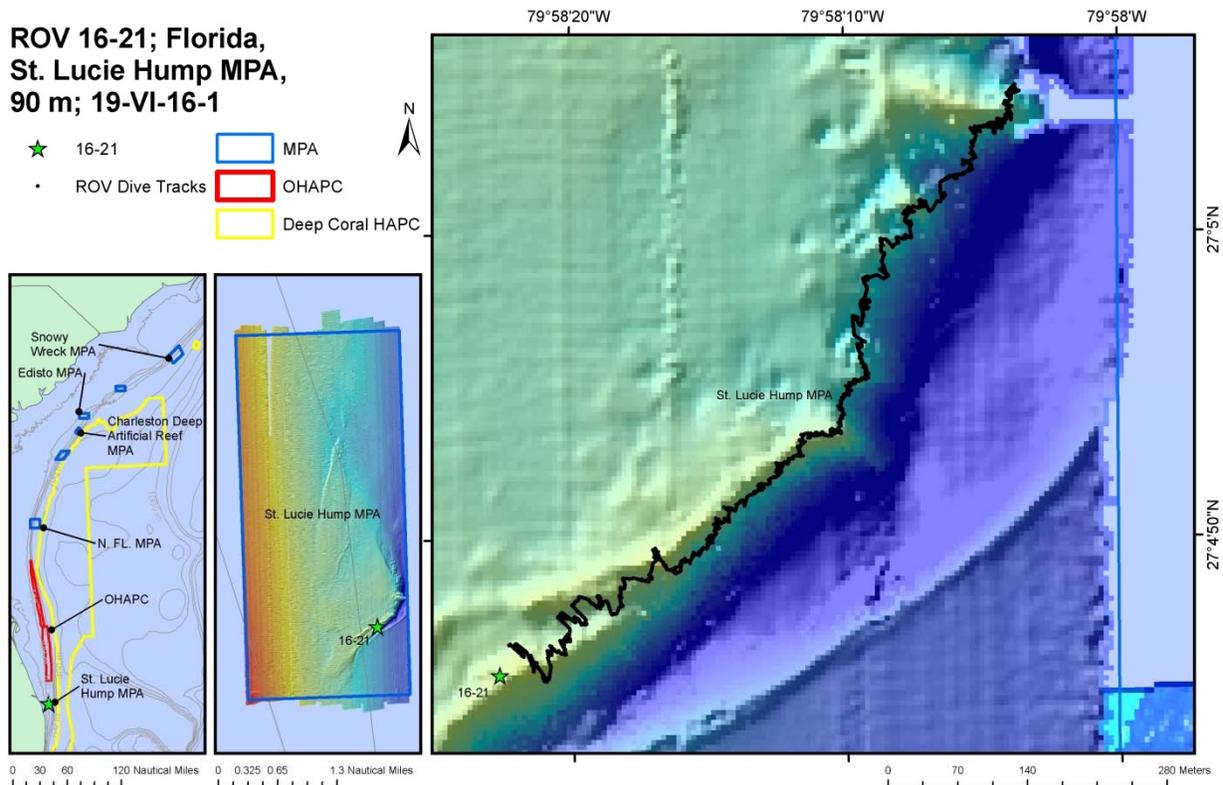


Figure 7. Map of St. Lucie Hump MPA with 2016 ROV dive site.

Dive 16-21: (Harter et al. 2017). Depth range: 84-96 m; new discovery of large live *Oculina varicosa* coral mounds, with several areas of ½ -1 m diameter, white live coral. Largest known population outside of the *Oculina* HAPC and south of Jeff's Reef, previously the southern most known *Oculina* coral reef in the U.S. Series of coral mounds along the N-S linear escarpment on new MB. Slopes 10-30°, some 45-60°. Some mounds consisting of 100% coral rubble and pavement with areas of 1-3 m rock outcrops and ledges. Dominant biota: Scleractinia- *Oculina varicosa* (1/2 to 1 m white colonies; dense populations in areas); Octocorallia- *Ellisella*, *Nidalia occidentalis*; Antipatharia- *Stichopathes lutkeni*; Demospongiae- yellow massive, *Geodia gibberosa*. Dominant fish: amberjack, anthiids, roughtongue bass, red barbier, tattler, cubbyu, eel (several spp), conger eel, bank butterflyfish, scorpionfish, spotted moray eel, twospot cardinalfish, no lionfish. Fishing gear: many *Oculina* corals wrapped with fishing line, trawl net.



Figure 8. St. Lucie Hump MPA; ROV 16-21; 84.4m; thickets of live white, *Oculina varicosa* coral colonies with scrawled cowfish.

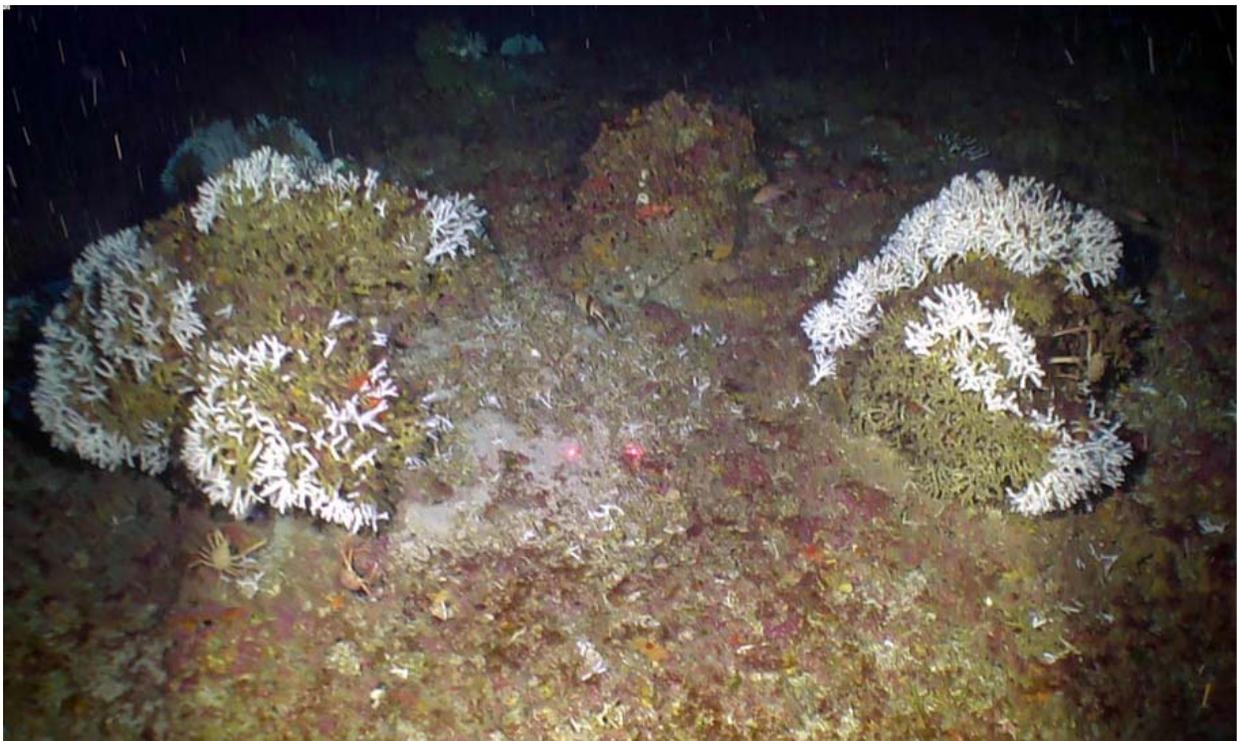


Figure 9. St. Lucie Hump MPA; ROV 16-21; 85 m; 1-m live *Oculina varicosa* coral colonies.

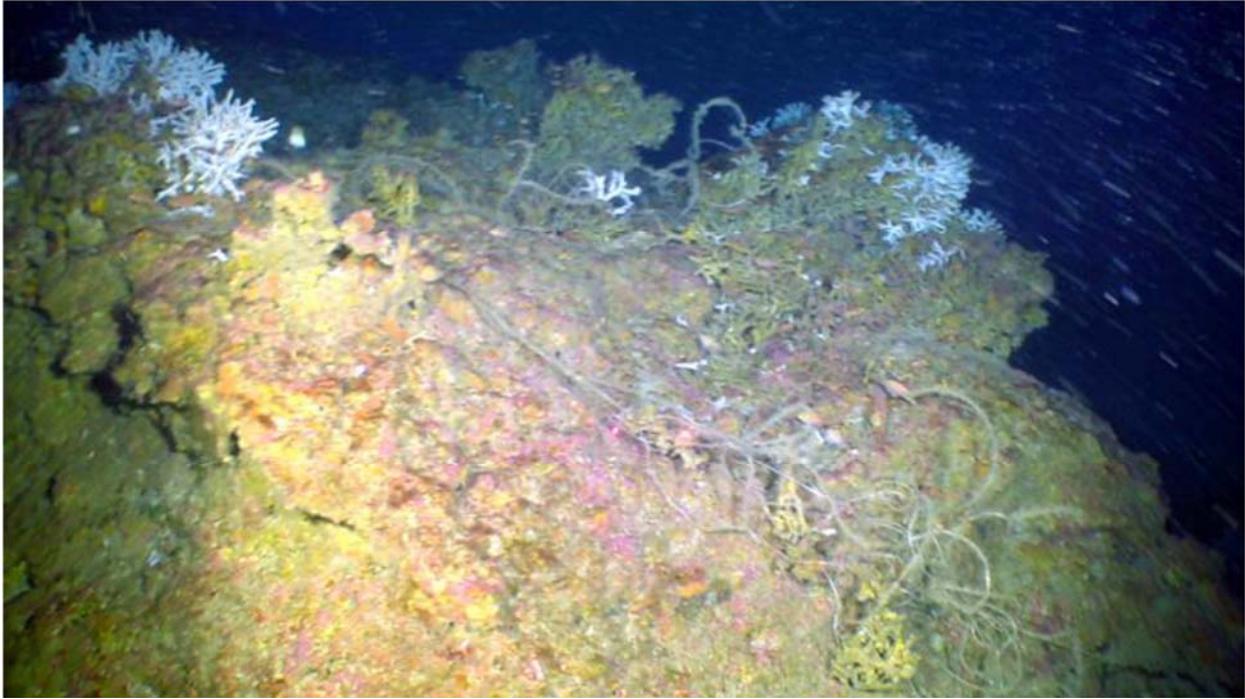


Figure 10. St. Lucie Hump MPA; ROV 16-21; 88 m; Thickets of large *Oculina varicosa* coral wrapped in fishing line.

Oculina OECA

The multibeam for the *Oculina* Experimental Control Area (OECA) shows a N-S series of *Oculina* mounds and hard bottom habitat through the center of the OECA; four dives were made along these mounds (Figures 2, 11, 12, 13, 14, 15).

[*Oculina*_MB_UNCW_2002_Grid (Shepard 2002), Pisces_2017_NOECA_grid (Harter et al. 2018), Pisces_2017_SOECA_grid (Harter et al. 2018), Pisces_2016_OECA_Grid (Harter et al. 2017)]

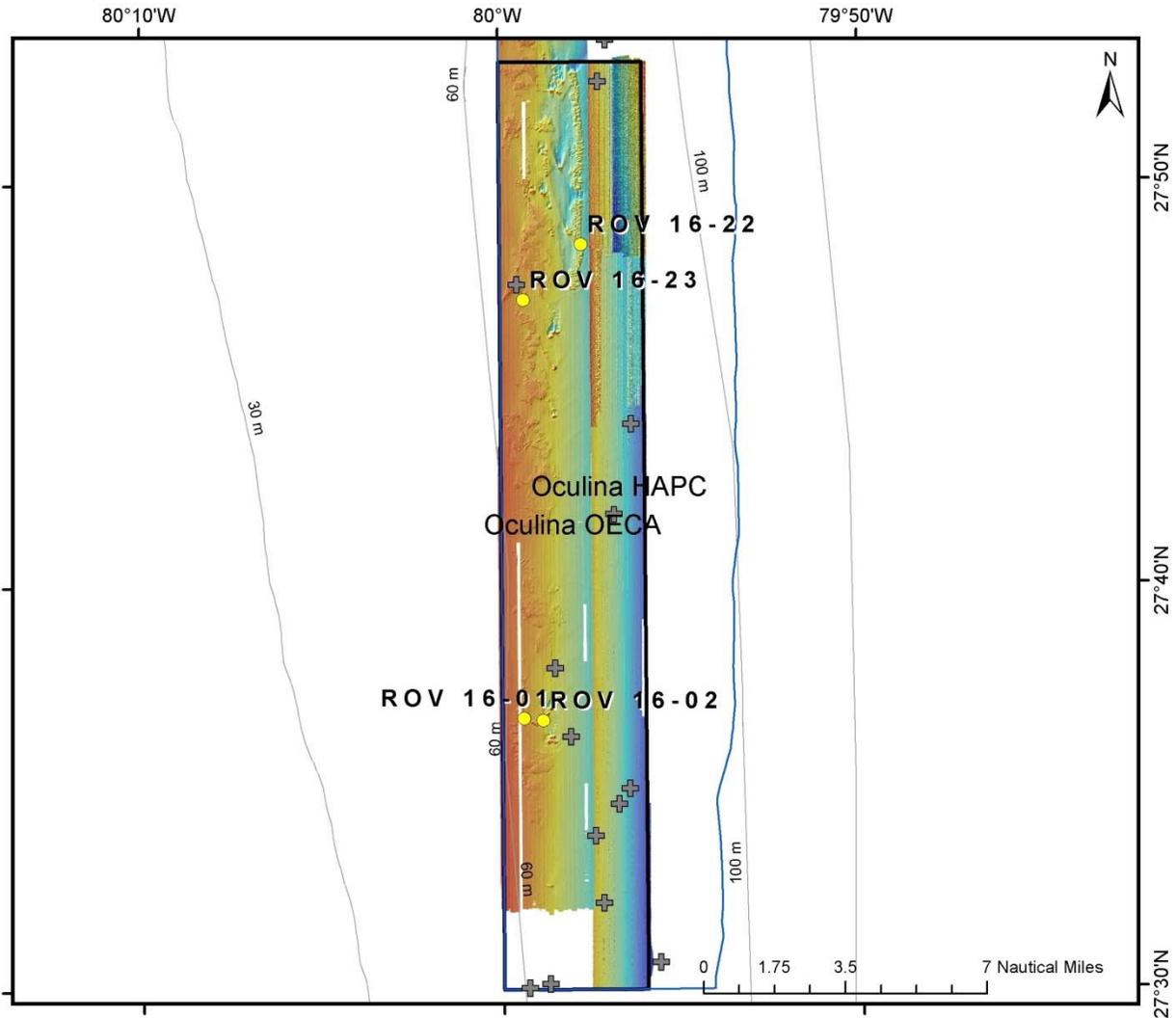


Figure 11. Map of *Oculina* Experimental Control Area (OECA) with 2016 ROV dive sites.

Dive 16-01: (Harter et al. 2017). Depth range: 67-73 m; multibeam map shows series of patches of low to moderate relief mounds and ridges to the west of Chapman's *Oculina* Reef. Transect from S to N across series of mounds. Mounds were all *Oculina* coral mounds, base 72-73 m, top 67-68 m, 2-3 m relief; 5-10° slope, low relief; 30-70% cover of coral rubble, 10-50 cm standing *Oculina*, sparse live coral 10-20 cm. Flat areas between the mounds was mostly flat sand with scallop shells (dead), occasional rock ledges and boulders, and most mounds with fish. Dominant fish: bank butterflyfish, reef butterflyfish, bigeye, black seabass, snowy grouper, triggerfish, yellowtail reeffish, scamp, vermilion snapper, tattler.

Dive 16-02: (Harter et al. 2017). Depth range: 60- 89 m; on bottom 2000 m south of Chapmans Reef South; low relief hard bottom; then transited N to South Reef of Chapmans, base 84 m depth, top 60.5 m. Base of reef and lower slope, 84-68 m- dozens to hundreds of live white *Oculina*, 10-25 cm diameter, 75 m depth. 68 m, south slope near eastern end of reef- hundreds of live *Oculina* 10-15 cm, dense *Centrostephanus* long spine black urchins, 6-9 spp of Demosponges, *Eucidaris* pencil urchins, coral rubble, standing dead coral and live coral.

Dominant fish: bank butterflyfish, reef butterflyfish, short bigeye, black seabass, scamp (common), blue angelfish, yellowtail reeffish, greater amberjack, saddleback bass, porgy, tattler, no lionfish. Fishing gear: pile of fishing line (recent), trawl net.

Dive 16-22: (Harter et al. 2017). Depth range: 78-92 m; transect along east edge of high relief, barrier reef mounds; starting near the southern end of the barrier reef zone. Series of NE-SW oriented mounds, very close together forming a barrier like reef. Peaks of larger mounds 76-78 m; smaller mounds are 80 m; valleys between the mounds are 88-92 m. Entire dive was 100% coral rubble, some mound peaks with standing dead coral in ridges with 1-ft relief. No live coral seen. Only macrofauna are cerianthid burrowing anemones, brittle stars, hydroids. Very few fish. This is where the rock shrimp trawling industry started in the early 1970s. Appalling and disturbing. Dominant fish: amberjack (common), tattler, longnose batfish, bank butterflyfish, reef butterflyfish, wrasse bass, yellowtail reeffish, apricot bass, scorpionfish, scrawled cowfish.

Dive 16-23: (Harter et al. 2017). Depth range: 59.7-74 m. 17 kn from SE, seas 3-4' from SE, surface current <1 kn; bottom current variable, <1/4 kn from N, and on higher peaks 1 kn from N; visibility 10-15 m. Start of transect on flat sand west of hard bottom on multibeam. Then got to area with moderate relief *Oculina* mounds, similar to high relief mounds but smaller; base about 70-72 m, 20-30° slopes, and peaks 66-68 m and narrow NE-SW oriented ridge, 3-4 m relief. One mound is 12 m tall, 59.7 at peak. Several areas of live *Oculina* coral, some 1/2-1 m diameter, white and healthy. Most live coral discovered to date within the OECA other than Jeff's Reef and Chapman's reef west. Some corals wrapped in fishing line. One area with piles of recent fishing lines and even portion of trawl net- this in an area closed to trawling since 1984. Mounds were 100% coral rubble, and standing dead coral, especially at peaks where 1' ridges of standing dead coral. Valley's between mounds 70-72 m, mostly rock pavement, coral rubble, smooth rock outcrops and 1-2 m ledges. North of the mound region is area of moderate relief rocky knolls, appear as flat top hard bottom mounds on the multibeam. This area is mostly pavement, coral rubble, standing coral, areas of live *Oculina*, and 1-2 m ledges. Dominant fish: 15-24 red snapper, 1 gag, 3 scamp, 1 unid. grouper, greenband wrasse, bank butterflyfish, scorpionfish, tattler, short bigeye, blue angelfish, grey triggerfish, 1 lionfish. Fishing gear: lots fishing line criss-crossed on bottom, trawl net.



Figure 12. *Oculina* Experimental Closed Area (OECA); ROV 16-23; 71.7m; large live *Oculina varicosa* coral colonies.



Figure 13. *Oculina* Experimental Closed Area (OECA); ROV 16-23; 71.8m; *Rypticus maculatus* whitespotted soapfish in *Oculina* habitat.



Figure 14. *Oculina* Experimental Closed Area (OECA) NOAA Ship *Pisces* cruise, June 7-22, 2016; school of red snapper.

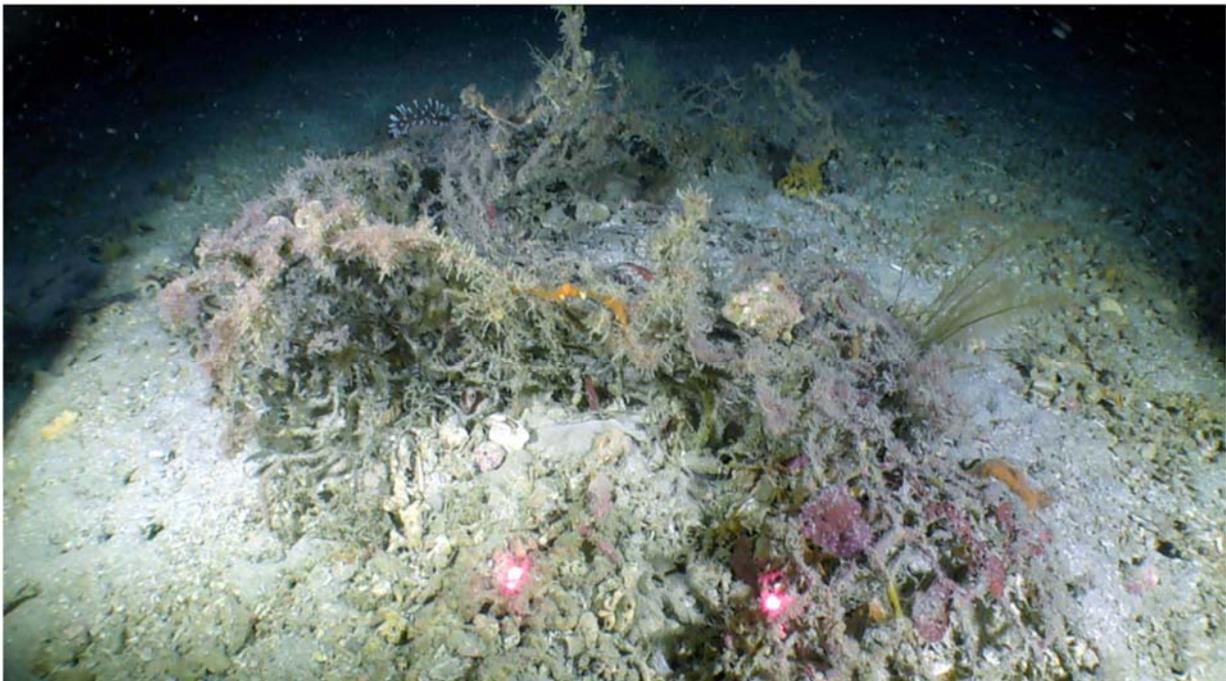


Figure 15. Lost fishing gear (top- longline, bottom- trawl net) discovered within the OECA during the NOAA Ship *Pisces* cruise, June 7-22, 2016.

Oculina HAPC

The multibeam for the *Oculina* HAPC shows a N-S series of hard-bottom mounds and *Oculina* reefs through the center of the HAPC; seven dive were made on these mounds (Figs. 2, 16, 17, 18, 19, 20).

[titusville_5m (Harter and Kracker 2011b), 3_Daytona2 and 3_Daytona8 (Harter and Kracker 2011a), *Oculina*_MB_UNCW_2002_Grid (Shepard 2002), Shepard_2005_*Oculina*AddOn (Shepard 2005), Pisces_2017_NOECA_grid, Pisces_2017_OECA_grid, Pisces_2017_SOECA_grid (Harter et al. 2018), Pisces_2016_Transect_Line_Grid, Pisces_2016_OECA_Grid, Pisces_2016_ExploratoryOECA_Grid (Harter et al. 2017)]

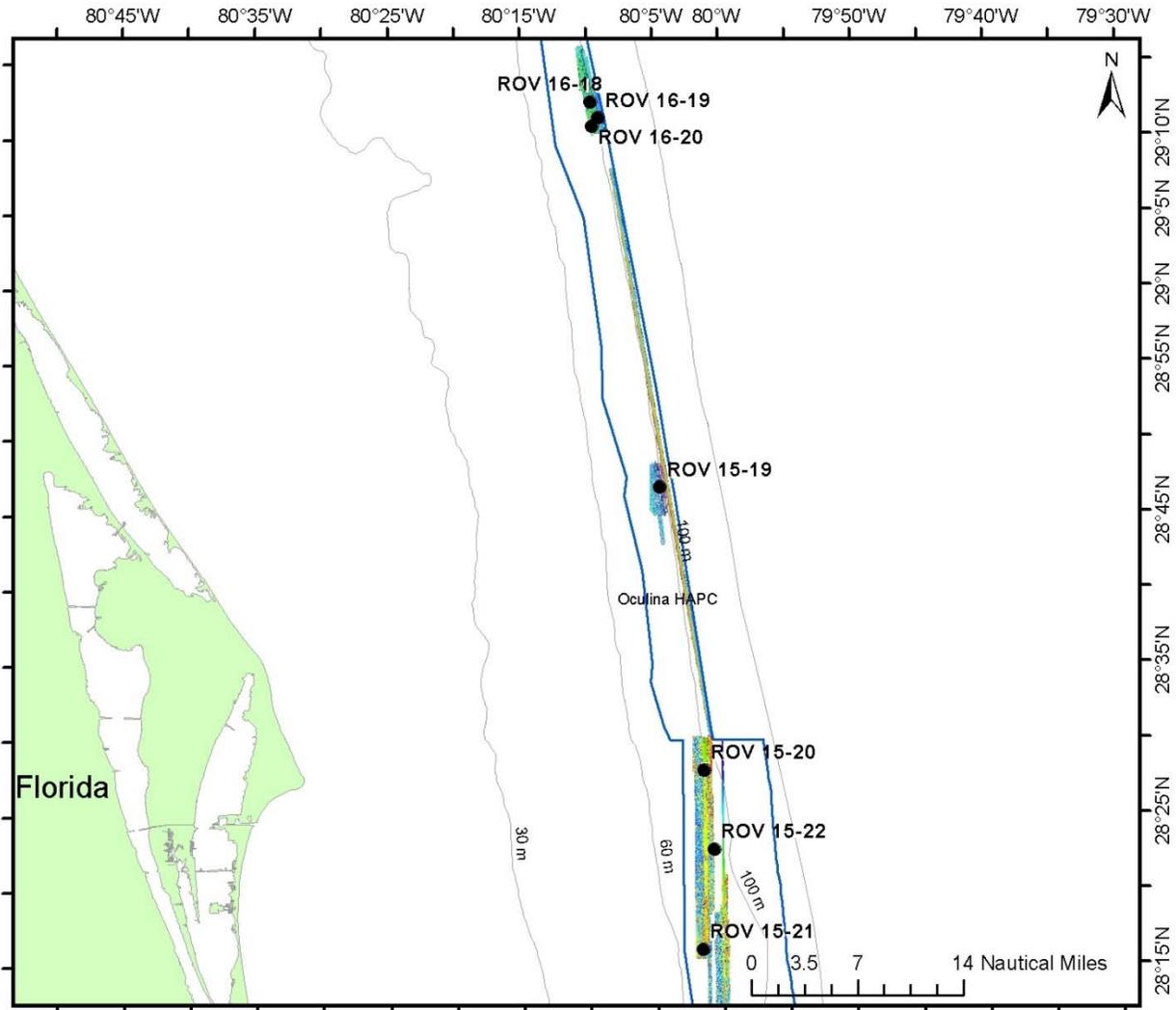


Figure 16. Map of part of *Oculina* Habitat of Particular Concern (OHAPC) with 2015 and 2016 ROV dive sites.

Dive 15-19: (Harter et al. 2016). Depth range: 68- 88 m; transect north along reef line. Transected 12 *Oculina* coral mounds, S to N, very little travel E or W. Due to current, could not explore along base of reefs. Could not explore the east slopes or along the base where the main ledges and fish are usually found. Could only travel north with the current so miss much of the

habitat. Visibility low (5-8 m) with the nepheloid particulates, mostly large gelatinous matter. Base of mounds 80-82 m; top of mounds, east- west linear coral rubble ridge, 68-70 m. Transects mostly on SW and S slope, and N slope. Slopes and top mostly 100% coral rubble, some sand patches, no exposed rock on upper slopes or top. Dense small biota encrusting on rubble. Dominated by hydroids, several species of black corals, red algae on upper slopes, *Stichopathes*, brittle stars. Live *Oculina varicosa* (5-15 cm diameter), white and healthy seen mostly near base and between the mounds on rock. Few fish seen. Valleys between the mounds is coral rubble, sand, and areas of low relief rock, 10-20 cm relief with more fish. Dominant fish: bank butterflyfish (common), short bigeye, yellowtail reeffish, bank seabass, scorpionfish, tattlers, snowy grouper-1, greenband bass, boarfish- first sighting on *Oculina* reefs, batfish; anthiids (rare), roughtongue bass; lionfish- first observations on *Oculina* banks- 5 total.

Dive 15-20: (Harter et al. 2016). Depth range: 69.4- 85.5 m; transect north across nine *Oculina* coral mounds. Valleys between mounds 80-82 m, peaks 69-72 m. All coral rubble on mounds; valleys coral rubble and areas of low relief rock pavement, low ledges. Dominant biota: Scleractinia coral- *Oculina varicosa*, live, white, 5-20 cm, scattered on most mounds; cluster white corals on upper slopes; Antipatharia- Antipatharia- white fan, *Tanacetipathes*- bushy, *Stichopathes lukeni*; Porifera- yellow and orange encrusting Demospongiae, Axinellida. Dominant fish: bank seabass, black seabass, bank butterflyfish, tattler, scorpionfish.

Dive 15-21: Harter et al. 2016). Depth range: 71- 74.5 m; multibeam map shows extensive area of low relief, flat topped mounds in west part of south Satellite of OHAPC. Multibeam shows 74 m along western base of mounds, and 68 m on top. Mounds- series of low relief, smooth rock knolls, from few meter diameter to >100 m. Peaks mostly 70-71 m. Some low relief ledges (10-30 cm) along west edges, but unable to get to these areas with the ship. Between the mounds mostly sand and/or rock pavement with sediment veneer, 73-74 m. Dominant biota: dense hydroids, black corals- *Stichopathes*, *Antipathes*; Porifera- encrusting sponges, axinellid bushy yellow sponges. Dominant fish: vermilion snapper, porgy, tattler, red snapper, gag grouper (several), blue angelfish, two tilefish burrows, greenband bass, bank seabass, black seabass- several, searobin, red hogfish, lionfish- 5. Fishing gear: long lines common; pile of anchor line.

Dive 15-22: (Harter et al. 2016). Depth range: 72 m; multibeam map shows continuous N-S row of 15 m tall *Oculina* mounds just west of the OHAPC boundary, but in the proposed Western Extension. Base about 84 m, peaks 70 m. ROV 10 m off bottom, drifting north at 1 kn; abort dive; unable to get to bottom or slow down.

Dive 16-18: (Harter et al. 2017). Depth range: 70.5-90 m; multibeam- *Oculina* North Extension off Daytona; east side of multibeam are series of high relief mounds, west of those are series of moderate mounds and hard bottom. Most of the mounds are 3-4 m relief, and series of rock knolls. Valleys between the mounds are series of low relief pavement and coral rubble. South slopes of mounds and peaks mostly 100% coral rubble, standing dead coral and occasional live coral. Base of north slope of some of the mounds have 1-3 m relief rock ledges, rock pavement, coral rubble with dense black coral, live *Oculina*, most 10-15 cm, some 30 cm. End of transect was in a scour surrounded by moderate relief mounds. Had very nice 1-3 m ledges, hard bottom with dense coral, black coral and fish. Dominant biota: Scleractinia- *Oculina varicosa*, live white, 10-20 cm, one 30 cm (count 24); Octocoral- *Diodogorgia*, yellow Plexauridae,

Titanideum frauenfeldii, *Nidalia occidentalis*; Antipatharia- *Stichopathes lutkeni*, *Antipathes atlantica*, *A. furcata*, *Antipathes* purple fan (abundant), *Tanacetipathes*. Dominant fish: 1 scamp, 3 snowy grouper, 2 lionfish, short bigeye, porgy, puffer, black seabass, tattler, blue angelfish, scorpionfish, roughtongue bass, bank butterflyfish, vermilion snapper, red hogfish. Fishing line common.

Dive 16-19: (Harter et al. 2017). Depth range: 75.5-97 m; multibeam shows a series of E-W oriented mounds forming a barrier reef along the east edge of the HAPC. Transect S to N across 13 major mounds and valleys. Most of the mound peaks at 76-78 m; valley between the mounds 87-92 m. South slopes and peaks were predominately 100% *Oculina* coral rubble, and standing dead coral mostly near the peaks, some mounds with dozens live *Oculina varicosa* colonies (10-15 cm). North slopes of most were hard bottom, rock pavement with 1-3 m relief rock outcrops and ledges. Dense cover of black corals, encrusting sponges and crustose coralline algae on the rock. Most of the fish are on the north side and ledge zone. Due to current could not transect E-W to view this zone of fish and habitat. Dominant fish: 1 gag, 8 scamp, 1 Warsaw grouper (5-6' est.), 14 lionfish, roughtongue bass, batfish, tattler, bank butterflyfish, apricot bass, scamp, lionfish, wrasse, amberjack (large schools), schools of vermilion snapper, red porgy; loggerhead turtle. Fishing line common.

Dive 16-20: (Harter et al. 2017) . Depth range: 68.5- 85 m; multibeam shows series of moderate relief mounds on west side of multibeam. Start of dive drifted west of the targeted transect, missing the mounds, but found low relief hard bottom, pavement, 1-2 ft rock boulders and habitat not apparent on the multibeam. Finally got back to the transect line over the mounds. Valleys between the mounds 78-82 m. Mound peaks 68-69 m; 100% coral rubble, standing dead coral and live *Oculina* common. Dominant biota: Scleractinia- *Oculina varicosa* (40 count), 15-25 cm, live, white; Antipatharia- *Stichopathes lutkeni*, *Tanacetipathes*, purple fan. Dominant fish: 1 lionfish, 7 red snapper, 1 snowy grouper, red hogfish, bank seabass, tattler, bank butterflyfish, grey triggerfish, short bigeye, orangeback bass, silky (?) shark.



Figure 17. *Oculina* HAPC; ROV 16-19; 88.5m; large Warsaw grouper and school of greater amberjack.



Figure 18. *Oculina* HAPC; ROV 15-19; 84 m; *Oculina varicosa* coral; white is a healthy live azooxanthellate colony.



Figure 19. *Oculina* HAPC; ROV 16-19; 82 m; Loggerhead turtle and greater amberjacks swimming over the *Oculina* reef.



Figure 20. *Oculina* HAPC; ROV 15-21; 70 m; school of gag grouper under ledge.

North Florida MPA

The multibeam for the MPA shows a N-S linear ledge along the west side of the MPA; six dives were made along this ledge (Figures 3, 21, 22, 23). Another moderate to high-relief hard bottom feature is apparent in the multibeam along the northeastern corner but no dives were made there. [Navy_2011_CONFIDENTIALUSWTR_Tif (US Navy 2011)]

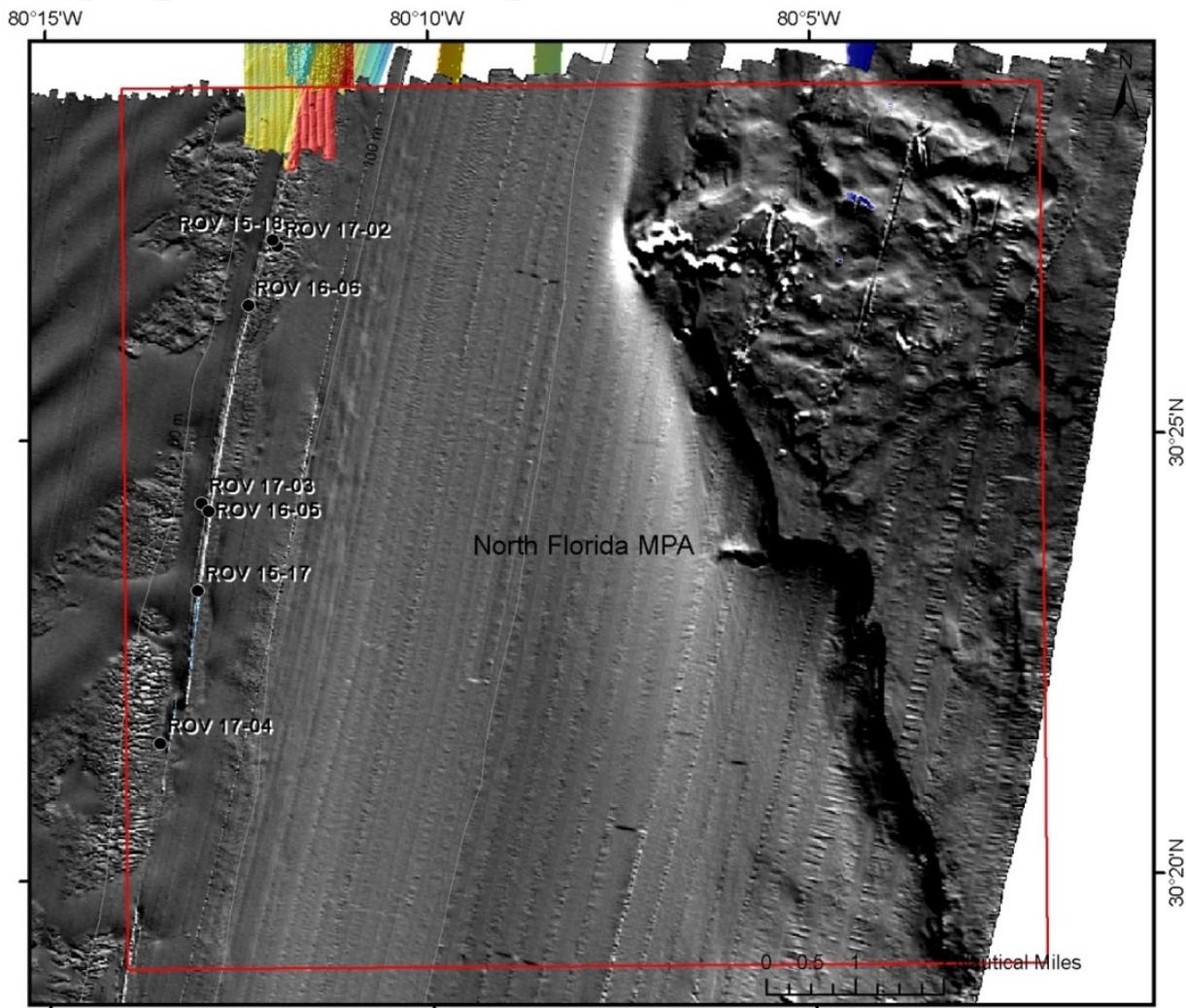


Figure 21. Map of North Florida MPA with 2015-2017 ROV dive sites.

Dive 15-17: (Harter et al. 2016). Depth range: 55.5- 64.6 m; transect heading N along ridge and slopes on east and west side. 62.5 m, east slope of ridge. Scattered boulders, ½-1 m diameter; 70% hard bottom cover, ½ m relief, 5-10 dg slope. 62 m- top of ridge. 70% hard bottom, low relief boulders, ½ m relief, 15 dg slope. Flat rock slabs, ½ m relief near top edge. Lower slope of scattered boulders extends about 10-15 m wide, then to sand. 64.5 m- sand at east base. 59 m- top of ridge; 100% hard bottom, flat fractured rock slabs, ½ - 1 m relief, upper slope 30 dg; lower slope, 50% hard bottom, ½ m boulders, extending over 10-15 m. Trouble station keeping with ship, pulled off bottom. Abort dive, poor ship station keeping. Dominant biota: Octocoral- *Diodogorgia*; Antipatharia- *Stichopathes lutkeni*, *Tanacetipathes*- bushy, 2'; Porifera- dense and diverse sponges, Demospongiae- starlet, Clathriidae, Axinellidae, *Ircinia strobilina*, *Ircinia*

campana, *Cinachyra*, *Geodia*, *Verongida*, *Aplysina*. Dominant fish: blue angelfish, tomtate, spotfin hogfish, reef butterflyfish, scamp (common), lionfish, squirrelfish, harlequin bass, gag (few), wrasse bass, bigeye, orangeback bass, twospot cardinalfish. Piles of fishing line common.

Dive 15-18: (Harter et al. 2016). Depth range: 56.3- 61.5 m; transect N along top and east slope of ridge. 60.2 m- lower east slope, flat rock slabs, ½ m relief, 5-10 dg slope, scattered boulders, 50% hard bottom. 100% cover of biota on rocks. 51.5 m- top of ridge, 100% hard bottom, fractured flat rock slabs, 1-3 m diameter, ½ m relief, 10 dg slope to east. East slope of boulder zone extends about 10-15 m. Sand at base, 58.7 m- east base. Dominant biota: Scleractinia coral- *Madracis mirabilis* or *Oculina varicosa*; Octocoral- *Ellisella*- whip, *Muricea*- 2' purple; Antipatharia- *Stichopathes lutkeni*, Antipatharia (white fan), *Tanacetipathes* (bushy 2'), *Antipathes furcata*; Porifera- Demospongiae- starlet, *Aplysina* sp. (purple fingers), Axinellidae, *Ircinia* spp., *Ircinia campana*, Clathriidae, *Holopsamma*. Dominant fish: dense fish, flying gurnard, juvenile french angelfish, spanish hogfish, cowfish, blue angelfish, scamp (common), lionfish, spotfin hogfish, tomtate, squirrelfish, amberjack, reef butterflyfish, grey triggerfish, wrasse bass, bicolor damselfish, tattler, queen triggerfish. Video of two lionfish, mouth to mouth, then chasing the other- male territoriality? Mating?

Dive 16-05: (Harter et al. 2017). Depth range: 56 to 64 m: multibeam shows N-S oriented ridge, 200 m wide; 73 nmi off Jacksonville inlet. Transect N to S along east slope and upper east edge of ridge. Top of ridge, 56 m; rock pavement, fractured, some rock slabs, 1/2 m relief; few fish on top. East slope- 15-20+ m wide slope, 10-30° slope; rock slabs, flat top, square flat top boulders, 1-2 m relief, 3-4 m relief over all slope, high rugosity. Dense biota dominating slope: Scleractinia- *Oculina varicosa*, 15 cm white; black coral- *Stichopathes*, *Tanacetipathes*; gorgonians- *Muricea*; sponges dense and diverse. Dominant fish: large schools of vermilion snapper, yellow goatfish, tomtate, grey snapper, gag-several, scamp (common); lionfish (not abundant), several scamp (grey head super male color phase), blue angelfish, reef butterflyfish, bank butterflyfish, yellowtail reeffish, various reef fish, spotfin hogfish, longsnout butterflyfish, porcupinefish, flying gurnard, graysby. Fishing line.

Dive 16-06: (Harter et al. 2017). Depth range: 56 to 58 m; multibeam shows narrow N-S ridge but with broad terrace on the east side, total width 700 m. Transect N to S along the narrow ridge top and east slope. Compared to Dive 5, this site had low relief, low rugosity and much fewer fish. Most of the habitat was low relief, flat square boulders, <1/2 m relief, flat bottom, low rugosity. Top of ridge, 56 m, base 57-58 m. Very few fish in these areas. Some areas with slight slope 5-10°, 1-2 m relief overall, top 56 m with flat slabs and boulders with <1 m relief; these regions had dense schools of tomtate; but fish were sparse overall. Dominant fish: tomtate, few scamp, hogfish, blue angelfish, reef butterflyfish, squirrelfish, rock beauty, mutton snapper, jackknife fish, flying gurnard, lionfish (few). Fishing gear: longline.

Dive 17-02: (Harter et al. 2017). Depth range: 56-61 m; multibeam map shows N-S linear ridge along west side of MPA. Transect along ridge heading N. Visual observation does not match the multibeam very well. ROV navigation is off by 10-30 m. No definitive west facing ridge as the multibeam shows. Multibeam is low resolution Navy tiff image, not xyz, made in 2011, and ledges may have filled in with sediment since then. 56 m, crest of west ridge, fractured square rock blocks, 3-4 m diameter, 1-2 m relief; West face- single ledge, 1-2 m relief. Dominant biota:

dense biota, 90% cover; *Stichopathes*, *Tanacetipathes*, Didemnidae, *Filograna*, *Schizoporella*, thin encrusting sponges- Spirastrellidae, *Ircinia campana*, *Aplysina*, Axinellidae, Dictyoceratida, yellow *Cinachyrella*. Dominant fish: lionfish- 22, reef butterflyfish, blue angelfish, yellowtail reeffish, tattler, sharpnose puffer, tomtate, grey triggerfish, yellowhead wrasse; 4 scamp, 1 gag, 1 graysby, 2 hogfish, amberjack. Fishing line.

Dive 17-03: (Harter et al. 2018). Depth range: 54-57 m; multibeam map shows N-S linear ridge along west side of MPA. Transect along ridge heading N; south of ROV 02. West edge of ridge; top 54 m, base 56 m. Jumble of fractured square rock, 1 m relief, rugose. Dominant biota: Octocorals- *Muricea*, *Swiftia exserta*, fields of *Iciligorgia schrammi* (most are partly encrusted and dead); Antipatharia- *Tanacetipathes* (bushy, 30 cm, abundant), *Stichopathes* (abundant); Porifera- *Ircinia campana*, Spirastrellidae, *Aplysina*. Dominant fish: 11 lionfish, reef butterflyfish, blue angelfish, yellowtail reeffish, tattler, tomtate, grey triggerfish; red snapper, 1 scamp, 5 gag, amberjack (abundant), grey triggerfish with sand pit nests.

Dive 17-04: (Harter et al. 2018). Depth range: 60-63 m; multibeam map shows N-S linear ridge along west side of MPA. Transect along ridge heading N. West base of ridge, 62 m base, 60 m top. Scattered flat rock slabs, 2-3 m diameter, <1 m relief. 62 m, east face of ridge, 1-2 m relief, scattered fractured boulders, high rugosity, 30 dg slope. 60 m, top of east edge of ridge; dense jumble of fractured square boulders, 1-3 m diameter, 1 m relief; dense cover biota. Ridge only 20-30 m wide. Dominant biota: Scleractinia coral- *Oculina varicosa* (several, 1 m cluster; six 10 cm clusters) Antipatharia coral- *Tanacetipathes* (bushy, 30 cm, abundant), *Stichopathes* (abundant); Gorgonian coral- *Diodogorgia*, *Muricea*, *Nicella*, *Ellisella* whips (knocked down); Porifera- *Ircinia campana*, Spirastrellidae, *Aplysina*, *Aiolochoia crassa*, DSMT demosponge. Dominant fish: lionfish- 66, scamp-24, tomtate, blue angelfish, reef butterflyfish, spotfin hogfish, red snapper- >100, amberjack, gag- 3, reticulate moray, mutton snapper, squirrelfish, cornetfish, vermilion snapper, grey triggerfish. Fishing line.



Figure 22. North Florida MPA; ROV 15-18; 56.9 m; scamp grouper and lionfish on rocky hardbottom with black coral- *Tanacetipathes*, and gorgonian coral- *Muricea*.



Figure 23. North Florida MPA; ROV 16-04; 56.5m; scamp grouper and tomtates on rocky hardbottom.

Outside Georgia MPA (no dives made within the MPA)

The multibeam shows NE/SW linear ridges southwest of the MPA; seven dives were made along these ledges (Figs. 3, 24, 25, 26). No multibeam or ROV dives are available for inside this MPA. [NancyFoster_14_08_MPA_GA_Grid (Harter 2014; Harter et al. 2014; Reed et al. 2015); NF-10-15-ARF_Georgia_east_2m.bag (McFall 2010)]

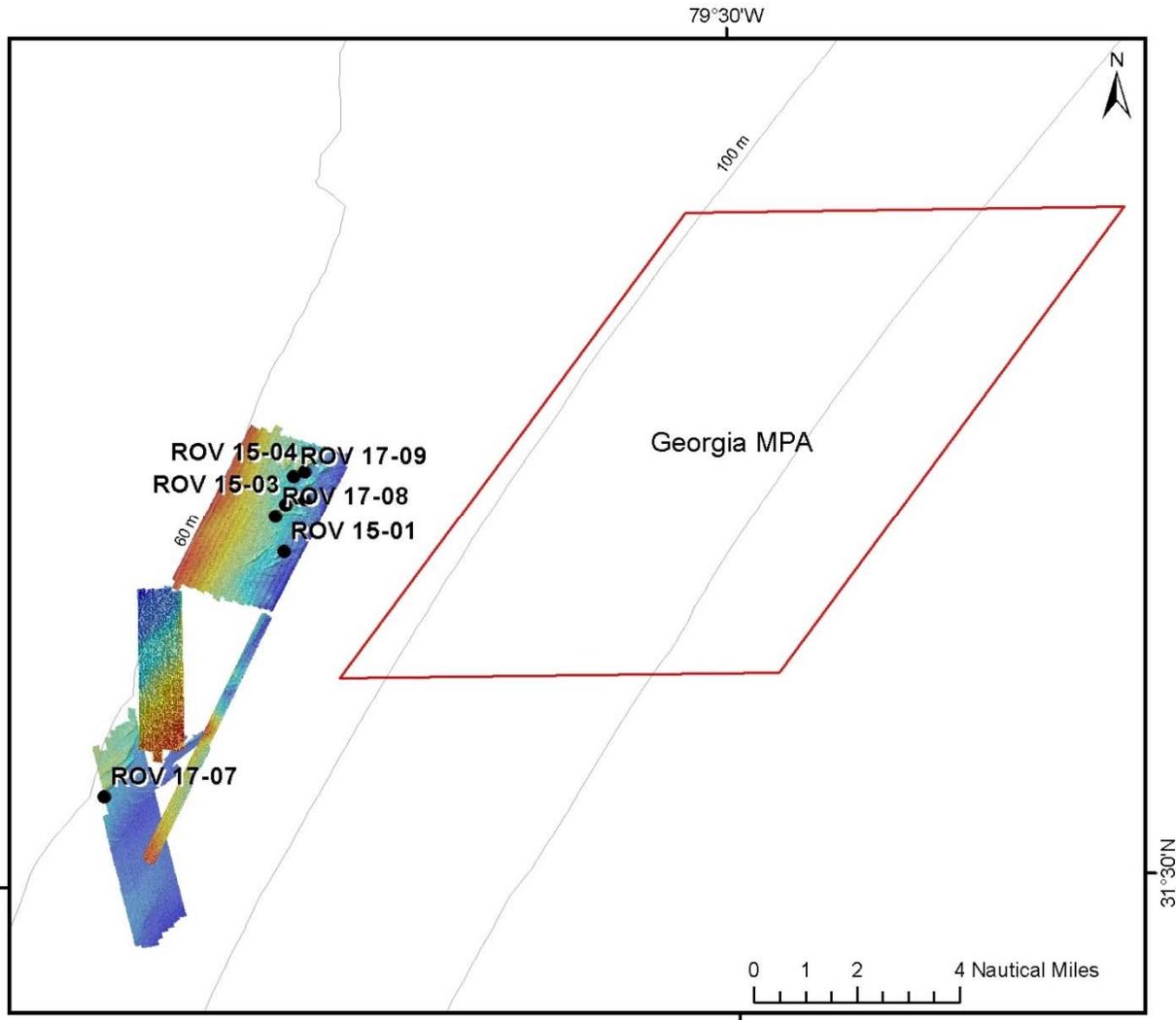


Figure 24. Map of Georgia MPA with 2015-2017 ROV dive sites.

Dive 15-01: (Harter et al. 2016). Depth range: 73-75 m; multibeam map shows two NE-SW oriented ridges, ~700 m long, at depth of 70 m on top to 73 m at base of east slope. NE end of reef, on east slope; 73 m. 10-30% cover hard bottom, pavement with sediment veneer, rubble. Half way along ridge on east slope; 73.5 m; patchy pavement, 30-50% cover, some 30 cm relief rock. Dominant biota: Octocorals- *Diodogorgia*, *Titanideum frauenfeldii*; Porifera- red and yellow encrusting demosponges, Clathriidae. Dominant fish: lionfish (common), bank butterflyfish, wrasse bass, short bigeye, few red snapper, scamp (common), red porgy (common), tattler, cubbyu, eels.

Dive 15-02: (Harter et al. 2016). Surface current 1.25 kn; unable to get to reef; dive aborted.

Dive 15-03: (Harter et al. 2016). Depth range: 70-72 m; multibeam map shows NE-SW oriented ridge, flat plateau on top. Transect along east edge and slope. NE end of reef, on east slope; 73 m. 10-30% cover hard bottom, pavement with sediment veneer, rubble. Head SW along ridge and slope; 70% hard bottom, pavement, few ½ m diameter boulders, with <30 cm relief. Dominant fish: lionfish, scamp, red snapper, cubbyu.

Dive 15-04: (Harter et al. 2016). Depth range: 66-68.5 m; multibeam map shows NE-SW oriented ridge, 1000 m long; 67-71 m. Transect along east edge and slope from NE end to south end. 66.2 m; top of east edge of ridge; 100% hard bottom, pavement, sediment veneer. 67.0 m; base of reef, pavement with sediment. Dominant biota: Octocorals- *Diodogorgia*, yellow Plexauridae, *Ellisella* sp., *Titanideum frauenfeldii*; black coral- *Stichopathes lutkeni*; Porifera- *Ircinia campana*, Axinellidae (3-5 spp), red and yellow encrusting. Dominant fish: lionfish, blue angelfish, red porgy, bank butterflyfish, eels, yellowtail reef fish, scamp (common), amberjack, black drum. Fishing gear- longline.

Dive 17-07: (Harter et al. 2018). Depth range: 62-69 m; multibeam map shows NE-SW linear ridge, 130 m wide, along the east edge of a shelf or plateau. Site Ga-4- west of site Ga-3 is second NE-SW ridge. Conduct two transects- Site GA-4, transect along ridge heading NE, then cut over to Site Ga-3. 65 m, on ridge according to multibeam. Low relief pavement, sediment veneer, no ledges. School of 50 red snapper. 65 m, Multibeam shows top of escarpment of ridge. Actual- flat, pavement, no ledges, few small cobble, 25 cm boulders, fairly barren. This is probably due to ROV navigation being off. Start photo transect of GA-3 site; 63 m, face of slope on multibeam; 100% pavement, no ledges. 67 m, multibeam- base of slope; low relief rock pavement, scattered 25 cm relief boulders. Dominant biota: Antipatharia- *Tanacetipathes* (bushy, 30 cm, abundant), *Stichopathes* (abundant), *Antipathes atlantica*; Gorgonacea- *Diodogorgia*, *Muricea*, *Nicella*; Porifera- *Ircinia campana*, Spirastrellidae, *Aplysina*, yellow sphere (Clathriidae), encrusting yellow and orange sponges, *Zyzya*. Dominant fish: Lionfish- 279, scamp- 6, hogfish- 4, gag- 2, graysby- 1, amberjack, tomtate, cubbyu, red snapper- 142, reef butterflyfish, tattler, short bigeye, blue angelfish, bank butterflyfish, sharpnose puffer, orangeback bass, cornetfish. Fishing line.

Dive 17-08: (Harter et al. 2018). Depth range: 69-70 m; multibeam map shows flat topped mound, 0.6 nmi long; transect heading east along south facing slope. At base of ridge, 69 m; flat sand, few 15 cm rocks; 90% soft bottom. Transect up to top of ridge; all flat sand, shell hash, few 10-20 cm relief outcrops. Top 68.5 m. 69 m, following transect line of 2014 where saw 30+ scamp. Dominant fish: lionfish- 50, red snapper- 4, gag- 1, moray, scamp- 1, spotfin butterflyfish, short bigeye, yellowtail reef fish, sharpnose puffers. Human debris: fishing line, trawl net, plastic mesh bags.

Dive 17-09: (Harter et al. 2018). Depth range: 55- 70 m; multibeam map shows flat topped mound, 0.5 nmi long, with NE-SW ridge along east facing drop off; transect heading NE along face of slope. Part of transect over same transect as dive 14-04 and 15-04. 68.5 m, hard bottom, pavement, sediment veneer, multibeam- south tip of ridge and mound. 68 m, flat rock pavement

with sediment, no ledges, few 10-20 cm ledges and outcrops. Dominant biota: Scleractinia coral- *Astrangia*; Antipatharia-*Stichopathes*; Gorgonacea- *Diodogorgia*, *Ellisella* whips (knocked down), *Titanideum frauenfeldii*; Pennatulacea- *Virgularia presbytes*; Porifera- *Ircinia campana*, Spirastrellidae, encrusting yellow and orange sponges, *Zyzya*, Clathriidae yellow ball. Dominant fish: lionfish- 76, red snapper- 20, tattler, reef butterflyfish, short bigeye, sharpnose puffer, spotfin butterflyfish, yellowtail reeffish. Human debris: fishing line, plastic mesh bags.



Figure 25. Georgia MPA; ROV 17-07; 62.7m; slipper lobster (*Scyllarides nodifer*).



Figure 26. Georgia MPA; ROV 17-07; 63m; red snapper and lionfish on rock outcrop.

Charleston Deep Artificial Reef MPA

Two barges were sunk between April and June in 2014 just prior to our ROV dives. The barges ended up west of the planned MPA; the MPA boundaries will be altered to include the barges (per SAFMC). Multibeam sonar for Barge 1 [NancyFoster_14_08_Barge1_Grid (Harter 2014; Reed et al. 2015)] shows an intact barge oriented NE-SW with a debris field just off the SW corner, and laying on a relatively featureless, flat bottom. Multibeam sonar for Barge 2 [NancyFoster_14_08_Barge2_Grid (Harter 2014; Reed et al. 2015)] also shows an intact barge laying NE-SW on a flat bottom. A hole is apparent at the NE corner (possible where the barge hit bottom), and two mound features are off the SW corner. Both barges are approximately 80 m long and 20 m wide. Five dives were conducted on these two barges (Figs. 4, 27, 28, 29).

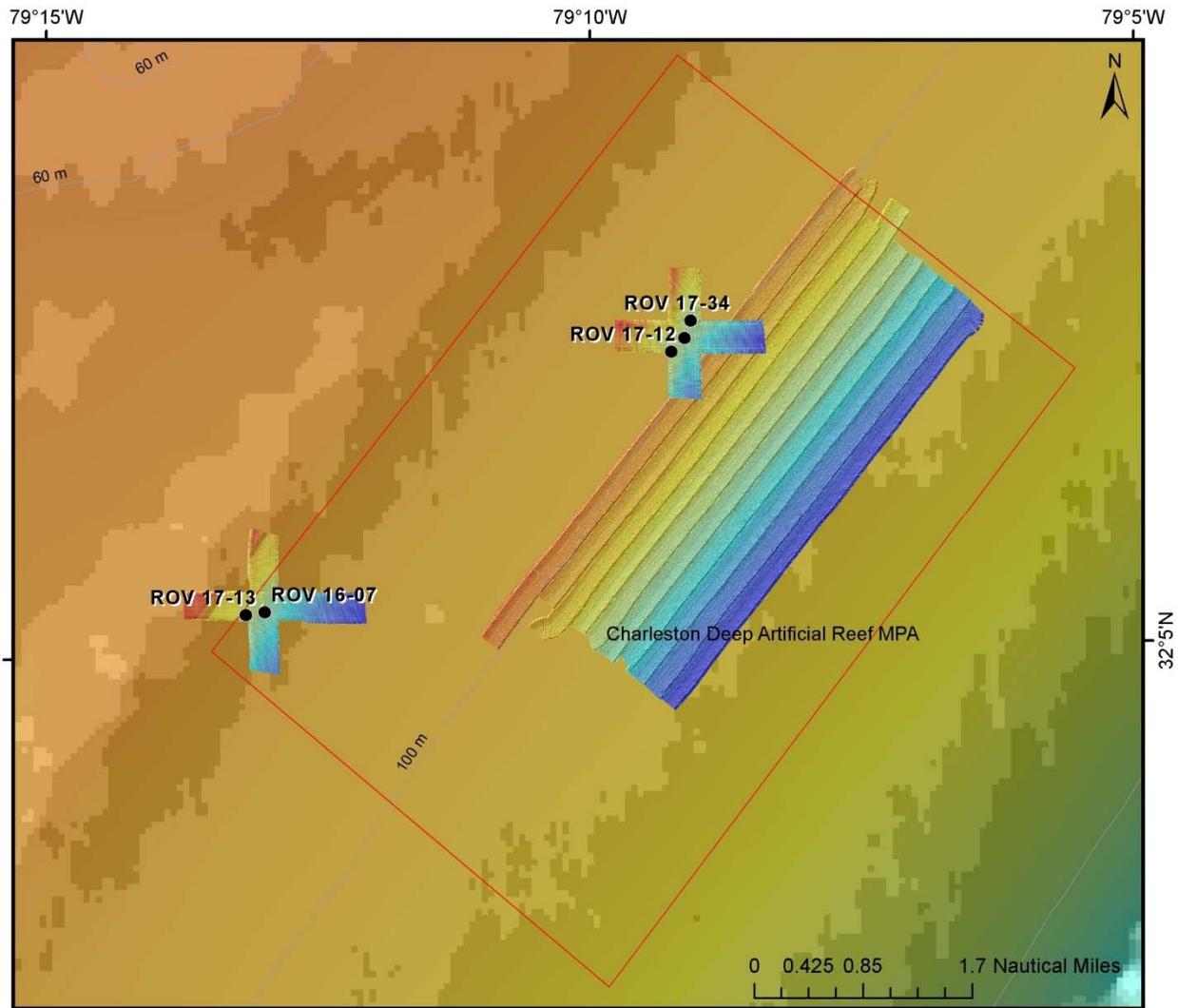


Figure 27. Map of Charleston Deep Artificial Reef MPA with 2016 and 2017 ROV dive sites.

Dive 16-07: (Harter et al. 2017). Depth range: 85.5 to 88 m; transect along south side of barge, from SE corner to SW corner, then about 50 m to loose container on bottom. Multibeam shows Barge 1 laying NE to SW, with 2 containers loose on bottom to the west, surrounded by flat featureless bottom. Sides vertical metal, about 5 m tall, covered nearly 100% w small dead bivalve shells (oysters?), *Arbacia punctulata* common. Fairly barren on top. Dominant fish: amberjack, almaco jack, scamp (common, not abundant), 1 yellowedge grouper, cubbyu, 1 red snapper, graysby, anthiids, lionfish (common, not abundant), bank seabass. Human debris: fishing line- common.

Dive 16-08: (Harter et al. 2017). Depth range: 100 to 101 m; multibeam shows Barge 2 laying NE to SW, with 1 container loose on bottom to the west about 50 m west of barge, and a large debris field of ~12 containers at SW end of barge. Transect along south side and top of barge from SW end to NE end. Debris field NW end of barge, jumble of maybe 6-12 containers. Sides covered with large vertical oysters (live), large spider crab. SW end of barge, 100 m at base, 96 m at top. 100% cover on side of small shells, possibly barnacle, small oysters. Few

Stichopathes. Barge 2 was only 20 m deeper than Barge 1, but had many more snowy grouper, and warsaw grouper. Also had no fishing line and much more fish. Dominant fish: amberjack (large schools), almaco jack, scamp (common, not abundant), 2 yellowedge grouper, blackbar drum, 1 red snapper, graysby, anthiids, lionfish (common, not abundant), bank seabass, warsaw grouper - several, snowy grouper- very common, some 50 cm, 1 misty grouper. Human debris: fishing line- none.

Dive 17-12: (Harter et al. 2018). Depth range: 100.5- 102 m; multibeam map (Nancy Foster 14-08 Barge, 1 m resolution) shows Barge 2 laying NE-SW, 81 m long, with pile of debris (cargo containers) off SW end. Sunk in 2014. Previously surveyed 2014 and 2016. 101 m, in debris field; metal with *Stichopathes*, and oysters. Dominant fish: juvenile blackline tilefish- 4, lionfish- 5, amberjack- common, scamp- 4, snowy grouper- 17, warsaw grouper-1, yellowedge grouper - 1, red barbier (abundant), cubbyu. Human debris: few fishing lines.

Dive 17-13: (Harter et al. 2018). Depth range: 85- 87 m; multibeam map of Barge 1 (Nancy Foster 14-08 Barge, 1 m resolution) shows 77 m long barge, oriented NE-SW, debris field of cargo containers off SW. 70 nmi offshore. ROV position now appears to be offset 20 m to north of multibeam position. This is an artifact of problem with ROV navigation. Later fixed and navigation replotted. Base 85 m, main deck 80 m. Very little biota on horizontal surfaces, no sponges, no black coral, no gorgonians, no anemones. Dense oysters on vertical surfacing. Dominant fish: juvenile blackline tilefish- 4, lionfish- 47, scamp- 13, snowy grouper- 2, gag grouper- 3, red barbier, cubbyu, amberjack. Human debris: few fishing lines.

Dive 17-34: (Harter et al. 2018). Depth range: 96-101 m; repeat dive on Barge 2 to test ROV navigation.



Figure 28. Charleston Deep Artificial Reef MPA; ROV 16-07; 85.5m; Yellowedge grouper on Barge 1.



Figure 29. Charleston Deep Artificial Reef MPA; ROV 16-08; 96.9m; Warsaw grouper.

Edisto MPA

The multibeam sonar [Sedberry OE Block 345, 5 m resolution (Sedberry 2006)] shows two distinct NE-SW oriented shelf-edge ridges at 50 m depth cutting through the middle of Edisto MPA and a wide rugose plateau to the SW. A second multibeam [Pisces_2016_Edisto_MPA_Grid (Harter 2016; Harter et al. 2017)] shows a low relief rise in the NW corner of the MPA. Ten ROV dives were conducted within the MPA during the three years (Figs. 4, 30, 31, 32).

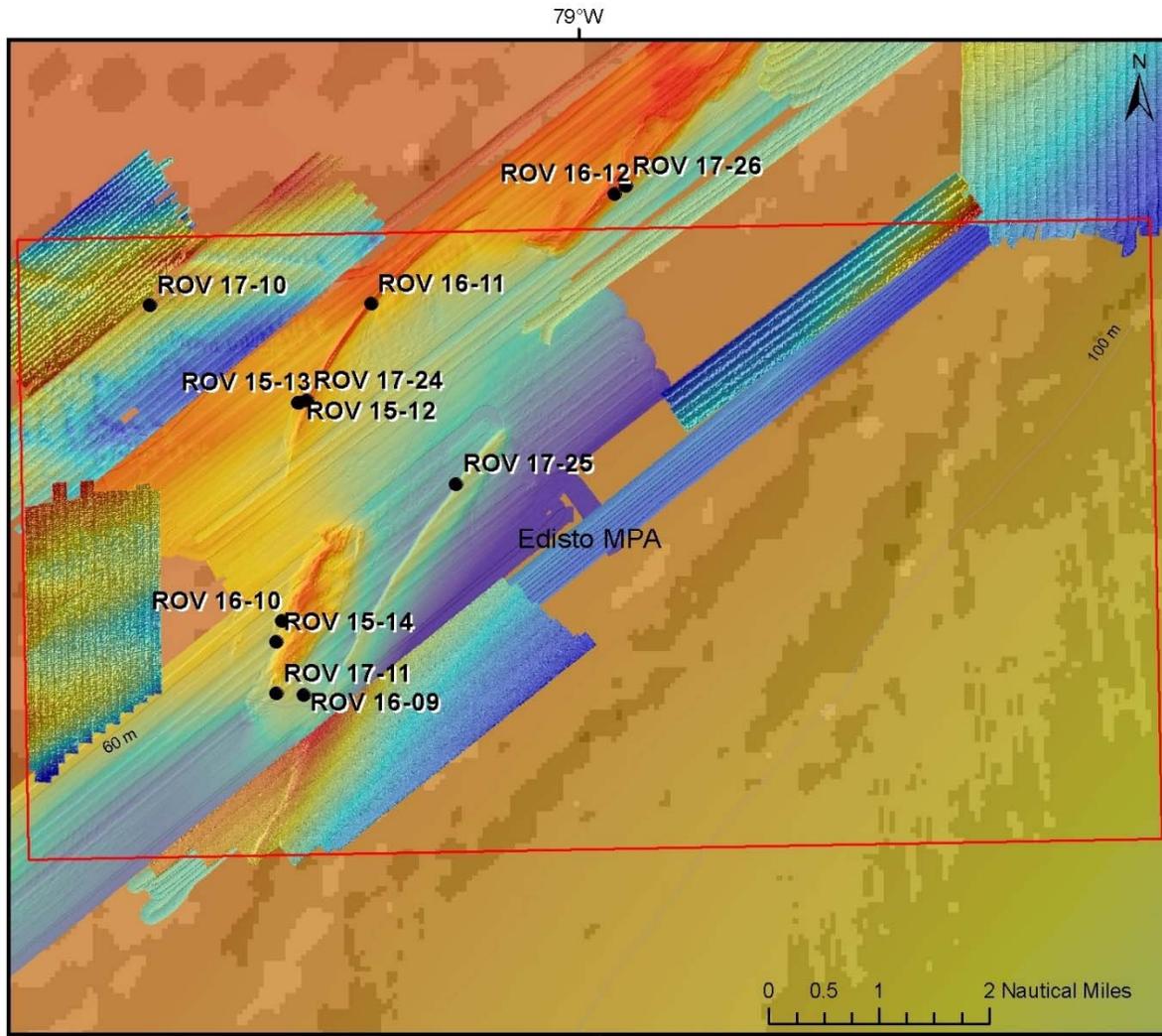


Figure 30. Map of Edisto MPA off South Carolina with 2015-2017 ROV dive sites.

Dive 15-12: (Harter et al. 2016). Depth range: 53.5 m; unable to get to reef, unable to station keep due to currents.

Dive 15-13: (Harter et al. 2016) . Depth range: 46-51 m; start transect at south end of ridge and head along ridge to NE. West slope of ridge of west ridge: ½ - 1 m boulders, broad boulder zone, 5 dg slope, 80% hard bottom, no vertical escarpment at top. 48 m- top of ridge: pavement, large flat, fractured rock slabs, 1-3 m square, but no vertical escarpment at edge. Low rugosity, few fish, 100% cover of macrobiota. 49 m- valley between the two ridges in multibeam; 50-70% hard bottom, low relief rock slabs and sediment, ½ m relief. 47 m- top of east ridge; 1-2 m escarpment at edge; 10 m wide pavement and slabs on top. Dominant biota: Octocoral- *Swiftia exserta*, *Ellisella*, *Telesto*, *Diodogorgia*, *Muricea*- 2' purple; Antipatharia- *Tanacetipathes*- bushy, *Stichopathes lutkeni*; Porifera- *Aiolochoxia crassa*, *Agelas clathrodes*, Demospongiae- starlet, *Ircinia campana*, *Aplysina*- tubes, *Callyspongia vaginalis*. Dominant fish: spotfin hogfish, blue angelfish, bank butterflyfish, tomtate, reef butterflyfish, hogfish, lionfish, scamp, bigeye,

cornetfish, longsnout butterflyfish, amberjack, large schools of tomtate, vermilion snapper, scamp- common, school grey snapper- common, gag; loggerhead turtle.

Dive 15-14: (Harter et al. 2016). Depth range: 48-54.5 m; transect along west slope of plateau, heading N. 53 m, base of west slope; 80% soft bottom, rubble/cobble patches, 10 cm relief. 52 m- west slope, 80% hard bottom, low relief rock, ½ m relief. 50 m- west slope, higher rugosity, ½-1 m ledges and rock slabs, more fish, shark, scamp. 48.5 m- top of slope, west edge of plateau. 100% hard bottom, pavement/sediment; dense biota. 48 m- escarpment at west edge of plateau. 1-2 m undercut ledge, rock slabs. Dominant fish: spotfin hogfish, spanish hogfish, blue angelfish, barracuda, reef butterflyfish, tomtate, scamp, almaco jack, bicolor damselfish, several sharks- 5' sand shark?, gag, creole, amberjack, stripped grunt, lionfish- many, grey snapper- schools very common, grey triggerfish, scorpionfish, squirrelfish, graysby.

Dive 16-09: (Harter et al. 2017). Depth range: 63-64.5 m; multibeam shows low broad ledge N-S, with steeper defined slope on west side. Transect N to S. All low relief, no slope, low rugosity; rock pavement with sediment veneer, and areas of low relief (1'), flat rock slabs (1-2 m diam.), but fairly dense biota dominated by dense gorgonian corals. Dominant fish: Calamus porgy, scamp, blue angelfish, lionfish (not common), spotfin butterflyfish, red snapper (few), grey triggerfish, speckled hind (1), short bigeye, tattler, 2-m *Dasyatis* stingray.

Dive 16-10: (Harter et al. 2017). Depth range: 48-52 m; multibeam shows N-S oriented oval high relief ridge, 1.6 nmi long N-S, 0.4 m wide. Transect along west slope and top. Top of ridge, 48-49 m, mostly flat pavement, low relief ledges, but 80-100% hard bottom and 100% cover of dense macrobiota. West slope on first half of the dive was 10-30° slope, moderate relief 1-3 m, high rugosity. Base of west slope, 51-52 m, flattened out to low relief 1 m ledges, rock boulders, 80% hard bottom. Near the end of the dive was west slope with very rugged topography, 3-4 m relief, very eroded rock, undercut ledges 1-2 m deep, large 3-4 m outcrops. Dominant fish: fish were very dense; tomtate, huge schools of small fish in water column, greater hammerhead (8-9'), unid sharks (several, heavy body), gag (few), scamp (common), greyhead scamp, blue angelfish, soapfish, reef butterflyfish, spotfin butterflyfish, graysby, spanish hogfish, cornetfish, scorpionfish, rock beauty, barracuda, schools of amberjack, patches with dense lionfish. Human debris: fishing line (not much).

Beautiful site. One of the best shelf-edge MPA sites for diversity and density of all biota and fish.

Dive 16-11: (Harter et al. 2017). Depth range: 46.4 to 48.7 m; multibeam shows narrow crescent shaped ridge, oriented NE-SW. Transect mostly along west slope and west top of ridge. East slope of ridge had pavement and 1-2 m ledges; appeared more distinct in multibeam; may have filled in. Top of ridge, 46-47 m; mostly flat pavement, fractured rock, some low relief ledges < 1m, 100% hard bottom; dense cover of biota. West slope, 46 m top, 48.7 m base flat sand. West slope more abrupt and distinct than east slope. Mostly moderate relief (1-2, some 3 m) ledges, undercut 1-2 m, rock slabs broken from edge. Dominant biota: dominated by gorgonians- *Diodorgorgia*, 1 m *Muricea*, *Ellisella*, *Swiftia exserta* (common); black coral- *Stichopathes*, some white fan *Antipathes*; hydroids- abundant (4-6 spp common); Porifera- *Ircinia campana*, *Xestospongia*, Spirastrellidae, Axinellidae, *Callyspongia vaginalis*. Dominant fish: scamp (18),

gag (6), lionfish (338), cornetfish, tomtate (huge schools), Calamus porgy, reef butterflyfish, amberjack, blue angelfish, short bigeye, barracuda, graysby, white grunt, french angelfish, goatfish, rock hind, sharpnose puffer. Several large clusters of lionfish found on west slope. Human debris: anchor line, no fishing gear. Very nice site.

Dive 17-10: (Harter et al. 2018). Depth range: 46.5 m; multibeam shows indistinct low relief hard bottom, maximum relief, 38 m on top, 41 to east. No previous dives. Multibeam- near starting waypoint on top of mound. Multibeam shows 38 m, ROV 46 m. 100% soft bottom, coarse sand/shell, sparse rubble. ROV navigation is off; not on correct location of multibeam map. 46.5 m, 100% sand/shell bottom. Multibeam- 7 m shallower than actual. Just soft bottom biota and few fish.

Dive 17-11: (Harter et al. 2018). Depth range: 52-59 m; multibeam map shows NE-SW oriented oval mound, 1.6 nmi long, top 51m, 56 m east base. Transect along SE face of mound, heading NE; no previous dives. 53 m, at start waypoint 1, top SE edge of mound, rock pavement, low rugosity, with areas of 1-2 m relief, 50-cm to 1 m ledges with eroded faces, high rugosity and fish; mostly low relief pavement. 52 m, top edge of eastern drop off, rock pavement, 1 m relief ledges. Dominant biota: Scleractinia coral- none; Antipatharia- *Stichopathes*, *Antipathes atlantica*, *Tanacetipathes*; Gorgonacea- *Diodogorgia*, *Ellisella* whips, *Titanideum frauenfeldii*, *Swiftia exserta* (common), *Ellisella elongata*, 5 cm orange plexaurids, *Muricea*; Porifera- *Ircinia campana*, Spirastrellidae, *Callyspongia vaginalis*, DMST sponge, *Cinachyrella*, *Aplysina* fingers. Dominant fish: lionfish- 31, graysby- 5, gag-1, scamp- 1, bigeye, reef butterflyfish, squirrelfish, spotfin hogfish, tomtate, amberjack, yellowtail reeffish, sharpnose puffer, tattler, blue angelfish, bank butterflyfish, flying gurnard. Human debris: beer cans.

Dive 17-24: (Harter et al. 2018). Depth range: 46- 53 m; multibeam map shows arc shaped narrow ridge, oriented NE-SW, 3 nmi long; 46 m top, 52 m base, 90 m wide. Transect headed NE along ridge. Previous dives 2012-07. 50.4 m. Multibeam shows middle of top of ridge. Rock slabs 1-2 m diameter, ½-1 m relief. 51 m, east of base of ridge. Heading N along east slope of ridge. 10-30 dg slope, square boulders, flat top boulders, 1-3 m diameter, 1-3 m relief, high rugosity. Nearly 100% cover biota. 46 m, top edge of west slope of ridge, 51 m at base in sand, 4-5 m total relief, 30-45 dg slope extending 20 m wide, large rock slabs, flat topped, 2-4 m diameter, 1-2 m relief, high rugosity, undercut rock slabs along top edge, horizontal layering of flat rock slabs. Dominant fish: Lionfish- 241, scamp- 34, graysby- 29, red snapper- 15, gag- 1, soapfish, sharpnose puffer, spotfin hogfish, tomtate, reef butterflyfish, blue angelfish, purple reeffish, squirrelfish, blackbar soldierfish, vermilion snapper, amberjack, Calamus porgy, sunshinefish, trumpetfish, spotted scorpionfish, honeycomb cowfish. Human debris: fishing lines.

Dive 17-25: (Harter et al. 2018). Depth range: 60-66 m; multibeam shows narrow ridge 2.6 nmi long, oriented NE-SW, 350 m wide, top- 57 m, base- 64 m. Previous dives- 2014-24, further to west on ledge. Heading NE along west slope of ridge. 62 m, on slope; scattered boulders, eroded rock, 1-2 m relief, areas of high rugosity. Upper slope with jumble of 1-2 m boulders, high rugosity in narrow band. Top of wall 60.7 m. Dominant fish: lionfish- 61, scamp- 22, vermilion snapper- 13, gag- 5, graysby- 4, sunshinefish, sharpnose puffer, tomtate, bank butterflyfish, blue angelfish, reef butterflyfish, squirrelfish, purple reeffish, cubbyu, spotted goatfish, amberjack,

striped grunt, Calamus porgy, short bigeye, spotfin hogfish. Human debris: fishing line, large anchor.

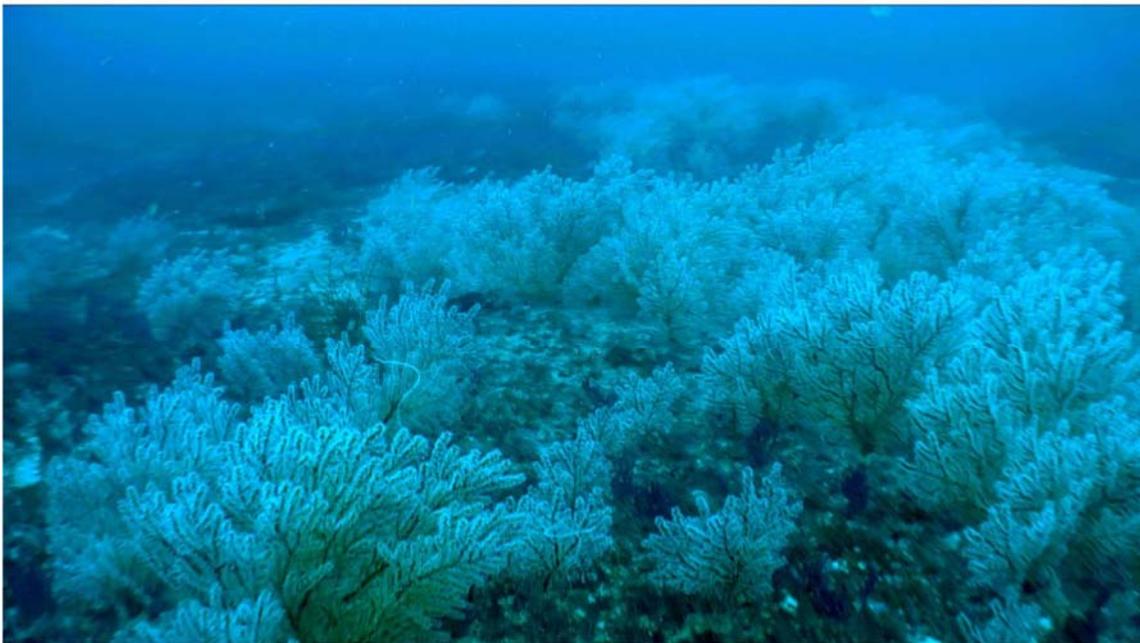
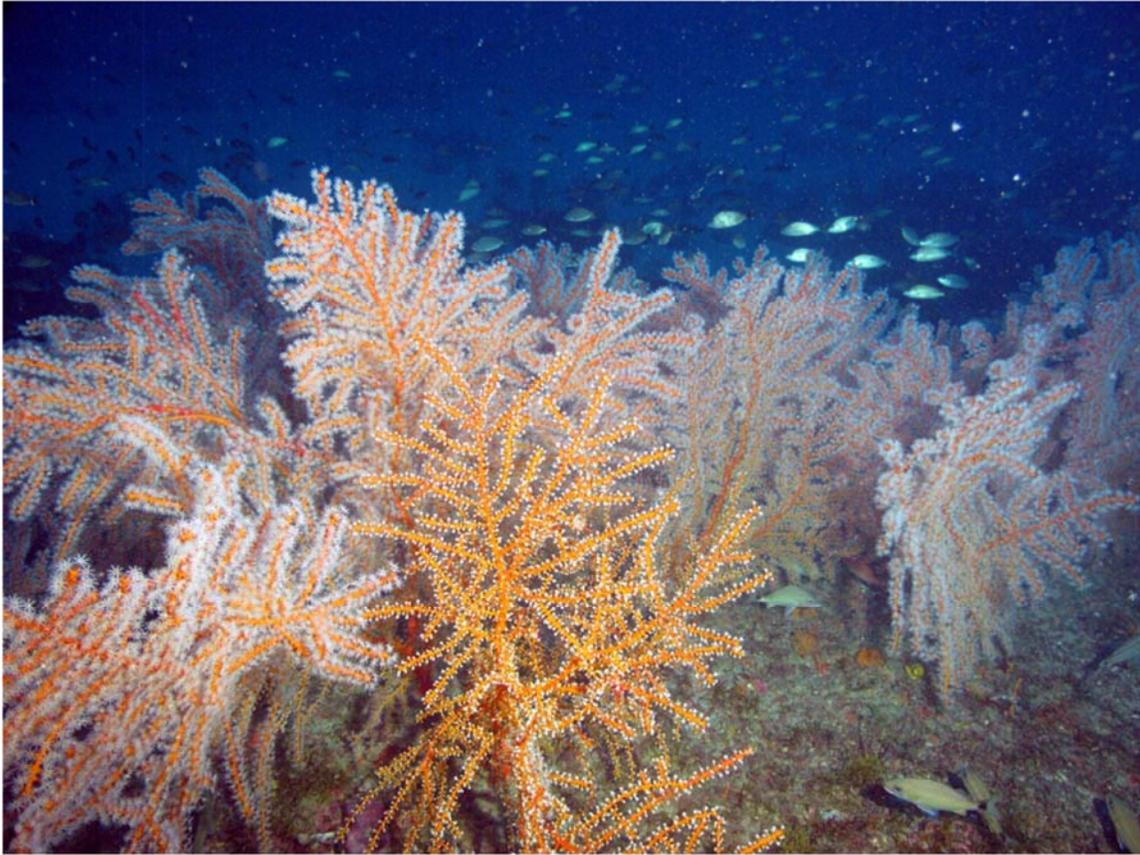


Figure 31. Fields of the gorgonian octocoral *Swiftia exserta* found at Edisto MPA during the NOAA Ship *Pisces* cruise, June 7-22, 2016.



Figure 32. Edisto MPA; ROV 16-11; 45.7m; school of lionfish.

Devil's Home SMZ

The multibeam sonar [NancyFoster_14_08_MPA_Devilshole (Harter 2014)] shows a steep walled plateau in the middle of Devil's Hole SMZ. Three ROV dives were conducted within the MPA during the three years (Figs. 4, 33, 34, 35).

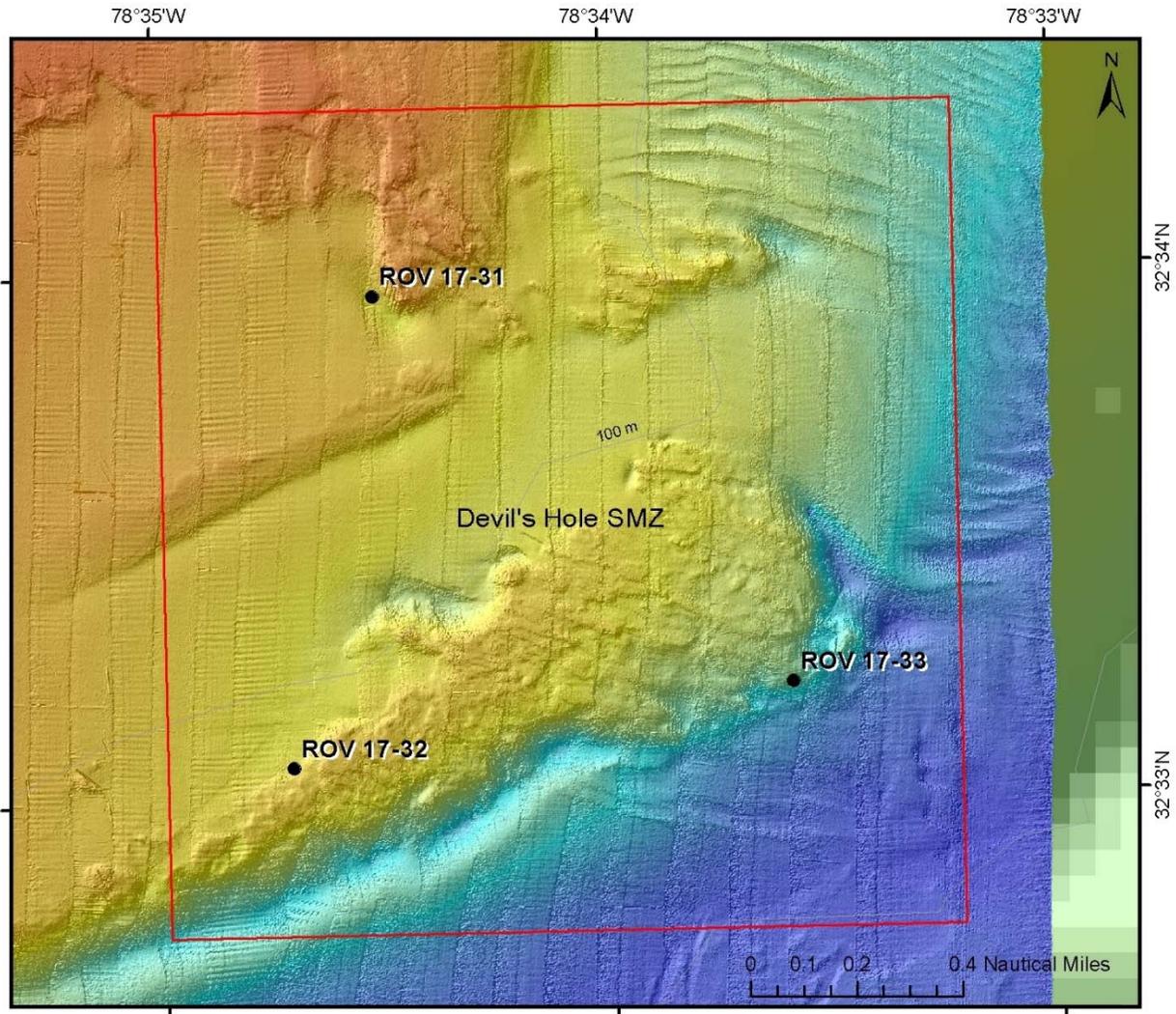


Figure 33. Map of Devil's Hole Special Management Zone (SMZ) with 2017 ROV dive sites.

Dive 17-31: (Harter et al. 2018). Depth range: 65- 86 m; multibeam map (Pisces 2013, East Devil's Hole, 5 m resolution) shows flat topped plateau with escarpment along east edge. Dive site along southeastern tip of plateau; west face of N-S oriented escarpment, 65 m top of ridge, 85 m at west base, 101 m at tip of south base. Previous dives- none. Transect heading N along the west facing slope. 86 m, west base of escarpment; 80% cover 1 m eroded boulders on flat bottom, 10 dg slope. *Oculina varicosa* (possibly *Madracis myriaster*, unable to discern from photo without a sample) (depth 75 m, abundant), 10 cm to 1 m on vertical rock. 69 m, upper escarpment, sharp ledge, 2-3 relief, eroded rugged boulders; top of edge, flat rock pavement, 68 m; base 86 m, 18 m relief overall. Dominant biota- low diversity, large sponges; *Oculina* (or *M. myriaster*) abundant to 1 m diameter on vertical face of boulders; huge schools of anthiids- red barbier, dense *Antipathes atlantica*, encrusting yellow and orange sponges. Dominant fish: lionfish- 87, scamp- 18, graysby- 5, vermilion snapper, gag- 2, red snapper-2, cobia, soapfish, bank butterflyfish, spotfin hogfish, red barbier (abundant), tomtate, cherubfish, creolefish, barracuda, amberjack, lantern bass, *Calamus porgy*. Human debris: large pile fishing line.

Dive 17-32: (Harter et al. 2018). Depth range: 90- 100 m; multibeam map shows flat topped plateau oriented NE-SW, 2 miles long, ½ mile wide; top- 90 m, west base- 94 m, 125 m in scour. Previous dives- none. Transect heading NE along the west facing slope. 95 m, on escarpment briefly, 1-2 m rugged boulders, dense *Oculina varicosa* (or *Madracis myriaster*) 25- 50 cm. Upper slope, flat rock slabs, 1-3 m diameter, 1-2 m relief, broken off edge of escarpment, 45 dg slope. 91 m, upper slope, pavement, rock slabs, 1 m ledges. Dominant biota- very diverse and dense, Scleractinia- *Oculina* abundant in high rugosity areas, *Oculina* (*Madracis*?) 10-25 cm common (90 m); Antipatharia- *Tanacetipathes* bushes; gorgonians- *Muricea*, dense yellow gorgonians. Dominant fish: lionfish- 8, scamp- 4, amberjack (abundant), roughtongue bass, bank butterflyfish, cubbyu, tattler, wrasse bass, cardinalfish, striped grunt, spanish flag. Human debris: anchor line, few fishing lines.

Dive 17-33: (Harter et al. 2018). Depth range: 112- 137 m; multibeam shows flat topped plateau oriented NE-SW, 2 miles long, ½ mile wide; depth on top of east side- 124 m, base in scour- 191 m. Previous dives- none. Transect heading north along east facing slope. 137 m, top of escarpment, flat, ½ m boulders, pavement. Escarpment to east, 45 dg slope, 1-2 m diameter boulders, very eroded, jumble of flat and rugged boulders, high rugosity. 130 m, flat top pavement, 5 dg slope, low relief outcrops, <1/2 m. Dominant biota: Scleractinia- *Oculina varicosa* (*M. myriaster*?) 30 cm (112 m), cup coral- 1; Antipatharia- none; Gorgonacea- several species, 10 cm grey fan (abundant on top of plateau); Porifera- very few, encrusting yellow and orange, curtain sponges- *Raspailliidae*? Dominant fish: scamp- 14, snowy grouper- 1, roughtongue bass, bank butterflyfish, bulleye, cubbyu, anthiids, cardinal soldierfish, scorpion, wrasse bass, green moray, manta ray. Human debris: anchor line, chain and anchor; deep drop weights, common (sash weights), steel fishing lines (numerous).



Figure 34. Devil's Hole SMZ; ROV 17-31; 69 m; large live *Oculina varicosa* (or *Madricis myriaster*?) coral colonies.



Figure 35. Devil's Hole SMZ; ROV 17-33; 118.2 m; scamp grouper on rocky slope.

Northern South Carolina MPA

The multibeam [Sedberry_OEBlock1_5m_UTM17N_MB_Grid, (Sedberry 2006)] shows the main NE-SW oriented ridge along the western edge of the MPA and another NE-SW oriented ridge along the middle of the MPA. Three dives were made on the ridges in the NW part of the MPA (Figs. 5, 36, 37, 38). A flat topped plateau (see Iceberg Scar site) forms the eastern portion of the MPA which is described after this section.

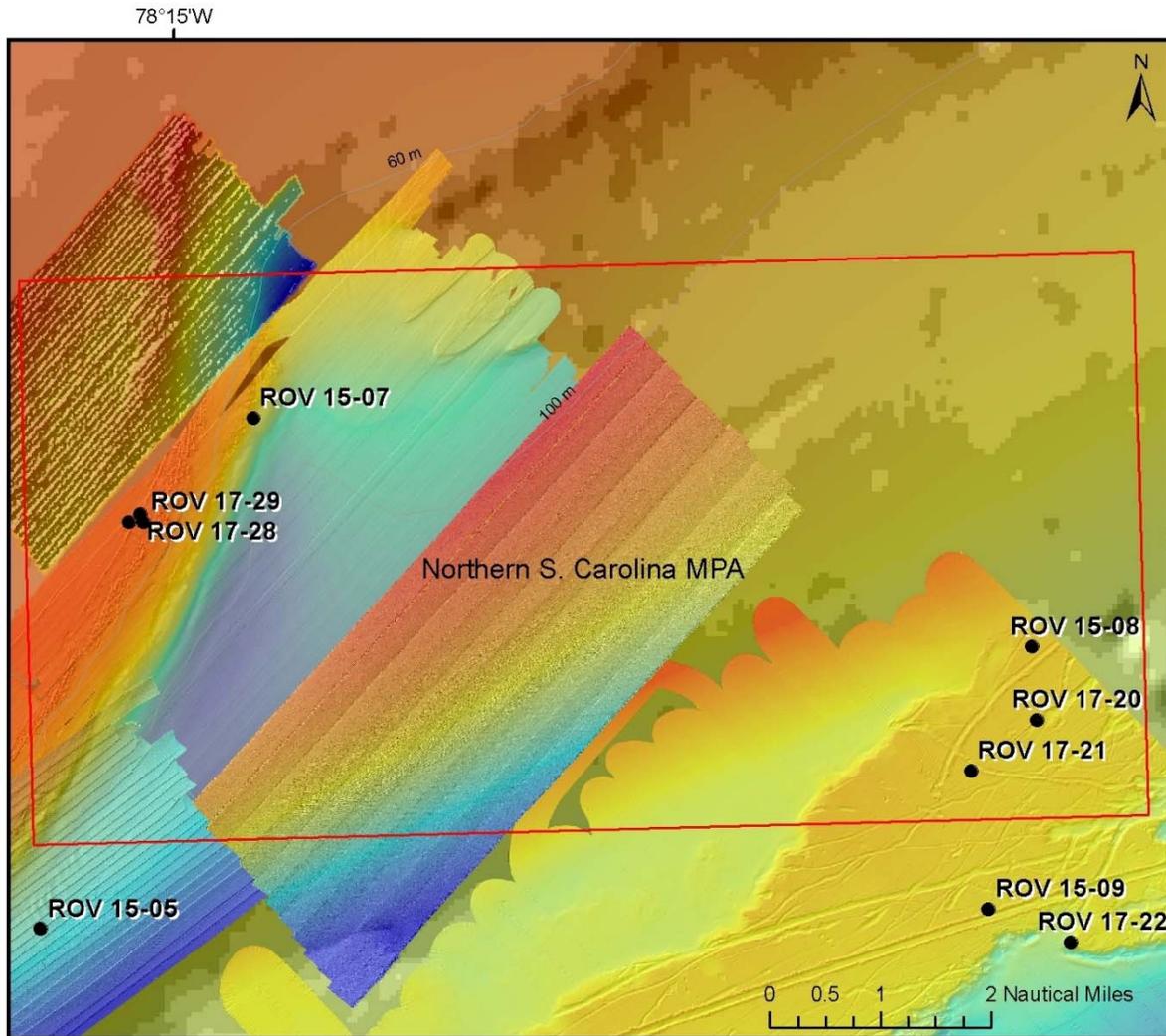


Figure 36. Map of Northern South Carolina MPA with 2015-2017 ROV dive sites.

Dive 15-07: (Harter et al. 2016). Depth range: 63-67 m; transect headed SW along ridge. 63.5 m-on ridge, hard bottom, low relief rock pavement, few 10-20 cm ledges. Multibeam shows E-W gully cut through edge of east slope of ridge. Top edge of gully, 63 m, pavement/sediment, no ledges. Base of gully, 64.5 m, 100% soft bottom. Dominant biota: Octocoral- *Diodogorgia*, *Ellisella*, *Muricea*, orange gorgonian, *Titanideum frauenfeldii*; Antipatharia- *Stichopathes lutkeni*, *Antipathes furcata*; Porifera- *Agelas* sp., *Agelas clathrodes*, *Aplysina* white tubes, *Ircinia* sp., *Ircinia campana*, Axinellidae. Dominant fish: scamp, hogfish, red porgy, lionfish.

Dive 17-28: (Harter et al. 2018). Depth range: 49- 51 m; multibeam map (Sedberry OE Block 1, 5 m resolution) shows a elongate N-S oriented mound, with narrow NNE-SSW ridge on west side, >1.7 nmi long, 47 m top, west base- 50 m, 45 m wide. Transect NE along ridge west slope. Ridge top 50 m, smooth rock pavement, dense cover small biota. 51 m, west facing slope of mound, 10 dg slope, rock pavement, on upper slope; lower slope, low relief rock slabs 1-3 m diameter, <1m relief. West base, 51 m, flat sand. East slope- no definite ledge, low relief rock pavement, sediment. Dominant fish: lionfish- 95, scamp- 19, graysby- 11, greater soapfish, tomtate (dense), barracuda, red snapper- 1, eels, rougtail stingray- 2, cobia, remora, sharpnose puffer, yellowhead wrasse, cubbyu, reef butterflyfish, bank butterflyfish, blue angelfish, doctorfish, squirrelfish, white grunt, Calamus porgy, rock beauty, spotted goatfish, spotfin hogfish, sunshinefish, striped grunt, white grunt. Human debris: few fishing lines.

Dive 17-29: (Harter et al. 2018). Depth range: 50- 52.5 m; Multibeam map (Sedberry OE Block 1, 5 m resolution) shows flat topped mound with low relief ridges and scattered mounds, relief 47.5 to 49.5 m, 10-20 m diameter. Previous dive in same region, but to the west, dive 14-08. Transect heading N along an apparent ridge on top of mound. Rounded smooth mounds, 50 m on top, 52.5 in sand at base, 2 m relief, 10-20 m diameter, 45-60 dg slope. No undercut ledges. Low rugosity. Flat sand between the mounds, 10 cm sand waves, E-W. Narrow sand chutes between mounds, to wide valleys. 50 m, Multibeam shows N-S linear ridge among the round mounds. Habitat of the ridge is similar to the rounded mounds but continuous; smooth rock slope on sides, rounded top, no ledges, no rugosity. Dominant biota: Scleractinia- *Madracis* or *Oculina*; Antipatharia- *Stichopathes*, *Tanacetipathes* single stalk, *Tanacetipathes* bush, *Antipathes atlantica*; Gorgonacea- *Diodogorgia*, 10 cm gorgonians, *Muricea*, few *Swiftia exserta*, *Ellisella barbadensis*, *Ellisella elongata*, *Carijoa*, *Iciligorgia schrammi*; Porifera- *Ircinia campana*, Spirastrellidae, encrusting yellow and orange sponges, purple tube *Aplysina*, Clathriidae, *Agelas clathrodes*, *Ircinia strobilina*, *Callyspongia vaginalis*, *Niphates spaghetti* sponge. Dominant fish: lionfish- 77, coney- 1, soapfish, graysby, scamp- 3, reef butterflyfish, Calamus porgy, sunshinefish, blue angelfish, sharpnose puffer, tattler, squirrelfish, orangeback bass, spotfin hogfish, yellowhead wrasse. Human debris: none.



Figure 37. Northern S. Carolina MPA; ROV 17-28; 49.3 m; scamp grouper on rocky slope.



Figure 38. Northern S. Carolina MPA; ROV 17-28; 50 m; school of cobia following large rough-tail stingray (*Dasyatis centroura*).

Northern South Carolina MPA (iceberg scar site)

The multibeam sonar [Sedberry_OEBlock2_5m_UTM17N_MB_Grid (Sedberry 2006)] shows a wide flat plateau intersected with straight deep grooves that are apparent iceberg scars from the last glacial period (Figs. 5, 36, 39, 40).

Dive 15-08: (Harter et al. 2016). Depth range: 158-162.5 m; multibeam map shows NE-SW oriented scar (ice berg scar); transect along the southern rim, heading SW. 158.5 m- on upper south rim; 30-50 cm boulders, ½ m ledges, 100% hard bottom. Heading SW along top rim. Dense macrobiota and dense fish. 160 m- 30 cm to 1 m boulders; 30-50 cm relief. Off rim to the south is 100% soft bottom. Dominant biota: very dense biota on all rock surfaces; very dense sponges; Octocoral- 4-5 spp. of gorgonacea; purple *Nicella?*, yellow gorgonacea, white gorgonacea; Porifera- *Leiodermatium* (abundant), *Corallistes typus*, Corallistidae, Pachastrellidae. Dominant fish: red porgy (dense, numerous schools), snowy grouper (30-60 cm) (abundant- count 55), blackbar drum, anthiids, roughtongue bass, red barbier, bigeye, french angelfish, blueline tilefish (several), *Laemonema*, greater amberjack, boarfish, no lionfish. Human debris: lots of fishing line on bottom, also several large piles (1 ft x 3 ft) of line.

Dive 17-20: (Harter et al. 2018). Depth range: 161- 167 m; multibeam map (Pisces 2012 Northern South Carolina, 5 m resolution) shows iceberg scar, 2000 m long, 50 m wide, oriented NE- SW. Multibeam depths- base- 170, plateau top- 163 m. Transect heading NE along scour. Previous dive 14-12, in same scour but further SW. 161.5 m, north rim, 5 m wide, 25 cm to 50 cm boulders, some larger 1-2 m diameter, flat topped boulders, <1/2 m relief, appear black, granitic. 161 m, top of plateau, sand. Dominant fish: snowy grouper- 19, yellowedge grouper-1, hake, reticulate morays, big roughy- 7, red hogfish, apricot bass, short bigeye, scorpion fish, saddlebass, yellowfin bass, boarfish (large schools), barracuda. Human debris: several piles fishing line.

Dive 17-21: (Harter et al. 2018). Depth range: 160- 164 m multibeam map (Pisces 2012 Northern South Carolina, 5 m resolution). Ice berg scar, E-W oriented scour, 4000 m long, 81 m wide; multibeam depths: base- 165 m, plateau top- 162 m. Transect heading E along south rim of scour. Previous dive 14-11 in the same scour but east of this dive site. Flat top plateau; flat sand, grey and black grains, sand ripples, rubble black- granitic? 163 m, south rim of scour, 25-50 m boulders, flat. Dominant biota: dense cover, Gorgonacea- 2 spp abundant 15 cm white, red-orange fans; Porifera- *Leiodermatium* (abundant), yellow cluster fingers, plate Corallistidae, thick cup Corallistidae, thick plate Astrophorida, yellow thick encrusting *Spongosorites*. Dominant fish: blueline tilefish-12, snowy grouper- 16, scamp- 2, big roughy (numerous), french butterflyfish, red porgy, yellowfin bass, scorpionfish, red hogfish, apricot bass, *Laemonema*, bigeye soldierfish, red barbier, roughtongue bass. Human debris: none.

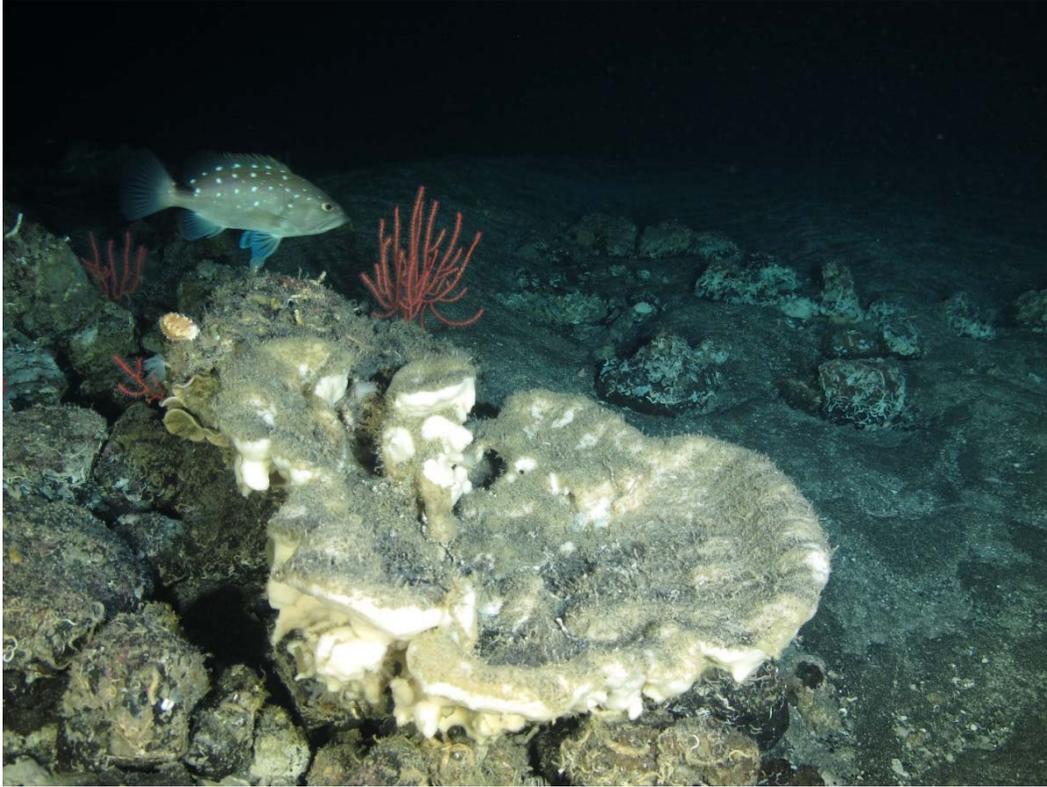


Figure 39. Northern S. Carolina MPA (iceberg scar site); ROV 17-21; 162.5 m; juvenile snowy grouper swims above a large *Corallistes* sponge, orange gorgonians.

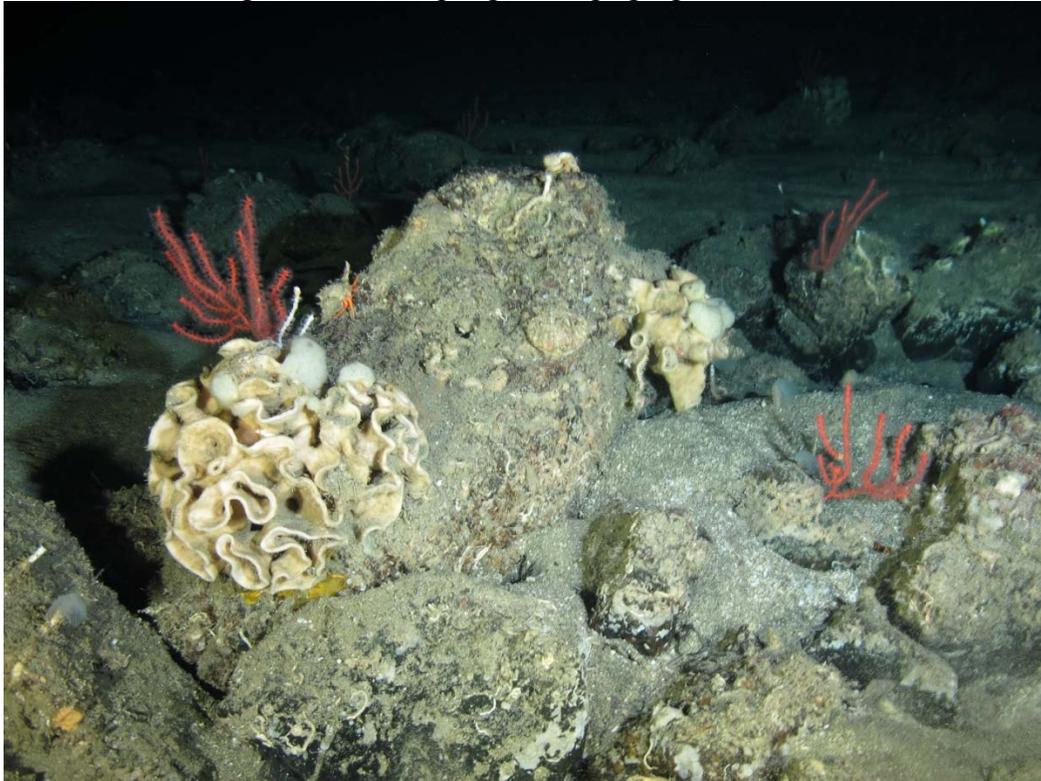


Figure 40. Northern S. Carolina MPA (iceberg scar site); ROV 17-20; 165.3 m; *Leiodermatium* flower sponge and red gorgonian octocorals.

Snowy Wreck MPA

Only the western corner of the MPA and a small area at the Snowy Grouper shipwreck site in the eastern corner of the MPA has multibeam sonar. The multibeam of the western part shows a NE-SW oriented ridge with a steep drop-off. Five dives were made on this reef portion of the MPA (Figs. 6, 41, 42, 43).

[SGW_dive32_33_5Mres; Pisces_2012_SnowyWreckMPA_MB_Grid (Harter 2012; Harter et al. 2013; Reed et al. 2013a); NancyFoster_14_08_MPA_NC_SnowyWreck_Grid (Harter 2014; Reed et al. 2015)]

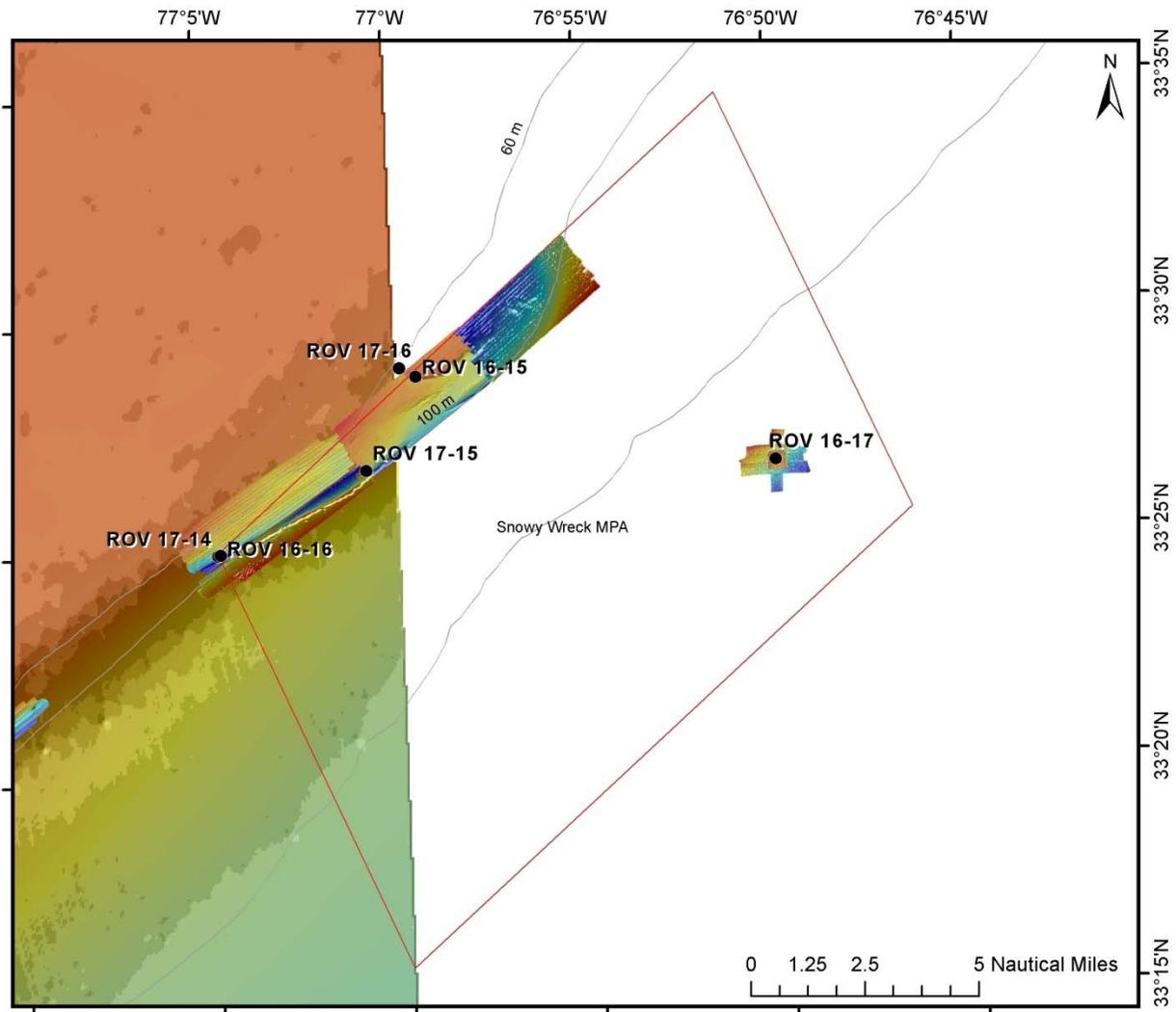


Figure 41. Map of Snowy Wreck MPA off North Carolina with 2016 and 2017 ROV dive sites. Dive 16-17 is at the Snowy Grouper shipwreck site.

Dive 16-15: (Harter et al. 2017). Depth range: 60-65 m; multibeam shows large flat topped plateau with escarpment on east side and south side. Transect along east and south slope and top edge. East slope and top edge, the multibeam shows steep escarpment. Top of plateau was 60-62 m, flat sand and flat rock pavement. Slope was barely perceptible in ROV. East slope was $<5^\circ$, 50% hard bottom, pavement and low relief, flat rock 1' relief, white sand between. SE corner of escarpment had the highest relief and rugosity: Upper slope $10-30^\circ$, rock boulders 1-2 m relief in

some areas, high rugosity. South facing slope, heading WNW: mostly 50-80% hard bottom, slope 0-20°, low relief flat rock and rock outcrops, occasional areas with 1-2 m relief. Dominant biota: Scleractinia- *Oculina varicosa* (or *Madracis myriaster*) three colonies, 15 cm, white; solitary cup coral; Octocorallia- *Diodigorgia*, *Iciligorgia schrammi*, *Swiftia exserta* (53- actual counts), *Ellisella*; Antipatharia- *Stichopathes lutkeni*, *Antipathes atlantica*, *Antipathes* sp (large to 1 m), *Tanacetipathes*, large white bushy Antipathes; Porifera- *Agelas clathrodes* (abundant, 1-3'), *Oceanapia?*, *Geodia neptuni*. Dominant fish: 121 lionfish, 2 gag, 8 graysby, 10 scamp, 2 rock hind. Human debris: several fishing lines.

Dive 16-16: (Harter et al. 2017). Depth range: 75- 104.2 m; multibeam shows cove and steep escarpment on east slope of plateau. Transect starting in cove, then heading NE along face of escarpment from top to bottom. Top edge of plateau, 75 m, mostly low relief rock pavement and sediment, low density of biota. Upper slope, 75-80 m also mostly pavement, sediment and low relief rock. Highest relief is between 90 and 100 m; 30-45° slope in some areas, 1 m rock outcrops, high rugosity with schools of anthiids, and scamp are common. Dominant biota: Scleractinia- *Oculina varicosa* (or *Madracis myriaster?*), 85-101 m, 10-20 cm (count-26+); solitary cup corals; Antipatharia- *Stichopathes lutkeni*, *Antipathes atlantica*, *Antipathes* sp. (black fan), *Tanacetipathes*; Octocorallia- 10 cm orange gorgonians; Porifera- encrusting spp., Spirastrellidae. Dominant fish: 123 lionfish, 36 scamp, 1 gag, 5 graysby, wrasse bass, french butterflyfish, roughtongue bass (abundant), black jack, amberjack, manta ray, bigeye, one site with 13 scamp, eels, scorpionfish, cubbyu. Human debris: lots of fishing line, anchor with line.

Dive 17-14: (Harter et al. 2018). Depth range: 75- 103 m; multibeam map [Pisces 2012 Snowy Wreck MPA, 5 m resolution (Harter 2012; Reed et al. 2013a)] shows ENE-WSW oriented ridge, facing southeast; top 77 m, base 115 m. Transect along face of ridge slope. Previous dives- 2014 and 2012. Top of ridge in cove-like feature; 75 m- sediment and flat pavement, 1 m ledge. 84 m. 1-2 m ledges, rugged, boulders 50 cm. 83 m, MB- lower face of escarpment, heading NE along ridge. Low to moderate slope- 10- 30 dg, rock pavement, boulders ½ - 1 m, sediment, low rugosity. 92 m, lower slope, 30-45 dg escarpments, ½ - 1 m boulders, rugose areas, interspersed with sand and pavement. 95- 97 m - rugged escarpments, vertical rock, eroded rock. 103 m- rugged, eroded, 60 dg slope, boulders, high rugosity. Dominant biota: Scleractinia- *Oculina varicosa* (or *Madracis myriaster?*) (white, common 75-103 m)- 25+ (not all counted); Gorgonacea- 10 cm yellow and orange plexaurid (abundant), several species of gorgonian, *Swiftia exserta*, purple *Nicella*; Antipatharia- *Stichopathes*, *Antipathes atlantica*; Porifera- encrusting yellow and orange demosponges, *Agelas clathrodes*. Dominant fish: lionfish- 223, scamp- 57, red snapper- 5, graysby- 3, soapfish, bank butterflyfish, tattler, reef butterflyfish, roughtongue bass, spotfin hogfish, blackfin snapper, amberjack (abundant), blue angelfish. Human debris: several fishing lines.

Dive 17-15: (Harter et al. 2018). Depth range: 92- 92.5 m multibeam map [NF 14-08 Snowy Wreck MPA, 1.5 m resolution (Harter 2014; Reed et al. 2015)] ENE-WSW oriented ridge, facing southeast; top 77 m, base 115 m. Transect along face of ridge slope. Previous dive- 2014. Difficulty staying on bottom with current; unable stay on bottom; abort dive.

Dive 17-16: (Harter et al. 2018). Depth range: 67-68 m; multibeam map [NF 14-08 Snowy Wreck MPA, 1.5 m resolution (Harter 2014; Reed et al. 2015)] shows SE edge of a flat topped

plateau, south slope oriented E-W, then curves to NE; top 61 m, base 70 m. Transect along face of ridge slope. Previous dive- 2014-15. 68 m, unable to go east, unable to get to dive site; abort dive.



Figure 42. Snowy Wreck MPA; ROV 16-15; 64.3 m; graysby.



Figure 43. Snowy Wreck MPA; ROV 17-19; 82.6m; *Oculina varicosa* (or *Madracis myriaster*?) coral covered rock wall.

Snowy Wreck MPA (Wreck Site)

The Snowy Grouper shipwreck lies near the eastern corner of the MPA at depths of 250 m (Figs. 6, 41, 44, 45). It is a steel ship of unknown age that is approximately 130 m long and 20 m wide. Known to have once held spawning aggregations of snowy grouper, it was quickly fished down after the wreck was discovered in the 1900's.

[Pisces_2016_Wreck_Point_Grid (Harter 2016; Harter et al. 2017),
Pisces_2012_SnowyWreckSITE_MB_Grid (Harter 2012; Reed et al. 2013a)]

Dive 16-17: (Harter et al. 2017) Depth range: 240-260 m; new multibeam shows wreck lying almost due E-W, approx. 130 m long; large scour at north side, west end. Transect from scour to west end, along north side to east end. Then followed large poly anchor line (1" fairly new) that was wrapped on the ship, and strung out due east. Wreck- west end base in sand, 260 m; deck level at railing- 253 m. Superstructure- 240 m. 1/2 way along hull- base 252 m, deck level 242 m. East end- 252 m at base, see inside broken open. No anchor seen or prop- not sure which end is which. multibeam shows a small mound about 50 m east of the wreck but we found a series of apparent scour holes but with no structure nearby to cause the scour. Never found the end of the anchor line. Dominant biota: sides covered with venus fly trap anemone, *Actinoscyphia*, small white anemones, serpulids. Some 10-15 cm *Lophelia* on vertical strut and railing, 240 m; Octocorallia- 15 cm grey fan Plexauridae. Dominant fish: snowy grouper- estimates of several hundred to 500, 2 yellowedge grouper, 1 *Laemonema*, few anthiids. Human debris: lots of fishing line; polypro anchor line (fairly new).



Figure 44. Snowy Wreck MPA (wreck site); ROV 16-17; 247 m; snowy grouper; anemones and zoanthids on the steel hull.



Figure 45. Snowy Wreck MPA (wreck site); ROV 16-17; 251.8 m; snowy grouper.

Characterization of Fish Populations, Benthic Macrobiota, and Benthic Habitat

A SEADESC (Southeastern United States Deep-Sea Corals) Level II analysis was completed for each dive in the individual cruise reports (Harter et al. 2016; 2017; 2018). These provided the following data for each dive site: cruise and ROV dive metadata, figure showing each ROV dive track overlaid on multibeam sonar maps, plot of ROV temperature profile, dive track data (start and end latitude, longitude, depth), objectives, general description of the habitat and biota, and images of the biota and habitat that characterize the dive site. In addition, these SEADESC Level II reports provided quantitative analyses of each dive site including: 1) CPCe 4.1[©] (Kohler and Gill 2006) analysis of percent cover of benthic macrobiota and substrate types (Appendix 1), and 2) densities of fish populations (Appendix 2).

Analysis of Fish Video Surveys

Appendix 2 lists all fish species identified from the quantitative video transects at each dive site and their densities (# of individuals 1000 m⁻²). A total of 163 species were observed. The areas with the highest overall densities of fish were inside and outside the Edisto MPA as well as inside the North Florida MPA. This was primarily due to large numbers of schooling tomtate and vermilion snapper inside the North Florida MPA and schooling tomtate, vermilion snapper, and striped grunt inside and outside the Edisto MPA. The lowest overall densities of fish were observed inside the OECA, the OHAPC, and outside Northern S. Carolina MPA. The greatest difference in total density of fish inside versus outside the MPAs was found at the Northern South Carolina MPA with a total density of 19,329 inside the MPA and only 1,449 outside the MPA. This is likely due to the low rugosity habitat that was examined outside the MPA. Six of the seven target species were observed over the three years including: blueline tilefish, speckled hind, yellowedge grouper, misty grouper, warsaw grouper, and snowy grouper. The most abundant grouper species was scamp and the most abundant snapper species was gray snapper.

Fish assemblage species diversity can be seen in Table 5. The highest total number of species (S) and species diversity (Shannon-Weiner index) was observed inside and outside the Edisto MPA while the lowest number of species and species diversity was found outside the Northern South Carolina MPA deep sites (iceberg scars) and inside the St. Lucie Hump MPA. Species diversity was higher inside all of the MPAs compared to the outside sites of the same MPA. For example, species diversity was higher inside the North Florida MPA compared to outside the North Florida MPA. This was also true for the Northern South Carolina, Snowy Wreck, Edisto, and OECA MPAs.

Table 5. Fish assemblage diversity inside and outside each MPA using the DIVERSE routine of PRIMER during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). S = total number of species, J' = Pielou's evenness, H'(loge) = Shannon-Weiner index of species diversity. MPAs are listed from smallest to highest species diversity.

	S	J'	H'(loge)
Outside Northern S. Carolina MPA - deep	30	0.8789	2.989
Inside St. Lucie Hump MPA	31	0.9205	3.161
Inside Northern S. Carolina MPA - deep	38	0.8826	3.21
Inside OHAPC	58	0.8476	3.442
Inside OECA	54	0.8857	3.533
Outside Georgia MPA	66	0.8744	3.663
Outside North Florida MPA	82	0.8461	3.729
Inside Devil's Hole SMZ	61	0.9194	3.78
Outside Northern S. Carolina MPA	62	0.9388	3.875
Inside North Florida MPA	103	0.8467	3.924
Outside Snowy Wreck MPA	82	0.9039	3.983
Inside Northern S. Carolina MPA	93	0.895	4.057
Inside Snowy Wreck MPA	90	0.9137	4.111
Outside Edisto MPA	119	0.8614	4.117
Inside Edisto MPA	124	0.8631	4.16

Fish assemblages inside and outside each MPA were compared using a multi-dimensional scaling (MDS) plot of Bray-Curtis similarities using square root transformed data of fish species (Fig. 46; PRIMER 6.0). Nine statistically different groups resulted from the SIMPROF test ($p < 0.05$). Letters in the figure indicate statistically significant groups. In general, fish assemblages were more similar by geographic region than they were by level of protection (inside vs. outside) with the exception being the Northern South Carolina MPA where inside was significantly different from outside. One of the statistically significant groups (a) consisted of inside and outside the iceberg scar sites of the Northern South Carolina MPA and their fish assemblages were 40% similar. The two *Oculina* sites (OECA and OHAPC; i) grouped together with sites outside the Georgia MPA (h) and their fish assemblages were 40% similar. Fish assemblages inside and outside the Snowy Wreck MPA (c) were 60% similar to those inside the Devil's Hole SMZ (b). Fish assemblages inside and outside the North Florida MPA (e), inside and outside the Edisto MPA (g), as well as inside the Northern South Carolina MPA were 60% similar to one another. Fish assemblages outside the Northern South Carolina MPA formed their own statistical group (d).

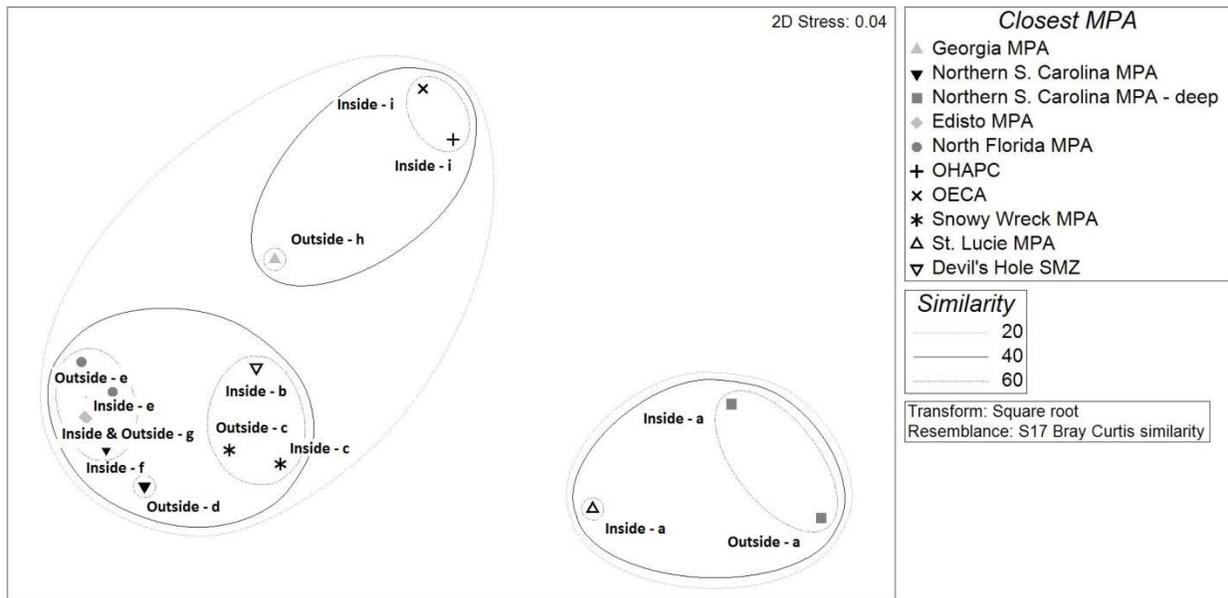


Figure 46. Multi-dimensional scaling (MDS) plot of ROV dive sites within and outside of the protected management areas (MPAs) based on Bray-Curtis similarity matrix calculated using square root transformed data of fish species during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). Assemblage similarity at 25, 40, and 60% are indicated. Statistically different groups (SIMPROF, $p < 0.05$) are indicated by letters a-i.

Densities of fish species in the snapper-grouper complex were compared inside and outside for each of the MPAs (Table 6). No dives were made inside the Georgia MPA or outside Devil's Hole SMZ and St. Lucie Hump MPA so comparisons could not be made for those areas. Thirty-five species in the snapper-grouper complex were observed on the ROV dives between 2015 and 2017 including six of the seven target grouper/tilefish species. At the *Oculina* sites, most species had higher densities in the OHAPC compared to the OECA with the exception of a few such as red snapper and scamp. Most fish species had higher densities inside the North Florida MPA compared to outside including red snapper, gray snapper, gag grouper, scamp, mutton snapper, and tomtate. At the Edisto MPA, approximately half of the snapper-grouper complex species had higher densities inside the MPA such as speckled hind, red snapper, gray snapper, and scamp while the other half had higher densities outside the MPA such as gag grouper, yellowmouth grouper, and porgies (*Calamus* sp.). Nearly all snapper-grouper complex species had higher densities inside the Northern South Carolina MPA including graysby, scamp, red porgy, tomtate, and striped grunt. Nearly all fish species had higher densities inside the Northern South Carolina deep sites (iceberg scars) compared to outside including blueline tilefish, snowy grouper and red porgy. The majority of snapper-grouper complex species had higher densities inside the Snowy Wreck MPA compared to outside including blackfin snapper, red snapper, gag grouper, and scamp. For this particular table, statistical analyses were not used when determining if average densities were higher inside or outside the MPA. They are based strictly on raw densities.

Table 6. Densities for species of the snapper-grouper complex inside and outside each MPA during 2015-2017 NOAA Ship Pisces cruises (15-02, 16-02, 17-02). A “Y” indicates a species had a higher density inside compared to outside the MPA while a “N” indicates a species did not have a higher density inside compared to outside the MPA. Density = # individuals 1000 m⁻²

Scientific Name	Common Name	OECA	OHAPC	Higher Inside MPA	North Florida MPA	Outside North Florida MPA	Higher Inside MPA	Edisto MPA	Outside Edisto MPA	Higher Inside MPA	Northern S. Carolina MPA	Outside Northern S. Carolina MPA	Higher Inside MPA	Northern S. Carolina MPA - deep	Outside Northern S. Carolina MPA - deep	Higher Inside MPA	Snowy Wreck MPA	Outside Snowy Wreck MPA	Higher Inside MPA
<i>Balistes capriscus</i>	gray triggerfish	7	2.35	Y	47.3	16.94	Y	15.99	3.27	Y	2.57		Y				0.51		Y
<i>Balistes</i> sp.	unid triggerfish				1.25	2.94	N	8.88	5.96	Y									
<i>Balistes vetula</i>	queen triggerfish				6	0.8	Y	1.01	4.14	N	2.44	0.4	Y						
<i>Calamus</i> sp.	unid porgy		0.45	N	4.2	5.13	N	60.8	111.88	N	56.81	11.43	Y				22.42	9.66	Y
<i>Canthidermis sufflamen</i>	ocean triggerfish																0.51		Y
<i>Caulolatilus microps</i>	blueline tilefish													12.79	4.06	Y			
<i>Centropristis ocyurus</i>	bank sea bass	24.54	94.88	N	1.25		Y	2.81	5.99	N									
<i>Centropristis</i> sp.	unid sea bass		3.41	N					0.61	N									
<i>Centropristis striata</i>	black sea bass	8.8	32.88	N															
<i>Cephalopholis cruentata</i>	graysby				8.9	5.35	Y	63.57	99.46	N	16.42	1.65	Y				23.08	11.6	Y
<i>Cephalopholis fulva</i>	coney				2.25		Y				0.4		Y						
<i>Epinephelus adscensionis</i>	rock hind								1.54	N	2.53		Y				1.95	6.03	N
<i>Epinephelus drummondhayi</i>	speckled hind							3.92		Y									
<i>Epinephelus guttatus</i>	red hind							0.54		Y	1.32		Y						
<i>Epinephelus</i> sp.	unid hind							0.4		Y									
<i>Haemulon album</i>	white margate								0.65	N									
<i>Haemulon aurolineatum</i>	tomtate				10862.64	5255.71	Y	19049.77	15751.11	Y	12884.78	41.25	Y				274.69	1923.54	N
<i>Haemulon plumierii</i>	white grunt				2.3	0.8	Y	1.67	2.05	N	18.2	1.88	Y					8.17	N
<i>Haemulon sciurus</i>	bluestriped grunt								0.67	N									
<i>Haemulon</i> sp.	unid grunt				188.5		Y	4071.08	4835.41	N							117.81	1088.1	N
<i>Haemulon striatum</i>	striped grunt				347.31	39.42	Y	5447.01	4497.71	Y	3479.44	194.04	Y				40.61	4057.57	N
<i>Hyporthodus flavolimbatus</i>	yellowedge grouper													0.4	0.67	N			
<i>Hyporthodus nigritus</i>	warsaw grouper		0.77	N															
<i>Hyporthodus niveatus</i>	snowy grouper	3.22	6.63	N										48.93	9.59	Y			
<i>Lachnolaimus maximus</i>	hogfish				5.94	0.91	Y	4.05	5.81	N	12.05	6.86	Y				10.21	4.13	Y
<i>Lutjanus analis</i>	mutton snapper				6.19		Y				0.4		Y						
<i>Lutjanus apodus</i>	schoolmaster				0.8		Y	0.8		Y									
<i>Lutjanus buccanella</i>	blackfin snapper				1.61	2.77	N			0.8	N						8.48	3.2	Y
<i>Lutjanus campechanus</i>	red snapper	19.15	5.54	Y	8.8		Y	5.22	0.61	Y							3.08	1.88	Y
<i>Lutjanus cyanopterus</i>	cupera snapper				4.9		Y												
<i>Lutjanus griseus</i>	gray snapper				86.13	13.13	Y	152.67	4.63	Y									
<i>Lutjanus</i> sp.	unid snapper		0.45	N	7.31	3.8	Y	4.07	3.36	Y	0.4		Y					0.4	N
<i>Mycteroperca interstitialis</i>	yellowmouth grouper							0.59	3.45	N	0.47		Y				1.12		Y
<i>Mycteroperca microlepis</i>	gag grouper	0.77	2.43	N	14.5	3.84	Y	14.63	18.1	N	1.28		Y				4.95	1.01	Y
<i>Mycteroperca phenax</i>	scamp	19.4	5.85	Y	51.35	17.24	Y	126.39	78.81	Y	38.87	8.08	Y	2.51		Y	66.32	61.35	Y
<i>Mycteroperca</i> sp.	unid grouper				0.85		Y	0.54	0.4	Y							0.61		Y
<i>Pagrus pagrus</i>	red porgy	5.28	4.8	Y	79.24	9.57	Y	73.05	80.95	N	16.61		Y	120.03	38.01	Y	1.26		Y
<i>Rhomboplites aurorubens</i>	vermillion snapper	10.17	170.92	N	6111.42	4452.52	Y	6574.2	2267.61	Y	36.94		Y	1.14		Y	50.58	484.79	N
<i>Seriola dumerili</i>	greater amberjack	28.61	49.8	N	8.1	3.95	Y	17.82	7.52	Y	1.28		Y	1.14		Y	10.75	5.08	Y
<i>Seriola fasciata</i>	lesser amberjack								10.28	N						1.2	N		
<i>Seriola rivoliana</i>	almaco jack	3.2	8	N	32.14	13.45	Y	91.2	75.41	Y	16.41		Y				26.15	16.68	Y
<i>Seriola</i> sp.	unid amberjack	2.43	11.69	N	21.12	12.21	Y	40.79	72.9	N	13.42	1.96	Y	3.26	8.73	N	55.1	24.33	Y
Serranidae	unid grouper							1.44	1.65	N				0.4		Y			

Scientific Name	Common Name	OECA	OHAPC	Higher Inside MPA	North Florida MPA	Outside North Florida MPA	Higher Inside MPA	Edisto MPA	Outside Edisto MPA	Higher Inside MPA	Northern S. Carolina MPA	Outside Northern S. Carolina MPA	Higher Inside MPA	Northern S. Carolina MPA - deep	Outside Northern S. Carolina MPA - deep	Higher Inside MPA	Snowy Wreck MPA	Outside Snowy Wreck MPA	Higher Inside MPA
Serranidae	unid sea bass	1.63	1.19	Y	0.54		Y												
Sparidae	unid porgy		0.77	N		1.58	N	0.54		Y			2.32	N					
Total		134.21	402.82		17912.84	9862.75		35835.46	27952.08		16603.02	269.88		190.61	62.24		720.21	7707.51	

Species diversity for those species within the snapper-grouper complex can be seen in Table 7. The lowest total number of species (S) and species diversity (Shannon-Weiner index) was observed inside the St. Lucie Hump MPA and outside the Northern South Carolina MPA deep sites (iceberg scars), which is also what was observed when the entire fish assemblage was examined. The highest total number of species for just the snapper-grouper complex species was observed inside and outside the Edisto MPA, also the same as when the entire fish assemblage was examined. However, interestingly, the highest species diversity for just the snapper-grouper complex was observed inside the Snowy Wreck MPA, outside the Georgia MPA, and inside the OECA which is unlike what was found when the entire fish assemblage was examined. With the exception of the Northern South Carolina MPA shallow sites, all of the MPAs had higher species diversity of snapper-grouper complex species inside the MPA compared to the same location outside the MPA.

Table 7. Fish assemblage diversity for species of the snapper-grouper complex inside and outside each MPA using the DIVERSE routine of PRIMER during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). S = total number of species, J' = Pielou's evenness, H'(loge) = Shannon-Weiner index of species diversity. MPAs are listed from smallest to highest species diversity.

	S	J'	H'(loge)
Inside St. Lucie Hump MPA	4	0.6768	0.9382
Outside Northern S. Carolina MPA - deep	6	0.8059	1.444
Outside North Florida MPA	21	0.486	1.48
Inside Northern S. Carolina MPA - deep	9	0.7004	1.539
Inside Northern S. Carolina MPA	21	0.5615	1.709
Inside North Florida MPA	28	0.5483	1.827
Outside Northern S. Carolina MPA	10	0.8125	1.871
Inside Devil's Hole SMZ	12	0.7958	1.977
Outside Edisto MPA	29	0.5884	1.981
Outside Snowy Wreck MPA	17	0.7019	1.989
Inside Edisto MPA	29	0.5929	1.997
Inside OHAPC	18	0.7647	2.21
Inside OECA	13	0.9106	2.336
Outside Georgia MPA	15	0.8782	2.378
Inside Snowy Wreck MPA	20	0.8679	2.6

Figure 47 shows where target species were observed as well as any large aggregations of snapper and grouper species. The target species include the seven deepwater grouper and tilefish which the MPAs were originally designed to protect. Aggregations in Figure 47 are not necessarily spawning aggregations (even though spawning coloration and behaviors were observed on a few occasions) but were high abundances of a species together in a small area (> 20 individuals), which is fairly uncommon for the larger snapper and grouper species. In the deeper part of the Northern South Carolina MPA (iceberg scar sites), there were frequently yellowedge grouper, snowy grouper, and blueline tilefish observed on the dives which does not show in the figure because the points are on top of each other.

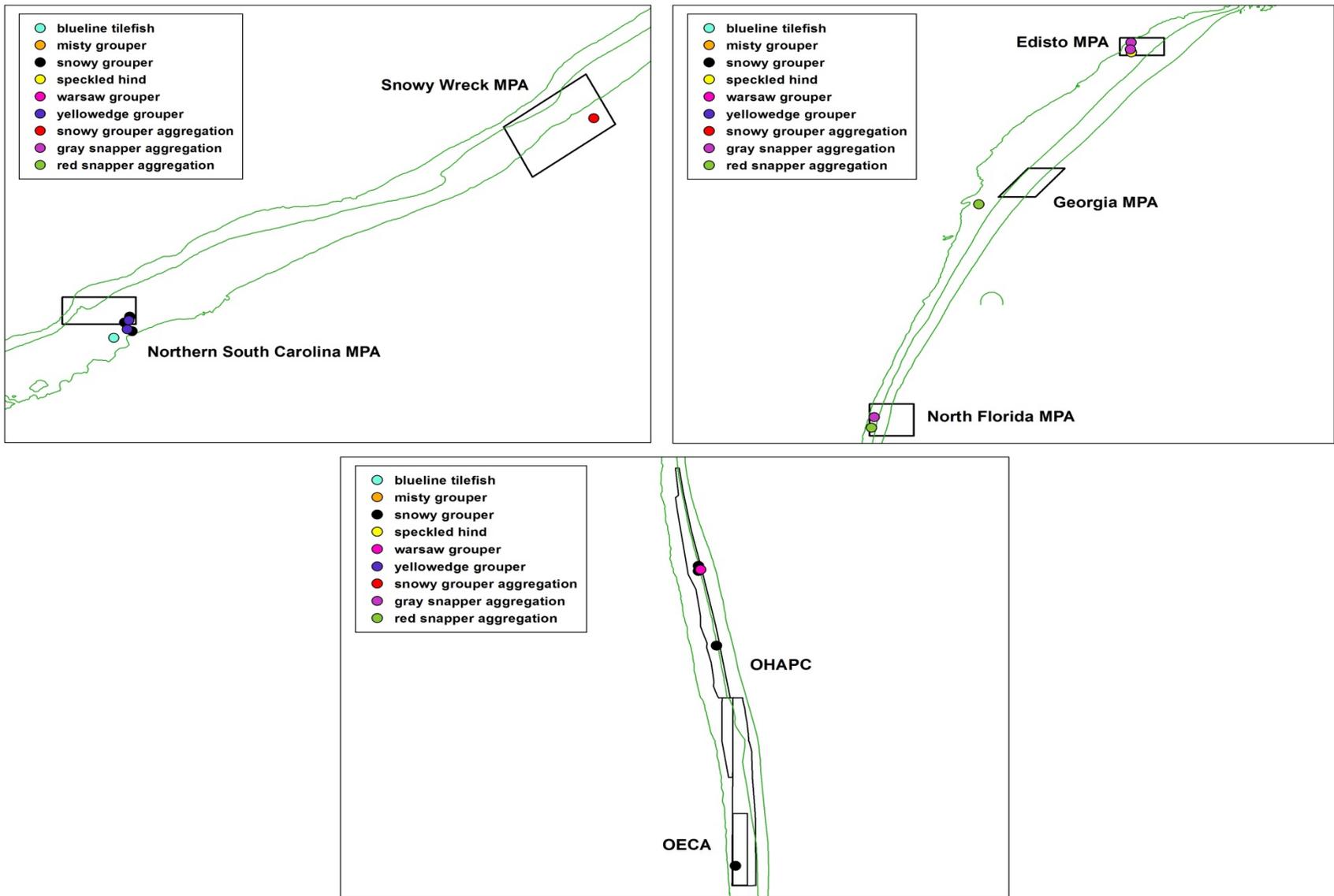
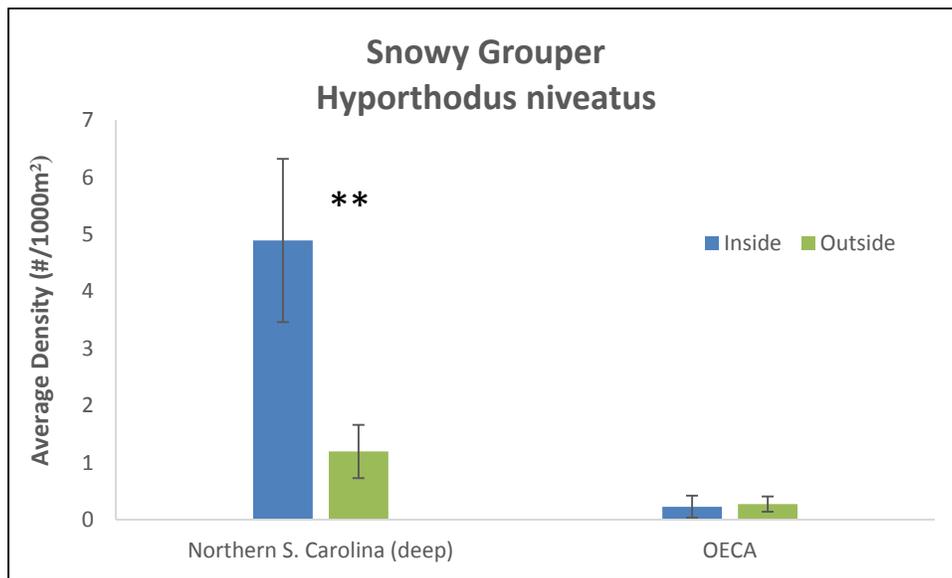
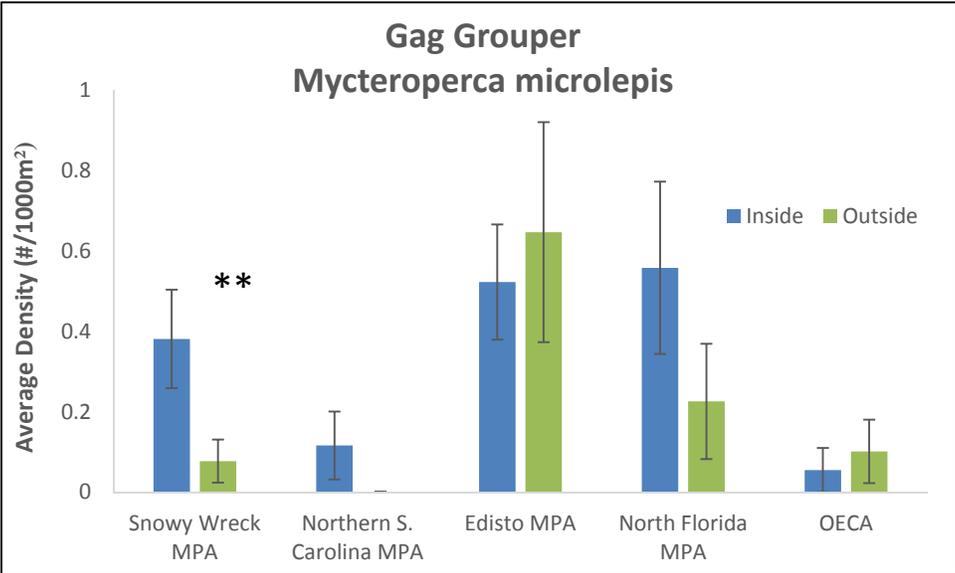
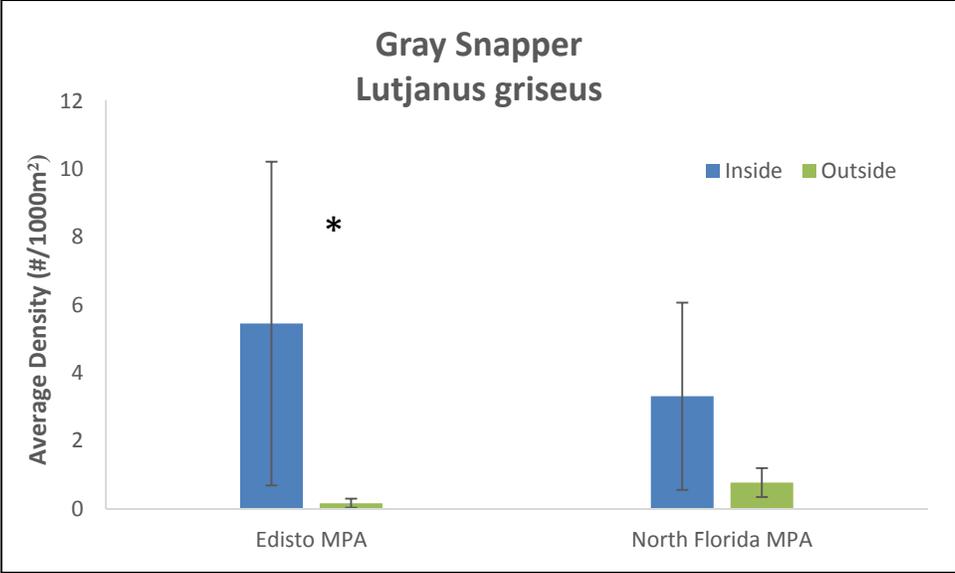


Figure 47. Maps showing where target grouper/tilefish species were observed during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). as well as any aggregations of snapper and grouper species.

A one-way ANOVA was conducted on several of the more abundant snapper-grouper complex species to determine if there were significant differences in fish densities inside vs. outside the MPAs (Fig. 48). Snowy grouper were only observed at the deep sites (i.e., iceberg scars) of the Northern South Carolina MPA and Oculina. Their densities were significantly higher inside the Northern South Carolina deep sites compared to outside ($p = 0.01$). Gray snapper, the most abundant snapper observed, had marginally significantly higher densities inside the Edisto MPA compared to outside ($p = 0.078$). Gag grouper had significantly higher densities inside the Snowy Wreck MPA compared to outside ($p = 0.034$). While scamp, the most abundant grouper, had higher densities inside all MPAs compared to outside, variances were too great for differences to be significant with the exception of Edisto MPA where differences were marginally significant ($p = 0.1$). Porgies (consisting of both red porgy and *Calamus* sp.) had significantly higher densities inside the Snowy Wreck MPA compared to outside. Other species that were tested but did not result in significant differences were blueline tilefish, tomtate, red snapper, and vermilion snapper. Of all species examined, densities were never significantly higher outside the MPAs compared to inside.





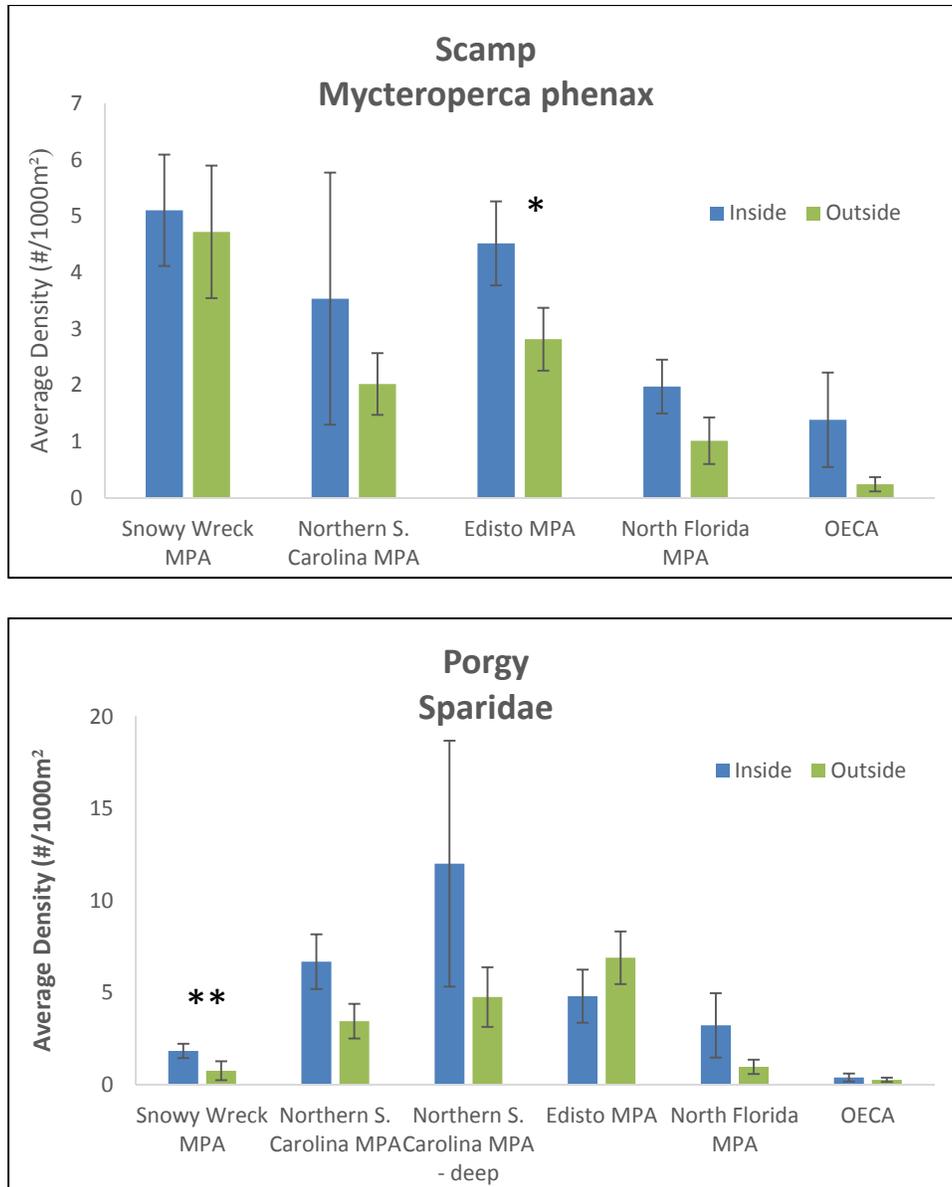


Figure 48. Average densities of snowy grouper, gray snapper, gag grouper, scamp, and porgies inside and outside each MPA from quantitative ROV video transects during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). A “*” indicates a marginally significant result from one-way ANOVA ($p \leq 0.1$) and a “**” indicates a highly significant result from one-way ANOVA test ($p < 0.05$).

Lionfish Populations

Lionfish continue to have a strong presence in and around the south Atlantic MPAs. Densities inside and outside each MPA are presented in Figure 49. A one-way ANOVA was run for each MPA to test for significant differences in lionfish densities inside vs. outside the MPA. Dives were only completed outside the Georgia MPA and inside the Devil’s Hole SMZ, so comparisons were not made for these areas. Lionfish densities were marginally significantly higher outside the OECA (i.e., inside the OHAPC) compared to inside ($p = 0.067$). Lionfish densities were also significantly higher inside the Snowy Wreck MPA compared to outside ($p =$

0.0005). Overall, lionfish densities were highest inside the Edisto MPA and were lowest in the *Oculina* areas (OECA and OHAPC). The only locations lionfish were not observed at all are the deeper sites including the iceberg scar sites inside and outside the Northern South Carolina MPA and inside the St. Lucie Hump MPA. Average lionfish densities for each year is shown in Figure 50. There was no significant difference in lionfish densities over the years ($p = 0.927$) and densities are higher than they were during the previous 3 years of this project. Average lionfish densities ranged from approximately 6 to 9 individuals 1000 m^{-2} between 2012 and 2014 while averages ranged from 15-16 individuals 1000 m^{-2} between 2015 and 2017.

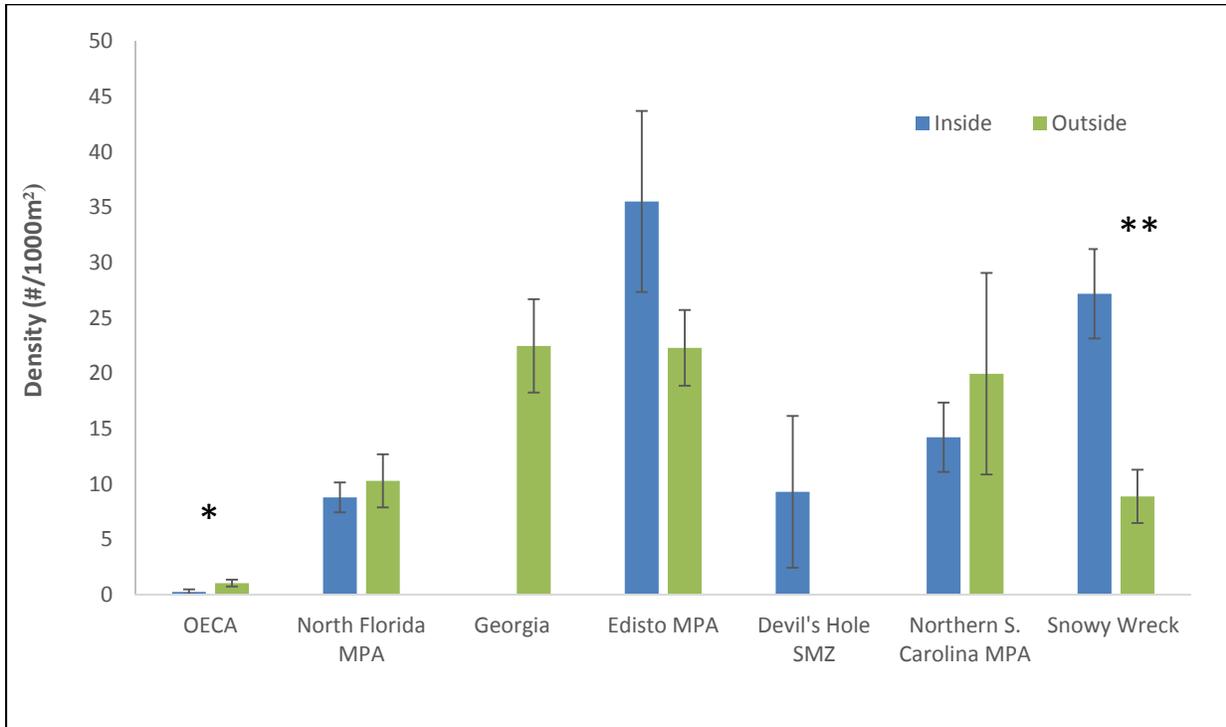


Figure 49. Density of lionfish (# individuals 1000m^{-2}) from quantitative ROV video transects during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02), at sites inside and outside each shelf-edge MPA. A “*” indicates a marginally significant result from one-way ANOVA ($p \leq 0.1$) and a “**” indicates a highly significant result from one-way ANOVA test ($p < 0.05$).

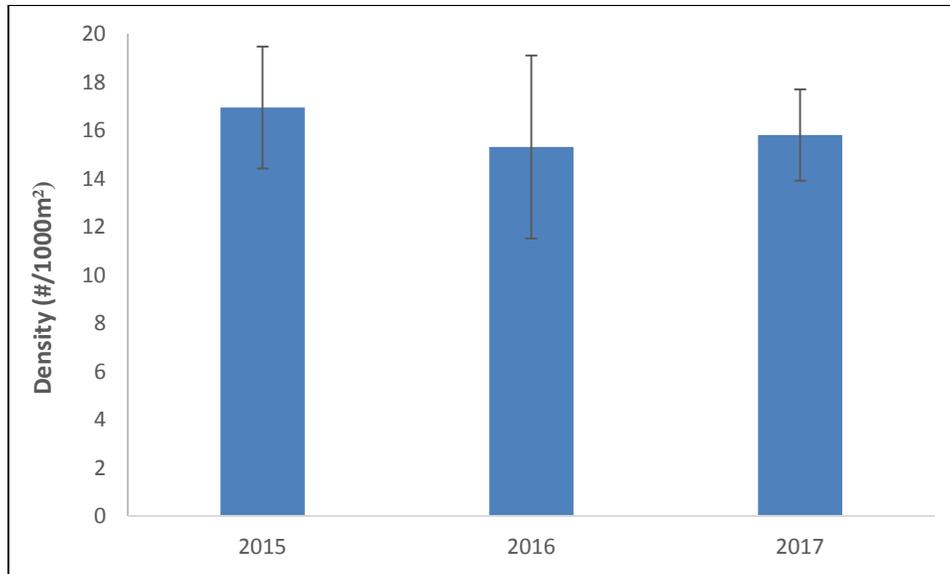


Figure 50. Lionfish densities (# individuals 1000m⁻²) based on quantitative ROV video transects summarized by year during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02).

Artificial Reefs

In 2016, a ROV dive was made on the wreck within the Snowy Wreck MPA. Fish species diversity was extremely low with only four species being observed. These include anthiids, mora cod, snowy grouper and yellowedge grouper. The vast majority of the fish on the wreck were snowy grouper. A noteworthy observation is the doubling of the number of snowy grouper in 2016 from the previous time we dove on the wreck in 2012. In 2012, we estimated approximately 240 snowy grouper on the wreck whereas 540 snowy grouper were estimated to be on the wreck in 2017.

Two barges were sunk in 2014 to comprise the Charleston Artificial Deep Reef MPA. Unfortunately, the barges did not land within the MPA boundaries, so they were open to fishing until July 2017 when the MPA boundary was moved to encompass the barges. One barge is at a depth of approximately 80 m (referred to as the shallow barge 1) while the other is at approximately 100 m (referred to as the deep barge 2). A ROV dive was made on the shallow and deep barge in both 2016 and 2017. Since transects were not made on these dives, fish abundances were recorded instead of densities. Table 8 lists the abundances of all fish species observed on the barge dives. A total of 25 species were observed including four target species (misty grouper, snowy grouper, warsaw grouper, and yellowedge grouper). Anthiids (which were mostly red barbier with a few rougtongue bass mixed in) covered the deep barge in 2017 and were too numerous to count. Not including the anthiids, the total number of individuals decreased from 2016 to 2017. 165 and 170 individuals were observed on the shallow and deep barges in 2016, respectively, while 110 and 78 individuals were observed on the shallow and deep barges in 2017, respectively. A few noteworthy changes in abundance from 2016 to 2017 include a decrease in the number of amberjack, lionfish, scamp, snowy grouper, and warsaw grouper.

Table 8. Abundances of all fish species observed on the ROV dives conducted on the barges of the Charleston Artificial Deep Reef MPA during 2016-2017 NOAA Ship *Pisces* cruises (16-02, 17-02).

Common_Name	2016 Shallow	2016 Deep	2017 Shallow	2017 Deep
amberjack (greater & almaco)	40	35	9	14
anthiid (mostly red barbier, few rough-tongue bass)	200	352	218	covering the barge
bank butterflyfish	1			2
bank sea bass	3	2	7	1
blackline tilefish (juvenile)			4	4
blue angelfish	3		3	
cubbyu	7		3	18
gag grouper			3	
graysby	1			
greenband wrasse				4
jackknife-fish		2		
lionfish	52	22	42	5
misty grouper		1		
red porgy				1
red snapper	6	1		
reef butterflyfish	5		3	
saddle bass	3	3	3	
scamp	16	15	7	7
snowy grouper (adults & juveniles)		26	2	17
spotted moray			1	
unid drum		18		
unid grouper	4			
unid porgy	2			
unid puffer				1
unid snapper				1
unid wrasse	10	7	17	
unknown	9	1	4	
vermillion snapper		30		
warsaw grouper		5		1
wrasse bass	2		2	
yellowedge grouper	1	2		2

Fish Communities and Habitat Relationships

Interrelationships of the fish communities with habitat factors were analyzed with MDS plots of similarity (Fig. 51). Depth was the most influential factor contributing to fish species composition. Depth of ROV dives was divided into three categories (45-80 m, 81-125 m, and 126-185 m). The MDS plot of depth shows the deepest dives (all of the dives in the 126 – 185 m range as well as a few from the 81 – 125 m range) were distinct from the shallower ones and cluster together where the fish assemblages were 40% similar. These dives consisted of all those conducted at the iceberg scar sites inside and outside of the Northern S. Carolina MPA as well as those within St. Lucie Hump MPA. Because of the deeper depths here, a distinct community of fish species was observed. The shallower sites (depths of 45–125 m) clustered together where the fish assemblages being 20% similar. An Analysis of Similarity (ANOSIM) was conducted on the depth data and confirmed the strong influence of this factor ($R = 0.508$) and Similarity Percentages (SIMPER) tests indicated that this difference was due to higher densities of anthiids and boarfish on the deeper dives and higher densities of tomtate and damselfish on the shallower dives.

Rugosity was the second most influential factor in determining fish assemblage composition (ANOSIM, $R = 0.374$). SIMPER test indicated that this difference was due to higher abundances of the schooling fish species (tomtate, vermilion snapper, and striped grunt) on the high rugosity sites.

Habitat type was the third most influential factor in determining fish species composition (ANOSIM, $R = 0.31$). Habitat type was divided into five hardbottom categories: pavement (no relief), LRO (low relief outcrops; <1m relief), MRO (moderate relief outcrops; 1-3m relief), HRL (high relief ledge; >3m relief), and mound (moderate to high relief mounds found at *Oculina* HAPC/OECA). Three statistically different groups resulted from the SIMPROF test ($p < .05$). Fish assemblages on mound and pavement clustered together as one significant group with fish assemblage similarity of 60%. Fish assemblages on low relief outcrops were their own significant group and those on moderate and high relief habitat were another significant group with fish assemblage similarity of 60%. These differences were primarily due to higher densities of tomtate, vermilion snapper, striped grunt, and damselfish on the low, moderate, and high relief habitats. Year did not have a significant effect on fish assemblage composition (ANOSIM, $R = 0.05$).

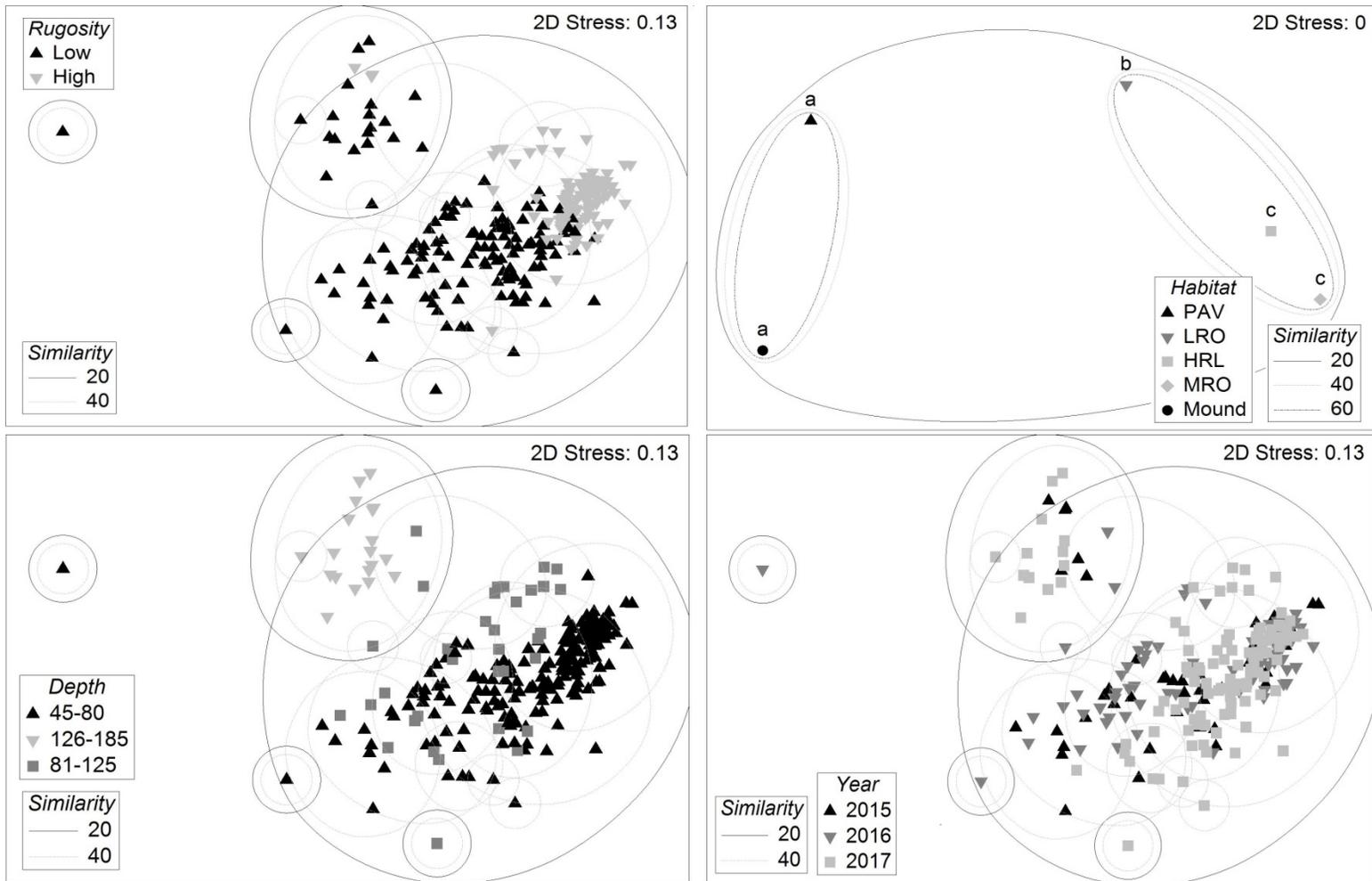


Figure 51. Multi-dimensional scaling (MDS) plot of ROV dive sites based on Bray-Curtis similarity matrix calculated using square root transformed data of fish species during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). Fish densities vs. rugosity, habitat type, depth, and year. Habitat types are abbreviated: PAV= pavement (no relief), LRO = low relief outcrops (<1 m relief), MRO= moderate relief outcrops (1-3 m relief), HRL= high relief ledge (>3 m relief), and Mound (moderate to high relief mounds found at Oculina). Assemblage similarity percentages are indicated for habitat, depth, and year. Statistically different groups (SIMPROF, $p < 0.05$) are indicated by letters a-c for habitat.

Benthic Habitat and Macrobiota

Appendix 1 lists the species of benthic macro-invertebrates and algae that were identified from the photo transects over all three years and their percent cover based on CPCe Point Count of the quantitative images. The individual cruise reports (Harter et al. 2016; 2017; 2018) present the data for each dive. Appendix 1 and the following results of this report combine the dives by site regions (Florida, Georgia, South Carolina, North Carolina) which are further divided as: the 11 marine protected area sites (MPAs, OHAPC, SMZ) and their respective 6 ‘Outside’ sites that are adjacent to the respective MPA but are not protected. Note that all the taxa listed in the Appendix 1 were counted in CPCe, however, some show 0.00% but have some lesser percentage than that (e.g., 0.001%).

A total of 150 taxa of benthic macrobiota were identified from the quantitative photo transects and were used for CPCe percent cover analyses (Appendix 1). These included 40 taxa of Cnidaria which included the following coral taxa: 9 Scleractinia hard corals (*Cladocora* sp., *Lophelia pertusa*, *Madracis decactis*, *Madracis myriaster*, *Oculina varicosa*, *Phyllangia americana*, *Scleractinia- unid colonial*, *Scleractinia- unid cup*, *Siderastrea radians*); 18-Alcyonacea (Alcyonacea- gorgonian, Alcyoniina, *Bebryce* sp., *Carijoa* sp., *Diodogorgia* sp., *Ellisella* sp., Ellisellidae, *Iciligorgia schrammi*, *Leptogorgia* sp., *Muricea* sp., *Nicella* sp., *Nidalia occidentalis*, Plexauridae, Plexauridae- purple, Plexauridae- yellow, *Plumarella* sp., *Swiftia exserta*, *Titanideum frauenfeldii*); and 5 Antipathidae (*Antipathes atlantica*, *Antipathes furcata*, Antipathidae, *Stichopathes lutkeni*, *Tanacetipathes* sp.). Non-coral Cnidaria included Actiniaria, Corallimorpharia, Zoantharia, *Virgularia presbytes* (sea pen), and Hydroidolina (hydroids).

Porifera were most species rich with 52 taxa; the most common demosponges were *Agelas* spp., *Aiolochoira crassa*, *Aplysina* spp., *Auleta* sp., *Callyspongia vaginalis*, *Chondrilla* sp., *Chondrosia* sp., *Cinachyra/Cinachyrella* sp., *Clathria* sp., *Cliona* sp., Corallistidae, *Erylus* sp., *Geodia* spp., *Ircinia campana*, *Ircinia strobilina*, *Leiodermatium* sp., *Neofibularia nolitangere*, *Niphates* sp., *Oceanapia* sp., Poecilosclerida, *Polymastia* sp., *Scopalina* sp., *Siphonodictyon coralliphagum*, Spirastrellidae, *Spongosorites* sp., *Theonella* sp., *Xestospongia muta*, and *Zyzya* sp. Only one species of Hexactinellida (glass sponge) was identified, *Farrea* sp. Other fauna included Annelida, Mollusca, Arthropoda, Bryozoa, Ascidiacea, and Echinodermata (18 taxa; including, Asteroidea- *Goniaster tessellatus*, *Narcissia trigonaria*; Crinoidea- *Davidaster discoideus*; Echinoidea- *Arbacia punctulata*, *Centrostephanus longispinus*, *Coelopleurus floridanus*, *Eucidaris tribuloides*, *Stylocidaris* sp.; Holothuroidea- *Holothuria lentiginosa*, *Paracolochirus mysticus*; Ophiozoidea- *Asteropora annulata*, *Ophioderma devaneyi*, Gorgonocephalidae. Algae were dominant at many of the sites and included Phaeophyta (dominated by *Dictyota* spp.), Chlorophyta, and Rhodophyta (primarily crustose coralline algae); but these were not identified to species level.

CPCe Point Count analysis calculated by dive the percent cover of benthic macrobiota and bare substrate, and was averaged by region and MPA status (Table 9, Appendix 1). In addition, the percent cover of hard bottom versus soft bottom was calculated for each region (Fig. 52). This was based on what type of substrate was under any point on biota. In general, the cover of hard bottom was high in all MPA reef sites (average 45% for all sites). Excluding the artificial reefs sites, percent hard bottom was greatest at the newly discovered *Oculina* mound site, St. Lucie

Hump MPA (94%), followed by the Outside Florida MPA site (87.14%). The OECA also had relatively high hard bottom cover (83.92%) as did the South Carolina sites, Edisto and Devil's Hole (80- 86%). No ROV dives were within the Georgia MPA, because it was established to protect sand-dwelling tilefish, but the sites outside the Georgia MPA had the lowest cover of hard bottom of all (27.71%). The Outside Georgia MPA sites also had the lowest cover of biota (8.10%) of all the reef sites. Within the MPA sites, macrobiota cover ranged from 10.81% (Northern South Carolina MPA ice berg scar site) to 41.34% (Edisto MPA) (Fig. 53, Table 9). There are no comparable 'outside *Oculina*' MPA sites for comparison; however, the OHAPC which still allows bottom fishing had less biota cover (11.41%) than the OECA (14.98%). Also the newly discovered *Oculina* reefs within the St Lucie Hump MPA had 24.09% cover of biota. The inside and outside North Florida MPA sites had 24.74% and 35.09% cover, respectively. The Edisto sites were similar in percent cover with 41.34% inside and 47.03% cover outside the MPA. The Northern South Carolina MPA site had 35.3% cover compared to the outside site with 20.42%. The Northern South Carolina MPA sites consists of two very different habitats. The western region at mesophotic reef depths of 67 m had 35.30% cover, whereas the ice berg scour sites at 167 m had 10.81% cover, with completely different biota. The Snowy Wreck MPA site off North Carolina also has two distinct regions. The reef sites are at mesophotic depths of 56-105 m and had 16.82% cover compared to an outside MPA site with 23.51% cover. The actual shipwreck site is on soft bottom, but the wreck of unknown age is 260 m deep and had 36.96% cover on the wreck. The other two artificial reef sites (Charleston Artificial Deep Reef MPA, shallow and deep barges), are also on soft bottom, but the barges provide reef structure for fish and encrusting invertebrates. Although the two barges were sunk the same year (2014), the deeper barge (102 m) had 58% biota compared to the 88 m barge with 26.82% cover.

Overall, algae were the dominant cover averaging 11.29% for all sites (Table 9). Figure 53 clearly shows the reef sites off South Carolina had much greater algal cover (maximum of 27.88% at Outside Edisto MPA; 21.41% inside Edisto MPA, and 24.07% at Northern S.C. MPA) than the other regions. Sponges (Porifera) were the next most common taxa averaging 4.43% cover for all sites. Sponges were most common at the North Florida sites (6.44% inside MPA, and 9.66% outside MPA) and South Carolina's Edisto sites (6.49% inside, 6.48% outside). The iceberg scar site outside of the Northern S.C. MPA also had relatively large numbers of sponges (6.97%) but being deeper, these species were all different from the mesophotic depth sites.

Table 9. Fish densities from ROV video transects and percent cover of benthic macrobiota and substrate from CPCe Point Count analysis of photographic transects listed by region and MPA status (i.e., inside MPA or outside MPA) during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-20, 17-02). Fish density= # individuals/ 1000 m², % HB= % cover of bare hard bottom, Coral= Scleractinia hard coral, Gorg= Octocorallia (gorgonian), Anti= Antipatharia (black coral), Algae= macroalgae, Por= Porifera (sponges).

State/MPA	Total # of Dives	Fish Density (# indiv /1000 m ²)	% HB	Biota	% Coral	% Gorg	% Anti	% Algae	% Por
Florida	25		56.71%	21.36%	0.53%	0.31%	2.15%	6.92%	4.52%
St. Lucie Hump MPA	1	2156	70.05%	24.09%	2.57%	0.27%	0.05%	13.81%	1.46%
Oculina Experimental Closed Area (OECA)	4	1027	71.73%	14.98%	0.31%	0.04%	0.61%	5.57%	2.79%

Oculina HAPC	7	1814	61.07%	11.41%	0.46%	0.40%	1.00%	1.10%	1.17%
North Florida MPA	7	24240	39.92%	24.74%	0.03%	0.22%	3.46%	7.87%	6.44%
Outside North Florida MPA	6	12955	51.12%	35.09%	0.44%	0.48%	4.37%	12.00%	9.66%
Georgia	7		23.04%	8.10%	0.05%	0.77%	0.42%	0.48%	1.67%
Outside Georgia MPA	7	3005	23.04%	8.10%	0.05%	0.77%	0.42%	0.48%	1.67%
South Carolina	38		39.94%	35.94%	0.16%	2.79%	0.72%	17.55%	4.96%
Charleston Deep Artificial Reef MPA (Barge 1)	2	n/a	67.94%	26.82%	0.00%	0.00%	0.00%	0.00%	1.06%
Charleston Deep Artificial Reef MPA (Barge 2)	3	n/a	35.28%	58.01%	0.00%	0.00%	0.44%	0.00%	0.10%
Edisto MPA	10	43997	36.72%	41.34%	0.22%	3.59%	1.04%	21.41%	6.49%
Outside Edisto MPA	8	37423	36.71%	47.03%	0.07%	3.57%	0.99%	27.88%	6.48%
Devil's Hole SMZ	3	16895	57.20%	28.59%	1.38%	7.41%	2.59%	4.99%	4.58%
Northern South Carolina MPA	4	19329	29.31%	35.30%	0.02%	1.16%	0.13%	24.07%	2.73%
Outside Northern South Carolina MPA	3	1449	45.30%	20.42%	0.00%	1.06%	0.17%	7.30%	5.03%
Northern South Carolina MPA (iceberg scar site)	3	2839	44.01%	10.81%	0.02%	2.60%	0.00%	0.00%	2.45%
Outside Northern South Carolina MPA (iceberg scar site)	2	5233	63.74%	11.07%	0.09%	0.36%	0.00%	0.00%	6.97%
North Carolina	9		46.49%	22.34%	2.22%	1.73%	1.79%	3.76%	3.60%
Snowy Wreck MPA	5	7423	39.90%	16.82%	0.47%	1.46%	1.55%	4.41%	3.71%
Outside Snowy Wreck MPA	3	12190	49.62%	23.51%	4.81%	2.37%	2.66%	4.30%	4.67%
Snowy Wreck MPA (wreck site)	1	n/a	58.74%	36.96%	0.24%	0.72%	0.00%	0.00%	0.05%
Grand Total	79		45.01%	27.70%	0.52%	1.72%	1.29%	11.29%	4.43%

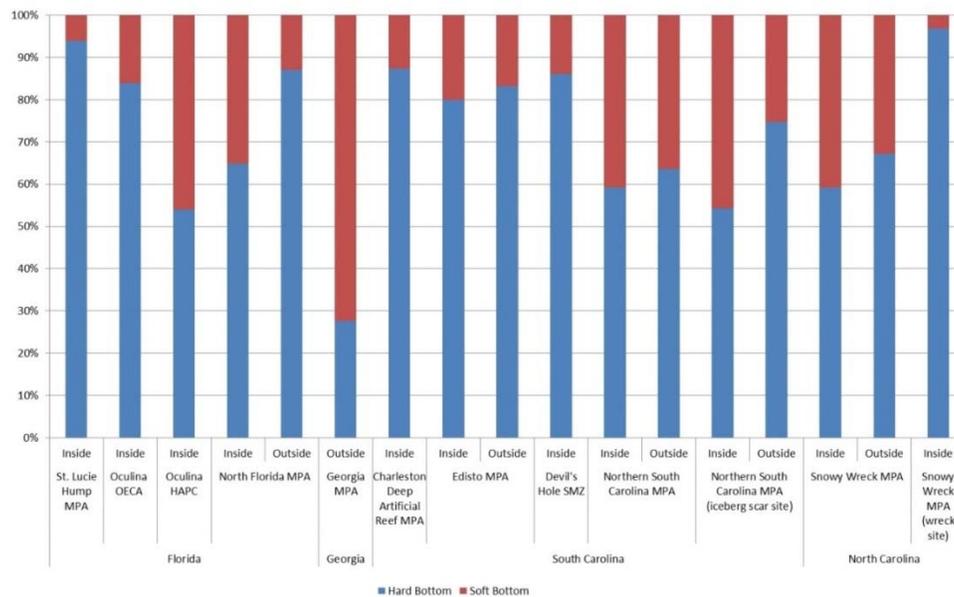


Figure 52. Percent cover of hard bottom (blue) vs soft bottom (red) by region and MPA status during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Points on biota were scored as underlying substrate.

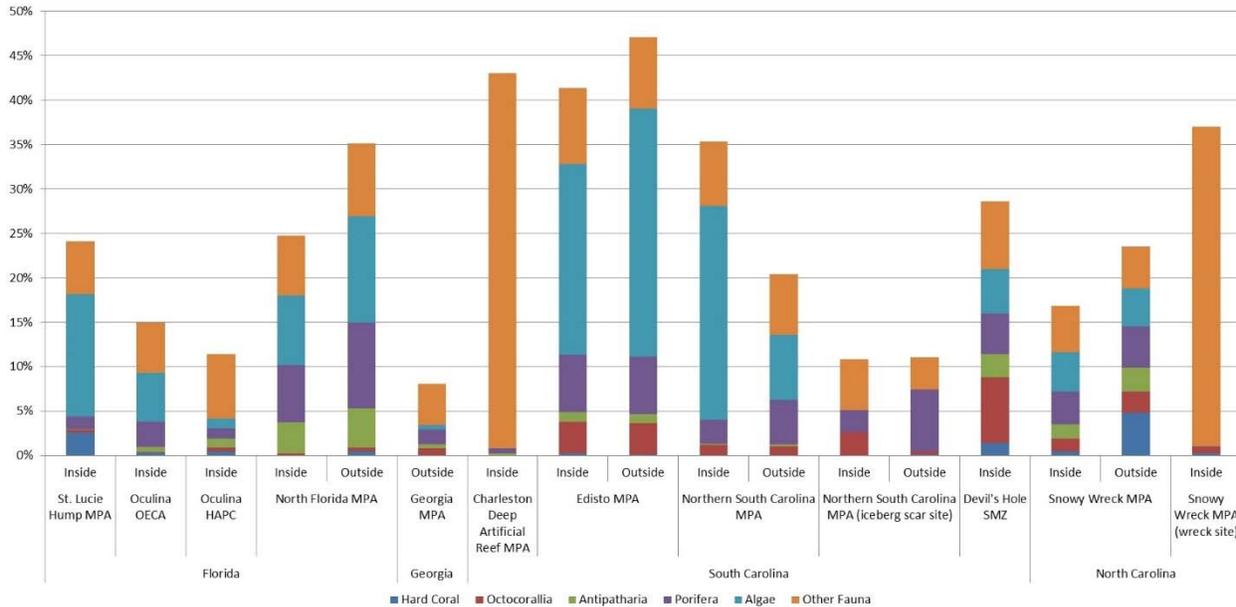


Figure 53. Percent cover of major benthic macrobiota taxa by region and MPA status during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02).

Coral Cover

Based on CPCe Point Count, the percent cover of hard corals averaged 0.52% for all sites but was greatest off North Carolina (2.22% average cover) and Florida (0.53%) (Figs. 53, 54; Table 9). Coral cover was lowest at the Georgia (0.05% cover), and South Carolina sites (0.16%). The greatest cover was 4.81% at the ‘Outside’ Snowy Wreck MPA. This was primarily *Oculina varicosa* and/or *Madracis myriaster* corals growing on rock ledges. These two species are very difficult to identify without a specimen in hand and look nearly identical from the distance in the photos. Both species form thin-branched colonies that are azooxanthellate (white due to low light levels) in deep-water (>60 m), and the skeleta is also sometimes pink especially at the base. Under a microscope, however, *Madracis* are easy to distinguish based on the 10 septa. Therefore these identifications are tentative until we can get collections. Only within the *Oculina* HAPC are we certain of the identification of *O. varicosa* from our extensive collections.

The greatest disparity of coral cover inside vs outside an MPA was at the Snowy Wreck MPA reef sites (4.81% Outside, 0.47% Inside). *Oculina varicosa* was the dominant colonial coral species at the *Oculina* mound sites (St. Lucie Hump MPA- 2.57% cover, OECA- 0.31%, and OHAPC- 0.46%). Many of the new growth *Oculina* corals are showing up in the OHAPC and OECA as smaller colonies 10-20 cm but these are scattered and CPCe Point Count is not a good indicator of density. The individual cruise reports give more detail of the recent dives on the St Lucie MPA and OHAPC reef sites and provide coral counts (Harter et al. 2017). In 2016, 459 colonies of live *Oculina varicosa* were counted within the OHAPC. Of these 154 were documented with 3 dives in the new northern extension of the *Oculina* HAPC, and 138 colonies were documented by a single dive at Chapman’s Reef within the OECA. The deep-water coral *Lophelia pertusa* was found at the Snowy Grouper shipwreck site at depths of 260 m. Typically *L. pertusa* occurs at depths >200 m and temperatures below 12°C.

Other non-scleractinian corals included Octocorals (gorgonians) which consisted of at least 18 species and probably more. Many could only be identified to genus or family without a specimen in hand. Percent cover of gorgonians averaged 1.72% for all sites and ranged from 0.31% cover in the region of Florida, 0.77% at Georgia, 2.79% at South Carolina, and 1.73% at North Carolina (Fig. 54, Table 9). The Devil’s Hole SMZ had the greatest cover (7.41%) which were various unidentified Plexaurids. The gorgonian *Swiftia exserta* was most common in the Edisto region (1.37% Outside Edisto MPA, 0.15% Inside). A total of 1,458 *Swiftia* colonies were counted at the Edisto sites in 2016. Historically the *Oculina* reefs have had few gorgonians, and currently we found 0.04% in the OECA and 0.4% in the OHAPC. Antipatharia black corals averaged 1.29% cover, and was greatest at North Florida (4.37% Outside MPA, 3.46% Inside MPA).

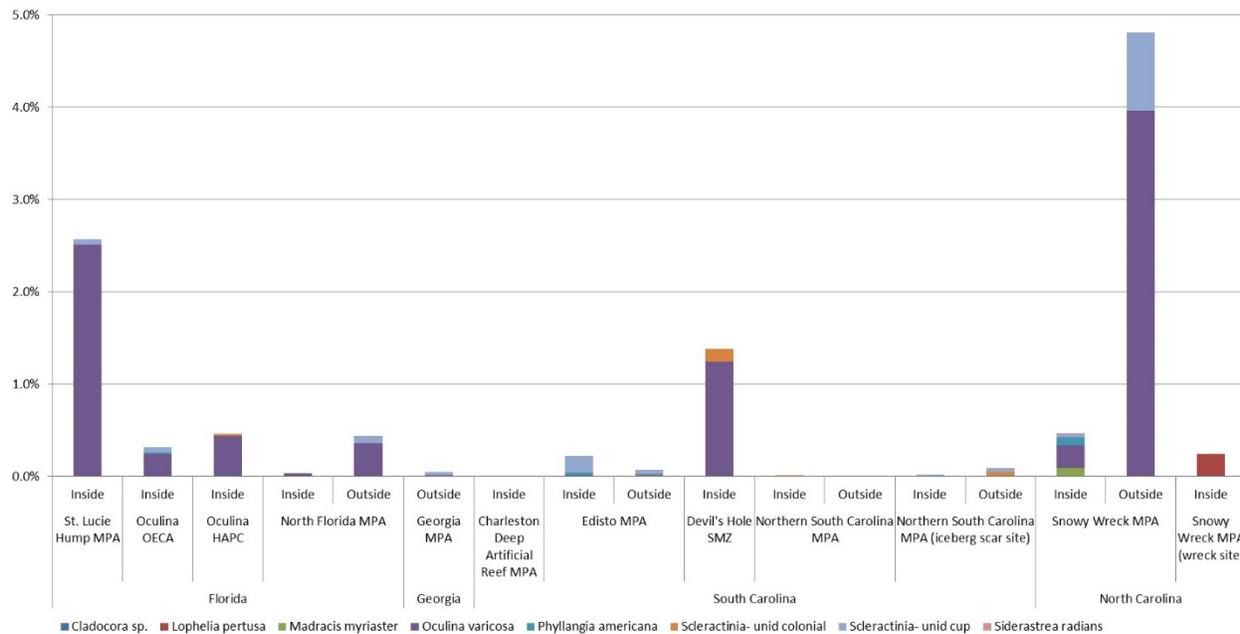


Figure 54. Percent cover of hard corals by region and MPA status during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02).

Benthic Biota and Habitat Relationships

The benthic communities were compared among sites using multi-dimensional scaling (MDS) plots of the Bray-Curtis Similarity index for benthic macrobiota percent cover (with square-root transformation). First the communities were compared to see if there were regional or latitudinal variances. For this analysis the Inside and Outside MPA sites were combined. ROV 15-01 and 15-21 were strong outliers, they had a >90% sediment substrate. These two dives were removed and the remaining dives reanalyzed. All the remaining dives, both inside and outside of each MPA, were plotted (Figure 55). The 2D stress on the MDS plot was moderate (0.17). Statistically significant SIMPROF letter groups are included. In general, there was a fairly strong clustering by region. The Charleston Deep Reef MPA (Barge 1 and 2, group d), the Snowy Wreck MPA (wreck site, group b) and one of the Devil’s Hole SMZ (group c) sites formed a strong cluster (similarity = 30). For the artificial reefs and shipwreck, this was due in part to the strong presence of bivalves (likely *Ostreidae*) growing on the wreck surfaces. A Simper test between SIMPROF groups showed that bivalves were the greatest contributor to the similarity in

these three groups. The other remaining sites that clustered with the barge/wreck sites were all >100 m deep (similarity = 20, group a). These included the deep iceberg scour sites and the deeper reef sites at Northern South Carolina. The iceberg scar site consisted of the following benthic taxa not found at the other sites: *Leiodermatium* sp. (sponge), *Paracolochirus mysticus* (sea cucumber), Majidae crabs, and *Nicella* sp. gorgonians. The Snowy Wreck MPA shipwreck site was also unique with the taxa: *Lophelia pertusa* (deepwater coral), unidentified Alcyoniina (soft coral), various Actiniaria (anemones including venus flytrap anemones), and *Eumunida picta* (squat lobster). The remaining sites were shallower, primarily at mesophotic depths (<100 m; similarity = 20, groups e-v). *Oculina* ECA, OHAPC and St. Lucie Hump MPA all grouped together (similarity = 40, group g). This is strongly linked to the presence of *Oculina varicosa* coral at these sites. The Northern S.C. mesophotic reef sites (<100 m; groups n and j), Edisto (groups l, m, o), Snowy Wreck reef sites (group v), Devil's Hole (<100 m; group t), and North Florida (groups q, r, s) sites generally clustered together (similarity = 60). The South Carolina Edisto region formed a very tight community but was not much different from the Northern South Carolina region (groups l, m, n, o; similarity = 60).

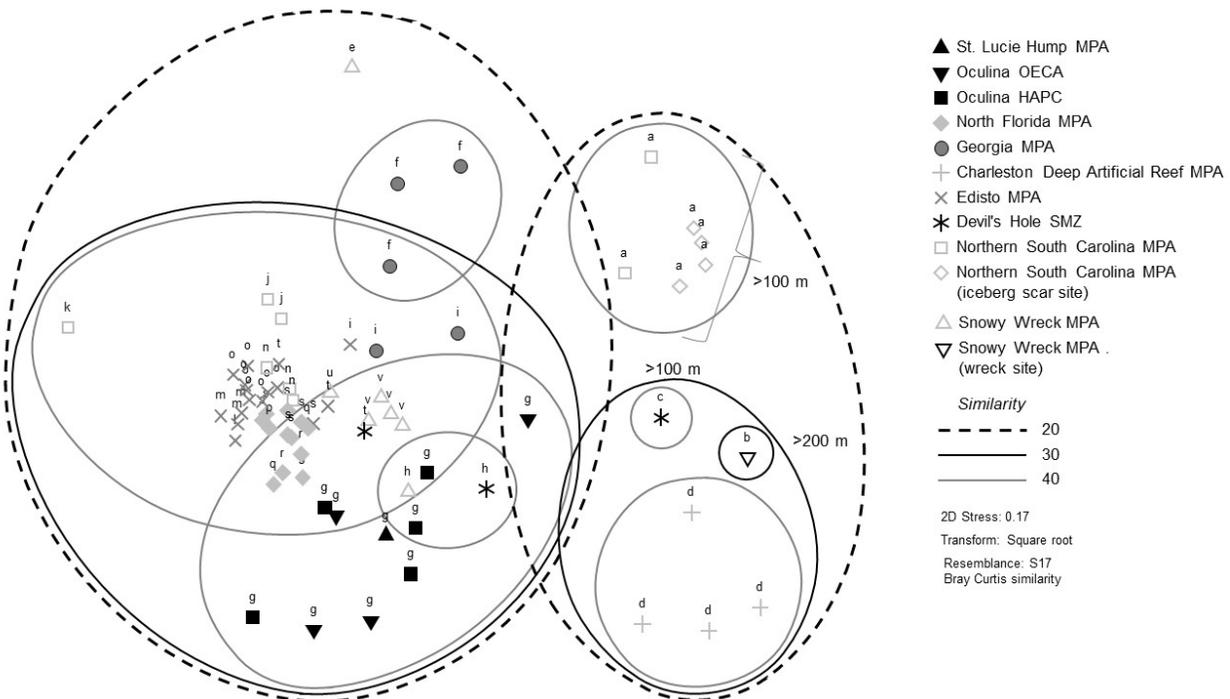


Figure 55. Multi-dimensional scaling (MDS) plot of benthic macrobiota by region (data for all dives inside and outside of each MPA site) based on Bray-Curtis similarity matrix calculated from square-root transformation of benthic macrobiota percent cover during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Statistically significant SIMPROF letter groups are included. Assemblage similarity at 20-40% is indicated.

Figure 56 shows a MDS plot comparing the benthic macrobiota Inside vs Outside of each MPA site. Statistically there was little difference between the Outside MPA sites compared to the adjacent Inside MPA sites. A SIMPROF dendrogram of these same data show the statistically different groups ($p < 0.05$ are indicated by red bars) (Fig. 57). North Florida MPA Inside and Outside sites were very similar (similarity = 75, group g). Edisto MPA was also tightly clustered

(similarity >80; group f) as was the Northern S. Carolina sites (similarity = 60; group e). The three *Oculina* sites (OECA, OHAPC and St Lucie) were statistically grouped (similarity ~55; group b); however, there is no “Outside” *Oculina* site for comparison. The Snowy Wreck reef sites were statistically different between Inside and Outside the MPA (similarity = 75; groups c, d). Interestingly, Inside Devil’s Hole MPA was statistically similar to Outside Snowy Wreck MPA reef site (similarity = 60, group c). There were no comparisons for Outside the Charleston Deep Artificial Reef MPA or for the Snowy Wreck MPA wreck site. The iceberg scar sites of the Northern S.C. MPA grouped together (similarity ~60), but were significantly different (groups h and i). These similarities between the Inside versus Outside MPA sites are a good sign that the outside sites are comparable to the MPAs for future surveys. These surveys appear to provide good baseline data for the MPA sites which only have been of protected status for just a decade.

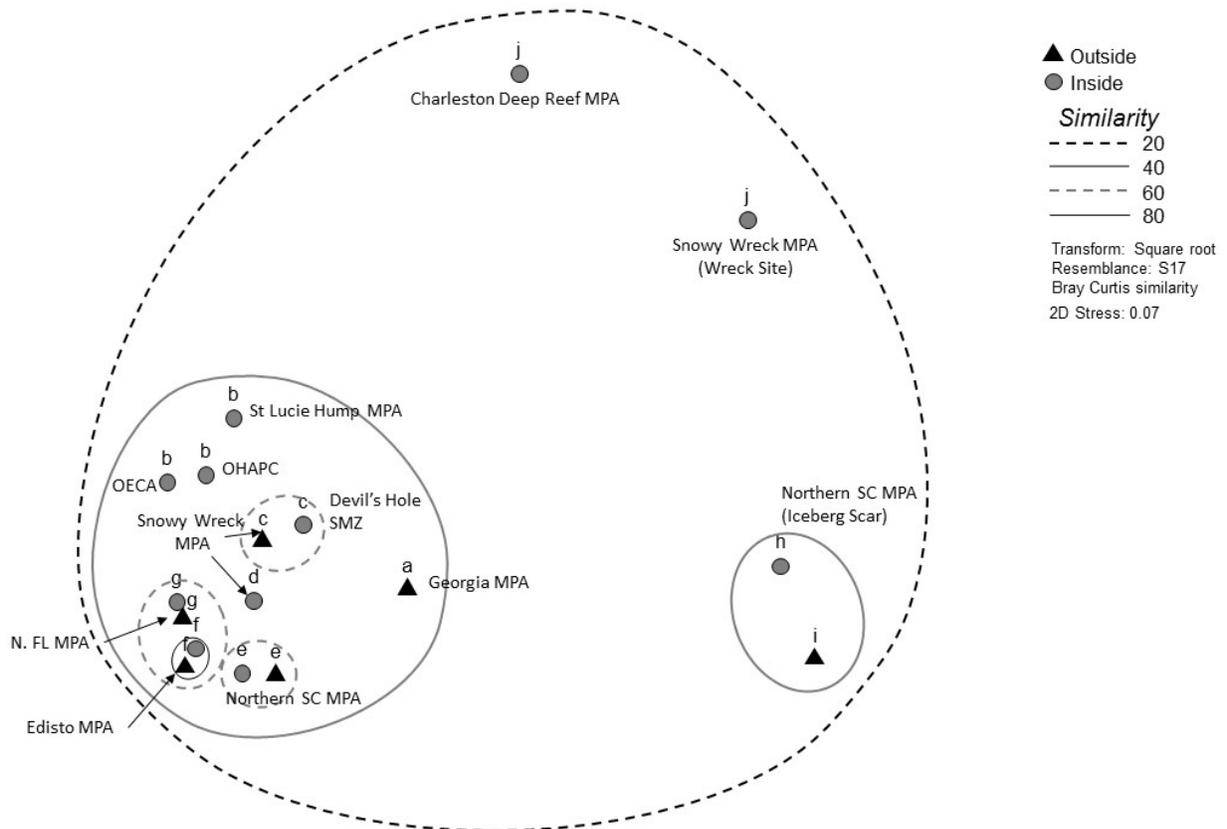


Figure 56. Multi-dimensional scaling (MDS) plot comparing benthic macrobiota Inside vs Outside of each MPA based on Bray-Curtis similarity matrix calculated from square-root transformation of benthic macrobiota percent cover during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02). Statistically significant SIMPROF letter groups are included. Assemblage similarity at 20-80% is indicated.

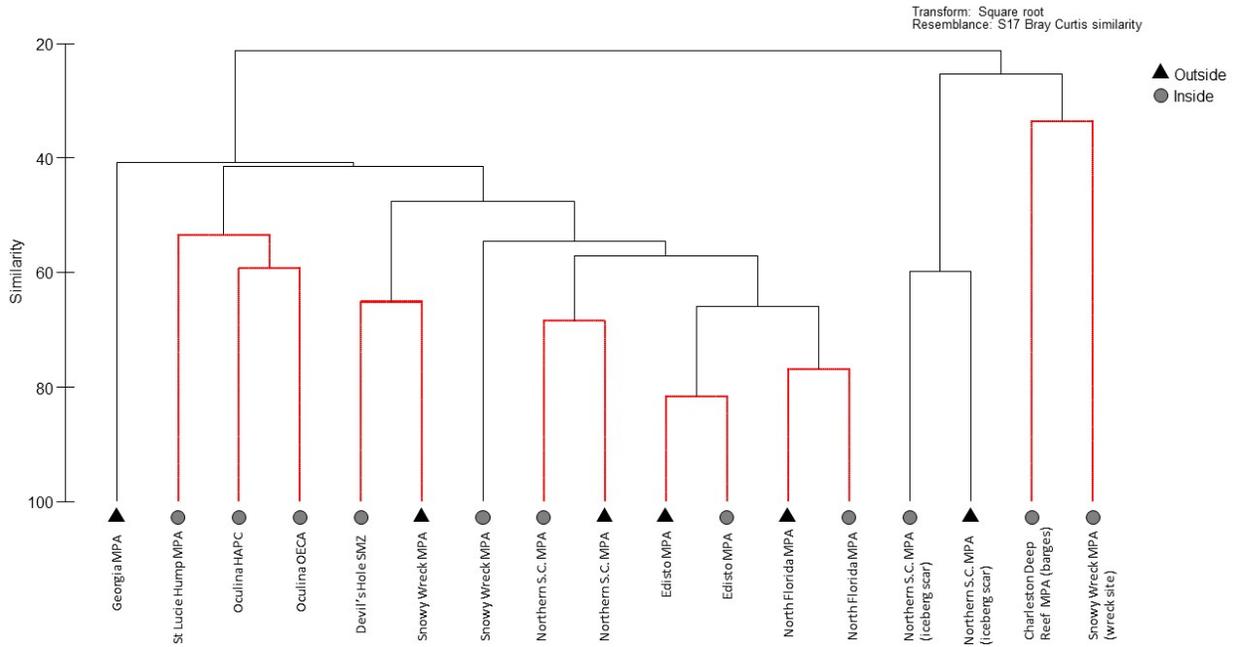


Figure 57. SIMPROF dendrogram showing Bray-Curtis similarity of percent cover of benthic biota for Inside and Outside of MPAs of each region. Statistically different groups ($p < 0.05$) are indicated by red bars.

Human Debris

CPCe Point Count of the quantitative ROV photo transects was used to plot the amount of human debris at each dive site (Fig. 58). The dominant debris, consisted of fishing lines, longlines, nets, and bottles. The greatest lost fishing gear was at Snowy Grouper shipwreck site (1.24% cover). The St. Lucie Hump MPA which is only about 5 nmi offshore Stuart, Florida also had considerable fishing line (0.32% cover) which was commonly wrapped around the *Oculina* coral colonies. There was a relatively high percent of human debris (fishing lines, longlines, trawl nets) within the closed OECA (Fig. 15).

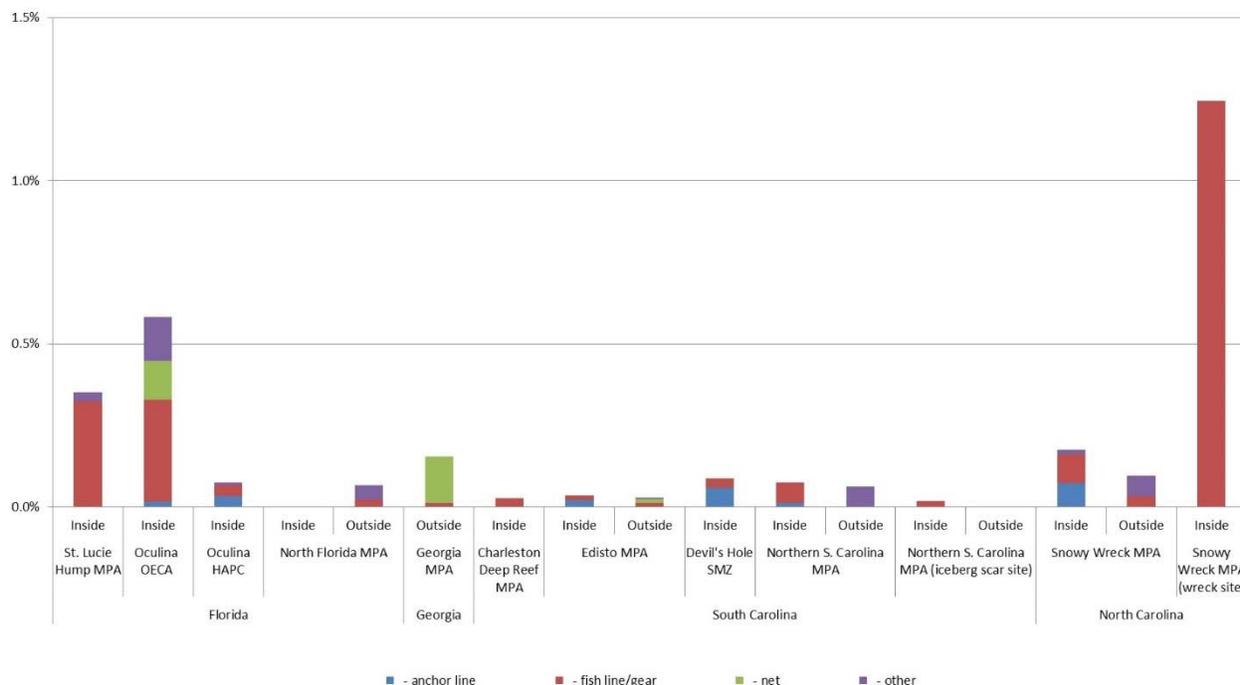


Figure 58. Percent cover of human debris calculated from the quantitative ROV photo transects by state and MPA status during 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02).

FUTURE WORK AND CONCLUSIONS

This cruise and research has resulted in a rich set of new data discovering and characterizing deepwater MPA sites and fish populations off the southeastern United States within the jurisdiction of the South Atlantic Fishery Management Council. New sonar maps, ground-truthed by ROV dives, and CTD casts have provided data for characterizing these newly designated shelf-edge MPA sites and adjacent areas. The new multibeam maps provide a wealth of information for future ROV dives both within and outside the current MPA sites. These data will be important for managers and scientists with NOAA Fisheries, the South Atlantic Fishery Management Council, NOAA DSCRTP, NOAA CRCP, and NOAA Mesophotic Reef Ecosystem Program. These data may then be compared to previous and future research cruises and to areas adjacent to the protected areas to better understand the long-term health and status of these important deepwater coral/sponge ecosystems. Another three year CRCP/SAFMC grant has been awarded to this team to continue to collect valuable information on these MPAs and their surrounding areas to better evaluate the efficacy of the closed areas. The new grant will also include work inside the *Oculina* Experimental Closed Area (OECA).

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APPENDIX 1

Species List and Percent Cover of Benthic Macrobiota

Species list of the benthic macro-invertebrates and algae that were identified from quantitative photo transects for each ROV dive during the 2015-2017 NOAA Ship *Pisces* cruises (15-02, 16-02, 17-02) to the South Atlantic MPAs. Still images captured from the photo transects were analyzed using CPCe[®] software to determine relative percent cover of benthic biota and habitat types. (Best viewed in PDF format in order to zoom view)

Major Category/Scientific Name- Authority	Florida					Georgia		South Carolina				North Carolina				Grand Total		
	St. Lucie Hump MPA	Oculina OECA	Oculina HAPC	North Florida MPA		Georgia MPA	Charleston Deep Artificial Reef MPA	Edisto MPA		Devil's Hole SMZ	Northern South Carolina MPA		Northern South Carolina MPA (iceberg scar site)		Snowy Wreck MPA		Snowy Wreck MPA (wreck site)	
	Inside	Inside	Inside	Inside	Outside	Outside	Inside	Inside	Outside	Inside	Inside	Outside	Inside	Outside	Inside		Outside	Inside
Biota	24.47%	15.71%	11.59%	24.84%	35.31%	9.04%	43.61%	42.17%	47.13%	28.76%	35.69%	20.48%	10.88%	11.12%	17.97%	23.64%	38.20%	28.12%
Algae	13.81%	5.57%	1.10%	7.87%	12.00%	0.48%	0.00%	21.41%	27.88%	4.99%	24.07%	7.30%	0.00%	0.00%	4.41%	4.30%	0.00%	11.29%
Cyanobacteria	0.05%	0.01%	0.00%	0.30%	0.75%	0.01%	0.00%	0.69%	1.74%	0.17%	1.55%	2.02%	0.00%	0.00%	0.16%	0.02%	0.00%	0.61%
Chlorophyta	0.05%	0.00%	0.01%	0.07%	0.07%	0.00%	0.00%	0.06%	0.06%	0.00%	0.02%	0.00%	0.00%	0.00%	0.06%	0.03%	0.00%	0.03%
Ochrophyta	0.00%	0.01%	0.02%	0.66%	2.18%	0.14%	0.00%	12.15%	17.05%	0.09%	17.86%	3.01%	0.00%	0.00%	3.02%	0.50%	0.00%	5.63%
<i>Dictyota</i> sp.	0.00%	0.00%	0.00%	0.01%	1.24%	0.00%	0.00%	4.43%	9.13%	0.00%	0.24%	0.89%	0.00%	0.00%	1.77%	0.00%	0.00%	2.01%
Ochrophyta	0.00%	0.01%	0.02%	0.65%	0.93%	0.08%	0.00%	7.71%	7.80%	0.09%	17.49%	2.12%	0.00%	0.00%	1.07%	0.47%	0.00%	3.58%
<i>Padina</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.01%
<i>Sargassum</i> sp.	0.00%	0.00%	0.00%	0.00%	0.01%	0.06%	0.00%	0.01%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.03%	0.00%	0.03%
<i>Spatoglossum</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Rhodophyta	13.71%	5.54%	1.08%	6.85%	9.01%	0.33%	0.00%	8.51%	9.02%	4.73%	4.63%	2.27%	0.00%	0.00%	1.17%	3.75%	0.00%	5.02%
Corallinales	12.11%	4.79%	0.54%	5.03%	5.84%	0.33%	0.00%	4.23%	2.87%	4.47%	2.39%	1.70%	0.00%	0.00%	0.48%	3.32%	0.00%	2.92%
Rhodophyta	1.60%	0.75%	0.54%	1.81%	3.17%	0.00%	0.00%	4.28%	6.15%	0.26%	2.24%	0.56%	0.00%	0.00%	0.69%	0.43%	0.00%	2.10%
Cnidaria	6.52%	5.17%	6.73%	7.76%	9.88%	2.55%	2.75%	9.25%	10.27%	14.01%	4.91%	5.38%	2.74%	0.50%	6.97%	12.80%	31.59%	7.77%
Alcyonacea - Alcyoniina	0.89%	0.01%	0.22%	0.00%	0.00%	0.01%	0.00%	0.01%	0.01%	0.03%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%	0.00%	0.05%
Alcyoniina	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.03%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%
<i>Nidalia occidentalis</i> Gray, 1835	0.89%	0.01%	0.22%	0.00%	0.00%	0.01%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%
Alcyonacea - gorgonian	0.27%	0.04%	0.40%	0.22%	0.48%	0.77%	0.00%	3.59%	3.57%	7.41%	1.16%	1.06%	2.60%	0.36%	1.46%	2.37%	0.72%	1.72%
Alcyonacea - gorgonian	0.14%	0.03%	0.12%	0.03%	0.07%	0.09%	0.00%	0.28%	0.16%	2.45%	0.19%	0.58%	0.75%	0.00%	0.51%	0.63%	0.72%	0.29%
<i>Bebryce</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%
<i>Carijoa</i> sp.	0.00%	0.00%	0.00%	0.02%	0.01%	0.01%	0.00%	0.48%	0.37%	0.17%	0.11%	0.00%	0.00%	0.00%	0.03%	0.03%	0.00%	0.13%
<i>Diodogorgia</i> sp.	0.00%	0.01%	0.09%	0.09%	0.22%	0.65%	0.00%	1.41%	1.44%	0.03%	0.25%	0.21%	0.00%	0.00%	0.00%	0.02%	0.00%	0.47%
<i>Ellisella</i> sp.	0.14%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.77%	0.02%	0.00%	0.27%	0.04%	0.00%	0.00%	0.01%	0.00%	0.00%	1.2%
Ellisellidae	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.18%	0.00%	0.09%	0.11%	0.04%	0.00%	0.00%	0.00%	0.02%	0.00%	0.03%
<i>Iciligorgia schrammi</i> Duchassaing, 1870	0.00%	0.00%	0.02%	0.03%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.34%	0.00%	0.00%	0.03%
<i>Leptogorgia</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Muricea</i> sp.	0.00%	0.00%	0.00%	0.04%	0.08%	0.00%	0.00%	0.14%	0.16%	0.00%	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.05%
<i>Nicella</i> sp.	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.16%	0.03%	0.95%	0.21%	0.12%	1.85%	0.23%	0.53%	1.62%	0.00%	0.27%
Plexauridae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Plexauridae- purple	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Plexauridae- yellow	0.00%	0.00%	0.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.63%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.12%
<i>Plumarella</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%	0.00%	0.00%
<i>Swiftia exserta</i> (Ellis & Solander, 1786)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	1.36%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.21%
<i>Titanideum frauenfeldii</i> (Kölliker, 1865)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.01%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Anthozoa - Non Coral	1.35%	0.49%	0.41%	0.00%	0.02%	0.01%	1.37%	0.01%	0.03%	1.04%	0.00%	0.02%	0.00%	0.00%	0.00%	0.88%	29.49%	0.72%
Actiniaria	0.03%	0.00%	0.02%	0.00%	0.01%	0.00%	0.84%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	25.18%	0.45%
Actinoscyphiidae/Hormathiidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.26%	0.07%
Cerianthidae	0.54%	0.30%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%
Corallimorpharia	0.00%	0.06%	0.01%	0.00%	0.01%	0.00%	0.00%	0.01%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Zoanthidae	0.78%	0.13%	0.26%	0.00%	0.00%	0.01%	0.53%	0.01%	0.00%	1.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.88%	0.05%	0.15%
Antipatharia	0.05%	0.61%	1.00%	3.46%	4.37%	0.42%	0.23%	1.04%	0.99%	2.59%	0.13%	0.17%	0.00%	0.00%	1.55%	2.66%	0.00%	1.29%
<i>Antipathes atlantica</i> Gray, 1857	0.00%	0.00%	0.09%	0.00%	0.03%	0.00%	0.00%	0.21%	0.49%	1.35%	0.02%	0.08%	0.00%	0.00%	0.22%	0.21%	0.00%	0.17%
<i>Antipathes furcata</i> Gray, 1857	0.03%	0.00%	0.24%	0.31%	0.16%	0.00%	0.00%	0.11%	0.04%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.47%	0.00%	1.1%
Antipathidae	0.00%	0.01%	0.19%	0.40%	0.19%	0.05%	0.00%	0.14%	0.10%	0.40%	0.00%	0.02%	0.00%	0.00%	0.19%	0.21%	0.00%	0.13%
<i>Stichopathes lutkeni</i> Brook, 1889	0.03%	0.52%	0.11%	1.66%	1.95%	0.38%	0.23%	0.41%	0.26%	0.12%	0.10%	0.04%	0.00%	0.00%	0.83%	1.22%	0.00%	0.53%
<i>Tanacetipathes</i> sp.	0.00%	0.07%	0.38%	1.10%	2.03%	0.00%	0.00%	0.18%	0.10%	0.52%	0.01%	0.02%	0.00%	0.00%	0.25%	0.56%	0.00%	0.36%
Hydrozoa	1.38%	3.69%	4.23%	4.04%	4.58%	1.28%	1.15%	4.38%	5.58%	1.56%	3.60%	4.12%	0.13%	0.05%	3.49%	2.05%	1.15%	3.46%
Hydroidolina	1.38%	3.69%	4.23%	4.04%	4.58%	1.28%	1.15%	4.38%	5.58%	1.56%	3.60%	4.12%	0.13%	0.05%	3.49%	2.05%	1.15%	3.46%
<i>Solanderia gracilis</i> Duchassaing & Michelin, 1846	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scleractinia	2.57%	0.31%	0.46%	0.03%	0.44%	0.05%	0.00%	0.22%	0.07%	1.38%	0.02%	0.00%	0.02%	0.09%	0.47%	4.81%	0.24%	0.52%
<i>Cladocora</i> sp.	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Lophelia pertusa</i> (Linnaeus, 1758)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.24%	0.00%
<i>Madracis decactis</i> (Lyman, 1859)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Madracis myriaster</i> (Milne Edwards & Haime, 1850)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.01%

Major Category/Scientific Name- Authority	Florida					Georgia		South Carolina				North Carolina				Grand Total		
	St. Lucie Hump MPA	Oculina OECA	Oculina HAPC	North Florida MPA		Georgia MPA	Charleston Deep Artificial Reef MPA		Devil's Hole SMZ	Northern South Carolina MPA		Northern South Carolina MPA (iceberg scar site)		Snowy Wreck MPA (wreck site)				
				Inside	Outside		Inside	Outside		Inside	Outside	Inside	Outside	Inside	Outside			
<i>Oculina varicosa</i> Lesueur, 1821	2.51%	0.24%	0.42%	0.03%	0.36%	0.01%	0.00%	0.01%	0.01%	1.24%	0.00%	0.00%	0.00%	0.00%	0.25%	3.96%	0.00%	0.40%
<i>Phyllangia americana</i> Milne Edwards & Haime, 1849	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.01%
Scleractinia- unid colonial	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.14%	0.01%	0.00%	0.00%	0.05%	0.00%	0.00%	0.01%	0.01%
Scleractinia- unid cup	0.05%	0.06%	0.00%	0.00%	0.08%	0.04%	0.00%	0.18%	0.05%	0.00%	0.00%	0.00%	0.02%	0.05%	0.03%	0.85%	0.00%	0.09%
<i>Siderastrea radians</i> (Pallas, 1766)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
Porifera	1.46%	2.79%	1.17%	6.44%	9.66%	1.67%	0.56%	6.49%	6.48%	4.58%	2.72%	4.93%	2.45%	6.70%	3.71%	4.67%	0.05%	4.42%
Demospongiae	1.46%	2.79%	1.17%	6.44%	9.65%	1.67%	0.56%	6.49%	6.48%	4.58%	2.72%	4.93%	2.45%	6.70%	3.71%	4.67%	0.05%	4.42%
<i>Agelas clathrodes</i> (Schmidt, 1870)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.17%	0.17%	0.83%	0.00%	0.00%	0.61%	0.00%	0.00%	0.08%
<i>Agelas</i> sp.	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.04%	0.01%	0.00%	0.14%	0.17%	0.00%	0.00%	0.13%	0.00%	0.00%	0.03%
<i>Aiolochoira crassa</i> (Hyatt, 1875)	0.00%	0.00%	0.02%	0.05%	0.03%	0.00%	0.00%	0.01%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.02%
<i>Aplysina</i> sp.	0.00%	0.12%	0.00%	0.08%	0.01%	0.00%	0.00%	0.04%	0.06%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%
<i>Auletta</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.14%	0.00%	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.01%
Axinellidae	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Callyspongia</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Callyspongia vaginalis</i> (Lamarck, 1814)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.01%	0.00%	0.05%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Chondrilla</i> sp.	0.00%	1.15%	0.00%	0.03%	0.03%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%
Chondrillida	0.00%	0.00%	0.00%	0.00%	0.21%	0.00%	0.00%	0.09%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%
<i>Chondrosia</i> - lobate gray (MPA)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Chondrosia</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Clathria</i> sp.	0.00%	0.00%	0.00%	0.07%	0.02%	0.02%	0.00%	0.01%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Clytia</i> sp.	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Corallistes</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Corallistidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.36%	0.00%	0.00%	0.00%	0.01%
Demospongiae- MPA3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Demospongiae- tan starlet thick encrusting	0.00%	0.00%	0.01%	0.30%	0.30%	0.02%	0.00%	0.29%	0.45%	0.00%	0.07%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%
Demospongiae unid. sp.	1.30%	1.13%	0.49%	2.78%	4.53%	1.21%	0.56%	4.04%	4.07%	4.09%	1.72%	2.35%	0.62%	4.10%	2.35%	4.11%	0.05%	2.57%
Demospongiae- Ye sphere (MPA)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dictyoceratida	0.00%	0.00%	0.00%	0.01%	0.03%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Erylus</i> sp.	0.00%	0.18%	0.09%	0.07%	0.06%	0.00%	0.00%	0.01%	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	0.06%	0.00%	0.04%
<i>Geodia gibberosa</i> complex Lamarck, 1815	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Geodia neptuni</i> complex (Sollas, 1886)	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%	0.02%
<i>Geodia</i> sp.	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.30%	0.00%	0.02%
<i>Halisarca</i> sp.	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Hymeniacion</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Ircinia campana</i> (Lamarck, 1814)	0.00%	0.00%	0.00%	0.47%	0.28%	0.02%	0.00%	0.35%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.11%
<i>Ircinia</i> sp.	0.00%	0.01%	0.07%	0.47%	1.04%	0.02%	0.00%	0.50%	0.47%	0.03%	0.03%	0.17%	0.00%	0.00%	0.00%	0.02%	0.00%	0.25%
<i>Ircinia strobilina</i> (Lamarck, 1816)	0.00%	0.00%	0.00%	0.08%	0.22%	0.00%	0.00%	0.01%	0.05%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%
<i>Leiodermatium</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.96%	1.59%	1.59%	0.00%	0.00%	0.00%	0.15%
Lithistida (acc. as Heteroscleromorpha)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Monanchora</i> sp.	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Neofibularia</i> sp.	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Niphates</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%	0.06%	0.00%	0.00%	0.01%
<i>Oceanapia</i> sp.	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Pachastrellidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.05%	0.23%	0.00%	0.00%	0.00%	0.01%
<i>Placospongia</i> sp.	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Poecilosclerida	0.00%	0.15%	0.03%	0.11%	0.07%	0.00%	0.00%	0.03%	0.02%	0.00%	0.03%	0.02%	0.00%	0.00%	0.00%	0.02%	0.00%	0.03%
<i>Scopalina</i> sp.	0.00%	0.00%	0.01%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
<i>Siphonodictyon coralliphagum</i> Rützler, 1971	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Spirastrellidae	0.08%	0.04%	0.39%	1.78%	2.68%	0.33%	0.00%	0.83%	0.86%	0.09%	0.13%	0.23%	0.00%	0.00%	0.35%	0.13%	0.00%	0.65%
<i>Spongosorites siliquaria</i> van Soest & Stentoft, 1988	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.01%
<i>Spongosorites</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tetractinellida (syn. Astrophorida)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Theonella</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%
Verongiida	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Major Category/Scientific Name- Authority	Florida				Georgia		South Carolina				North Carolina				Grand Total			
	St. Lucie Hump MPA	Oculina OECA	Oculina HAPC	North Florida MPA		Georgia MPA	Charleston Deep Reef MPA		Edisto MPA	Devil's Hole SMZ	Northern South Carolina MPA		Northern South Carolina MPA (iceberg scar site)			Snowy Wreck MPA		Snowy Wreck MPA (wreck site)
				Inside	Outside		Inside	Outside			Inside	Outside	Inside	Outside		Inside	Outside	
<i>Xestospongia</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Zyzzya</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.36%	0.00%	0.00%	0.00%	0.01%
Hexactinellida	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.10%	0.00%	0.27%	0.00%	0.00%	0.00%	0.01%
<i>Farrea</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Hexactinellida	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.27%	0.00%	0.00%	0.00%	0.01%
Porifera	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Annelida	0.11%	0.15%	0.16%	1.10%	0.83%	1.80%	0.18%	0.62%	0.52%	1.07%	1.19%	1.10%	4.19%	2.14%	0.03%	0.05%	3.26%	0.88%
Annelida	0.08%	0.04%	0.13%	0.01%	0.01%	1.69%	0.00%	0.02%	0.01%	0.00%	0.00%	0.00%	1.72%	0.05%	0.01%	0.00%	0.29%	0.22%
Polychaeta	0.03%	0.10%	0.03%	1.09%	0.82%	0.12%	0.18%	0.60%	0.51%	1.07%	1.19%	1.10%	2.47%	2.10%	0.01%	0.05%	2.97%	0.66%
<i>Filograna</i> sp.	0.03%	0.06%	0.01%	1.05%	0.80%	0.11%	0.00%	0.58%	0.49%	0.35%	0.86%	0.02%	0.04%	0.00%	0.01%	0.02%	0.00%	0.36%
<i>Hermodice carunculata</i> (Pallas, 1766)	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%
Sabellidae	0.00%	0.01%	0.02%	0.02%	0.00%	0.00%	0.00%	0.01%	0.02%	0.55%	0.34%	1.08%	0.15%	0.27%	0.00%	0.00%	0.00%	0.10%
Serpulidae	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.13%	0.01%	0.00%	0.17%	0.00%	0.00%	2.29%	1.82%	0.00%	0.02%	0.00%	0.19%
Mollusca	0.00%	0.18%	0.02%	0.01%	0.00%	0.01%	37.50%	0.02%	0.04%	2.10%	0.04%	0.12%	0.05%	0.00%	0.10%	0.34%	0.72%	1.30%
Mollusca	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bivalvia	0.00%	0.00%	0.02%	0.01%	0.00%	0.00%	37.50%	0.01%	0.04%	2.10%	0.02%	0.12%	0.00%	0.00%	0.10%	0.34%	0.72%	1.28%
Bivalvia	0.00%	0.00%	0.02%	0.01%	0.00%	0.00%	37.50%	0.01%	0.04%	2.10%	0.02%	0.12%	0.00%	0.00%	0.01%	0.34%	0.72%	1.28%
<i>Pycnodonte</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
Gastropoda	0.00%	0.18%	0.01%	0.00%	0.00%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Fasciolaria tulipa</i> (Linnaeus, 1758)	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gastropoda	0.00%	0.15%	0.01%	0.00%	0.00%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Perotrochus amabilis</i> Rios, 2003	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Echinodermata	0.81%	0.88%	1.42%	0.00%	0.01%	0.01%	0.59%	0.04%	0.13%	0.20%	0.01%	0.04%	0.13%	0.32%	0.00%	0.00%	0.24%	0.27%
Asteroidea	0.03%	0.07%	0.00%	0.00%	0.00%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Goniaster</i> sp.	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Goniaster tessellatus</i> (Lamarck, 1816)	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Narcissia trigonaria</i> Sladen, 1889	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Tamaria</i> sp.	0.03%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Crinoidea	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.03%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
Crinoidea	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.03%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Davidaster discoideus</i> (Carpenter, 1888)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
<i>Davidaster</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Echinoidea	0.65%	0.75%	1.38%	0.00%	0.00%	0.00%	0.59%	0.00%	0.02%	0.12%	0.00%	0.04%	0.04%	0.14%	0.00%	0.00%	0.14%	0.22%
<i>Arbacia punctulata</i> (Lamarck, 1816)	0.03%	0.00%	0.01%	0.00%	0.00%	0.00%	0.53%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
<i>Centrostephanus longispinus</i> (Philippi, 1845)	0.16%	0.33%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%
Cidaroida	0.03%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Coelopleurus floridanus</i> A. Agassiz, 1872	0.35%	0.00%	0.78%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.14%	0.09%
Echinoidea	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Eucidaris tribuloides</i> (Lamarck, 1816)	0.08%	0.42%	0.36%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.06%
<i>Stylocidaris</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%
Holothuroidea	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%	0.01%	0.00%	0.09%	0.14%	0.00%	0.00%	0.00%	0.01%
<i>Holothuria lentiginosa enodis</i> Miller & Pawson, 1979	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Holothuroidea	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Paracolocirus mysticus</i> (Deichmann, 1930)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.01%	0.00%	0.09%	0.14%	0.00%	0.00%	0.00%	0.01%
Ophiuroidea	0.11%	0.06%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.10%	0.01%
<i>Asteropora annulata</i> Örsted & Lütken in: Lütken, 1856	0.03%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gorgonocephalidae	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Ophioderma devaneyi</i> Hendler & Miller, 1984	0.05%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Ophiuroidea	0.03%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.10%	0.00%
Bryozoa	0.00%	0.00%	0.01%	0.57%	0.51%	0.13%	0.00%	0.11%	0.09%	0.03%	0.19%	0.56%	0.00%	0.00%	0.06%	0.06%	0.00%	0.16%
Bryozoa	0.00%	0.00%	0.01%	0.57%	0.51%	0.13%	0.00%	0.11%	0.09%	0.03%	0.19%	0.56%	0.00%	0.00%	0.06%	0.06%	0.00%	0.16%
Bryozoa	0.00%	0.00%	0.01%	0.13%	0.12%	0.08%	0.00%	0.02%	0.03%	0.03%	0.08%	0.50%	0.00%	0.00%	0.03%	0.06%	0.00%	0.06%
<i>Schizoporella</i> sp.	0.00%	0.00%	0.00%	0.44%	0.39%	0.05%	0.00%	0.09%	0.06%	0.00%	0.11%	0.06%	0.00%	0.00%	0.03%	0.00%	0.00%	0.09%
Arthropoda	0.03%	0.07%	0.11%	0.01%	0.10%	0.06%	0.20%	0.05%	0.01%	0.06%	0.02%	0.04%	0.07%	0.00%	0.01%	0.00%	0.00%	0.05%

Major Category/Scientific Name- Authority	Florida		Georgia		South Carolina		North Carolina		Grand Total										
	St. Lucie Hump MPA	Oculina OECA	Oculina HAPC	North Florida MPA	Georgia MPA	Charleston Deep Artificial Reef MPA	Edisto MPA	Devil's Hole SMZ	Northern South Carolina MPA	Northern South Carolina MPA (iceberg scar site)	Snowy Wreck MPA	Snowy Wreck MPA (wreck site)							
	Inside	Inside	Inside	Inside	Outside	Inside	Inside	Outside	Inside	Inside	Outside	Inside							
Cirripedia	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	
Decapoda	0.03%	0.07%	0.07%	0.01%	0.10%	0.05%	0.05%	0.05%	0.01%	0.06%	0.02%	0.04%	0.07%	0.00%	0.01%	0.00%	0.00%	0.00%	0.04%
Decapoda	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Majidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Paguroidea	0.00%	0.01%	0.03%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.05%	0.00%	0.01%	0.00%	0.00%	0.00%	0.01%
<i>Panulirus argus</i> (Latreille, 1804)	0.00%	0.00%	0.00%	0.01%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Parthenope</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scyllaridae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Scyllarides</i> sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Stenorhynchus seticornis</i> (Herbst, 1788)	0.03%	0.06%	0.03%	0.00%	0.03%	0.01%	0.00%	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Pycnogonida	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Anoploactylus lentus</i> Wilson, 1878	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Pycnogonida	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Chordata - Invertebrate	0.00%	0.00%	0.02%	0.11%	0.75%	0.28%	0.00%	0.38%	0.29%	0.09%	1.04%	0.35%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.26%
Tunicata	0.00%	0.00%	0.02%	0.11%	0.75%	0.28%	0.00%	0.38%	0.29%	0.09%	1.04%	0.35%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.26%
Ascidiacea	0.00%	0.00%	0.00%	0.02%	0.11%	0.11%	0.00%	0.08%	0.07%	0.00%	0.57%	0.29%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%
Didemnidae	0.00%	0.00%	0.02%	0.09%	0.64%	0.18%	0.00%	0.30%	0.22%	0.09%	0.47%	0.06%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.17%
Chordata - Vertebrate	1.35%	0.16%	0.64%	0.67%	0.89%	1.03%	1.12%	2.43%	1.24%	1.15%	1.05%	0.37%	1.12%	1.09%	1.14%	1.19%	1.05%	1.11%	
Chordata	1.35%	0.16%	0.56%	0.67%	0.89%	1.03%	1.12%	2.43%	1.24%	1.15%	1.05%	0.37%	1.12%	1.09%	1.14%	1.19%	1.05%	1.11%	
Actinopterygii	1.35%	0.16%	0.56%	0.67%	0.89%	1.03%	1.12%	2.43%	1.24%	1.15%	1.05%	0.37%	1.12%	1.09%	1.14%	1.19%	1.05%	1.11%	
Reptilia	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	
<i>Caretta caretta</i> (Linnaeus, 1758)	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	
UNKNOWN	0.00%	0.00%	0.02%	0.20%	0.45%	0.07%	0.13%	0.54%	0.09%	0.32%	0.05%	0.10%	0.00%	0.05%	0.35%	0.11%	0.05%	0.18%	
Non-Fauna	0.38%	0.73%	0.18%	0.10%	0.22%	0.94%	0.59%	0.83%	0.10%	0.17%	0.39%	0.06%	0.07%	0.05%	1.15%	0.13%	1.24%	0.41%	
Detritus	0.03%	0.15%	0.11%	0.10%	0.16%	0.79%	0.56%	0.79%	0.07%	0.09%	0.32%	0.00%	0.05%	0.05%	0.98%	0.03%	0.00%	0.30%	
Human debris	0.35%	0.58%	0.07%	0.00%	0.07%	0.15%	0.03%	0.03%	0.03%	0.09%	0.07%	0.06%	0.02%	0.00%	0.18%	0.10%	1.24%	0.12%	
Human debris- anchor line	0.00%	0.01%	0.03%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.06%	0.01%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.01%	
Human debris- fish line/gear	0.32%	0.31%	0.03%	0.00%	0.02%	0.01%	0.03%	0.01%	0.01%	0.03%	0.06%	0.00%	0.02%	0.00%	0.09%	0.03%	1.24%	0.07%	
Human debris- net	0.00%	0.12%	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	
Human debris- other	0.03%	0.13%	0.01%	0.00%	0.04%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.06%	0.00%	0.00%	0.01%	0.06%	0.00%	0.02%	
Bare Substrate	75.53%	84.29%	88.41%	75.16%	64.69%	90.96%	56.39%	57.83%	52.87%	71.24%	64.31%	79.52%	89.12%	88.88%	82.03%	76.36%	61.80%	71.88%	
Non-Fauna	75.53%	84.29%	88.41%	75.16%	64.69%	90.96%	56.39%	57.83%	52.87%	71.24%	64.31%	79.52%	89.12%	88.88%	82.03%	76.36%	61.80%	71.88%	
Habitat	75.53%	84.29%	88.41%	75.16%	64.69%	90.96%	56.39%	57.83%	52.87%	71.24%	64.31%	79.52%	89.12%	88.88%	82.03%	76.36%	61.80%	71.88%	
Artificial Reef/Wreck	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	44.25%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	58.69%	2.36%	
Bare coral rubble	45.77%	48.31%	42.80%	0.21%	0.02%	0.07%	0.00%	0.07%	0.03%	0.06%	0.01%	0.02%	0.00%	0.00%	0.01%	0.26%	0.00%	8.12%	
Bare rock, pavement, boulder, ledge	19.06%	11.78%	13.84%	36.51%	49.79%	20.18%	0.00%	34.80%	35.75%	52.77%	28.15%	41.43%	43.65%	63.51%	38.30%	43.14%	0.00%	31.49%	
Bare rubble/cobble	0.46%	5.52%	3.06%	3.13%	1.21%	2.77%	6.72%	1.84%	0.93%	4.27%	1.15%	3.85%	0.37%	0.23%	1.55%	6.13%	0.05%	2.42%	
Bare soft bottom	5.49%	12.56%	27.34%	35.24%	13.57%	67.92%	5.42%	21.11%	16.15%	14.03%	35.00%	34.22%	45.11%	25.15%	42.12%	26.75%	3.06%	26.87%	
dead standing Scleractinia (habitat)	4.76%	6.12%	1.38%	0.08%	0.10%	0.02%	0.00%	0.02%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.04%	0.10%	0.00%	0.63%	
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

APPENDIX 2

Species List and Density of Fish Populations

Species list all of fish that were identified and counted from the quantitative video transects for each ROV dive during the 2015-2017 NOAA Ship Pisces cruises (15-02, 16-02, 17-02) to the South Atlantic MPAs. Fish density (# individuals/1000 m²) was calculated as (# of individuals/transect area) *1000. Transect length was calculated from the ROV tracking. Transect width was measured using the paired lasers. Fish densities were not included for the Artificial Reef sites (Dive 17-12, 17-13).

Scientific Name	Common Name	Florida				Georgia	South Carolina				North Carolina		Totals			
		St. Lucie Humps MPA Inside	Oculina		North Florida MPA		Georgia MPA	Edisto MPA		Devil's Hole SMZ	Northern S. Carolina MPA			Northern S. Carolina MPA (iceberg scar site)	Snowy Wreck MPA	
			OECA	OHAPC	Inside	Outside	Outside	Inside	Outside	Inside	Inside	Outside		Inside	Outside	Inside
<i>Acanthostracion polygonius</i>	honeycomb cowfish			0.54			1.21	4.45			3.60	0.40			10.21	
<i>Acanthostracion quadricornis</i>	scrawled cowfish	5.44	0.77	1.12	0.40	1.25	4.53	2.45			0.40			1.21	17.57	
<i>Acanthostracion</i> spp.	unid cowfish			1.65	0.89		20.89	15.58			3.65	1.56			44.23	
<i>Acanthurus chirurgus</i>	doctorfish							0.80							0.80	
<i>Acanthurus</i> spp.	unid surgeonfish			5.91	9.90		27.52	24.09			31.92	3.78		38.09	151.78	
<i>Aluterus monoceros</i>	unicorn filefish													3.59	3.59	
<i>Aluterus scriptus</i>	scrawled filefish						0.40	1.94			0.40				2.74	
<i>Aluterus</i> spp.	unid filefish						0.40								0.40	
<i>Anthias nicholsi</i>	yellowfin bass	4.52										36.40	826.34		867.27	
Anthinae	unid anthiid	1246.38	40.82	96.00		1.40	9.30		6643.32	0.47		1505.38	3736.33	2188.89	1271.85	16740.14
<i>Antigonia capros</i>	deepbody boarfish			1.11											540.53	
<i>Apogon affinis</i>	bigtooth cardinalfish													6.67	6.67	
<i>Apogon pseudomaculatus</i>	twospot cardinalfish	1.83	3.55	1.68	1.71	2.80	6.42	4.10	3.87	0.86	0.40			1.64	28.85	
<i>Apogon</i> spp.	unid cardinalfish		0.77		1.77		2.22	19.50	15.38	3.36		62.70		0.51	106.22	
<i>Aulostomus maculatus</i>	trumpetfish			1.74				9.34	24.20					0.61	38.39	
<i>Balistes capricus</i>	gray triggerfish		7.00	2.35	47.30	16.94	17.80	15.99	3.27		2.57			0.51	113.73	
<i>Balistes</i> spp.	unid triggerfish			1.25	2.94			8.87	5.96						19.03	
<i>Balistes vetula</i>	queen triggerfish			6.00	0.80			1.01	4.14		2.44	0.40			14.78	
Balistidae	unid filefish/ triggerfish								1.20						1.20	
<i>Bodianus pulchellus</i>	spotfin hogfish			291.10	240.92	21.39	408.90	622.99	40.22	86.13	36.13			96.40	1947.73	
<i>Bodianus rufus</i>	spanish hogfish			0.45			11.40	9.20		6.54	0.40			2.05	30.04	
Bothidae	unid flounder		2.22	0.91		0.61									3.74	
<i>Brotula barbata</i>	bearded brotula													0.42	0.42	
<i>Calamus</i> spp.	unid porgy	6.06		0.45	4.20	5.13	9.97	60.79	111.87	4.76	56.80	11.42		22.42	303.55	
<i>Cantherhines macrocerus</i>	whitespotted filefish										0.80			0.51	1.31	
<i>Cantherhines pullus</i>	orangespotted filefish			0.41	0.72			0.90	1.44						3.47	
<i>Canthidermis sufflamen</i>	ocean triggerfish													0.51	0.51	
<i>Canthigaster</i> spp.	unid puffer		1.74	0.45	364.28	275.46	165.44	604.23	779.69	35.39	213.93	89.78		87.19	2760.73	
Carangidae	unid jack							28.25			1.60				29.85	
<i>Caranx bartholomaei</i>	yellow jack							20.04	10.20						30.24	
<i>Caranx crysos</i>	blue runner							0.68							0.68	
<i>Caranx lugubris</i>	black jack							1.36						1.54	2.90	
<i>Caranx ruber</i>	bar jack							0.68	0.51		0.45	0.63			2.27	
Carcharhinidae	unid shark							2.82	3.33						6.15	
<i>Carcharhinus falciformis</i>	silky shark								0.47						0.47	
<i>Carcharhinus plumbeus</i>	sandbar shark							0.68						0.40	1.08	
<i>Carcharhinus</i> spp.	unid shark							0.90							0.90	
<i>Caulolatilus microps</i>	blueline tilefish											12.79	4.06		16.84	
<i>Centropristis ocyurus</i>	bank sea bass		24.54	94.88	1.25		2.78	2.81	5.98						132.24	
<i>Centropristis</i> spp.	unid sea bass			3.41					0.61						4.02	
<i>Centropristis striata</i>	black sea bass		8.80	32.87											41.68	
<i>Centropyge argi</i>	cherubfish							43.35	3.14	42.51	4.93	13.22		6.67	3.06	116.90
<i>Cephalopholis cruentata</i>	graysby			8.90	5.35	2.50	63.56	99.46	3.36	16.41	1.65			23.08	11.60	235.88
<i>Cephalopholis fulva</i>	coney			2.25							0.40				2.65	
<i>Chaetodon ocellatus</i>	spotfin butterflyfish			0.68	28.51	34.36	86.01	60.69	59.99	3.28	52.37	6.82		12.58	16.09	361.38
<i>Chaetodon sedentarius</i>	reef butterflyfish	5.29	28.72	32.45	447.72	246.80	155.39	499.34	550.91	28.75	142.14	70.12		171.35	159.90	2538.90
<i>Chaetodon</i> spp.	unid butterflyfish			0.56	3.00	0.49	4.24	31.87	4.46						5.58	50.19
Chaetodontidae	unid butterflyfish			0.44	0.80	1.05		6.54	2.87		1.60			6.22		19.52
<i>Chilomycterus antillarum</i>	web burrfish														0.40	0.40
<i>Chilomycterus atringa</i>	spotted burrfish													1.03		1.03
<i>Chilomycterus schoepfi</i>	striped burrfish			0.54												0.54
<i>Chilomycterus</i> spp.	unid burrfish														0.40	0.40
<i>Chromis cyanea</i>	blue chromis							3.26			4.53					7.79
<i>Chromis enchrysurus</i>	yellowtail reeffish	1.83	138.31	110.04	915.69	429.18	103.92	351.31	150.96	10.70	48.82	43.74		7.20	60.63	2372.32
<i>Chromis insolata</i>	sunshinelfish				329.09	170.00	2.50	410.83	835.92	36.42	235.19	191.18		376.41	277.60	2865.14
<i>Chromis scotti</i>	purple reeffish				350.58	152.46	22.01	793.19	853.93	63.58	47.83	18.36		29.98	45.42	2377.34
<i>Chromis</i> spp.	unid damselfish				225.98	49.37	8.83	344.73	742.65	87.10	155.60	138.69		86.30	86.20	1925.46
<i>Clepticus parrae</i>	creole wrasse			25.84				193.72	180.26		4.52	7.52		30.26	6.40	448.52
Clinidae	unid blenny										0.45					0.45
<i>Conger oceanicus</i>	conger eel	0.77														0.77

Scientific Name	Common Name	Florida				Georgia	South Carolina					North Carolina		Totals				
		St. Lucie Humps MPA Inside	Oculina		North Florida MPA		Georgia MPA Outside	Edisto MPA		Devil's Hole SMZ	Northern S. Carolina MPA		Northern S. Carolina MPA (iceberg scar site)		Snowy Wreck MPA			
			OECA	OHAPC	Inside	Outside		Inside	Outside		Inside	Outside	Inside		Outside	Inside	Outside	Inside
<i>Cookeolus japonicus</i>	bulleye									24.28							25.88	
<i>Dactylopterus volitans</i>	flying gurnard			6.35				0.40									6.75	
<i>Dasyatis centroura</i>	rougtail stingray			0.80				1.25				0.90	0.40				3.36	
<i>Dasyatis</i> spp.	unid stingray				1.20			2.11	1.40			0.40					5.11	
<i>Decapterus</i> spp.	unid scad							975.91	358.97								1334.89	
<i>Decodon puellaris</i>	red hogfish	6.12	17.47	21.83										131.92	38.78	3.04	1.03	220.18
<i>Diodon hystrix</i>	porcupinefish					1.83		0.59				0.47					0.61	3.49
<i>Diodon</i> spp.	unid spiny puffer							1.18	0.44								0.60	2.23
Diodontidae	unid spiny puffer								1.20									1.20
<i>Diplectrum formosum</i>	sand perch		2.68															2.68
<i>Diplodus holbrookii</i>	spottail pinfish							33.42	28.75									62.17
Echeneidae	unid remora												0.80					0.80
<i>Epinephelus adscensionis</i>	rock hind								1.54			2.53				1.95	6.03	12.05
<i>Epinephelus drummondhayi</i>	speckled hind							3.92										3.92
<i>Epinephelus guttatus</i>	red hind							0.54				1.32						1.86
<i>Epinephelus</i> spp.	unid hind							0.40										0.40
<i>Equetus lanceolatus</i>	jackknife fish			5.26	3.31	2.98						5.86				0.61	0.61	18.62
<i>Fistularia petimba</i>	red cornetfish							0.47										0.47
<i>Fistularia</i> spp.	unid cornetfish							3.73	5.30			4.21						13.64
<i>Fistularia tabacaria</i>	bluespotted cornetfish			5.35	0.40	0.65		8.17	17.32			8.84						40.71
Gadiformes	unid hake			1.19														1.19
<i>Gephyroberyx darwini</i>	big roughly													18.90	122.88			141.78
<i>Gonioplectrus hispanus</i>	spanish flag				1.22					7.39						0.66	14.82	24.10
<i>Gymnothorax funebris</i>	green moray													0.40				0.40
<i>Gymnothorax miliaris</i>	goldentail moray			0.45														0.45
<i>Gymnothorax moringa</i>	spotted moray	0.77		1.08	1.27	0.61		2.76	0.51			0.80	0.40			2.29	1.66	12.14
<i>Gymnothorax saxicola</i>	ocellated moray eel	1.68																1.68
<i>Gymnothorax</i> spp.	unid moray eel			0.45														0.45
<i>Haemulon album</i>	white margate								0.65									0.65
<i>Haemulon aurolineatum</i>	tomtate			10862.56	5255.71	0.56		19048.45	15750.11	1616.98		12857.81	41.25			274.69	1923.54	67631.65
<i>Haemulon plumierii</i>	white grunt			2.30	0.80			1.67	2.05			18.20	1.88				8.17	35.07
<i>Haemulon sciurus</i>	bluestriped grunt				0.67													0.67
<i>Haemulon</i> spp.	unid grunt			188.50				4070.88	4835.16	378.15						117.81	1088.10	10678.60
<i>Haemulon striatum</i>	striped grunt			347.30	39.42			5446.10	4497.63	462.18		3472.34	194.04			40.61	4057.57	18557.18
<i>Halichoeres bathyphilus</i>	greenband wrasse	0.92	13.49	27.96	6.52	1.62	21.95	9.94	3.83	0.82		9.44		4.36		6.64	16.20	123.69
<i>Halichoeres cyanocephalus</i>	yellowcheek wrasse				0.40			3.55	8.79			1.76	1.03					15.53
<i>Halichoeres garnoti</i>	yellowhead wrasse				184.75	64.36		99.44	156.15			222.18	33.20			71.01	2.87	833.95
<i>Halichoeres</i> spp.	unid wrasse	3.22	106.96	269.40	313.72	220.57	124.00	277.62	288.43	106.30		342.48	140.48	2.34		151.61	155.54	2502.67
<i>Hemanthias vivanus</i>	red barbier	48.60	9.92	17.23			1.26			6129.26				22.16	153.75	114.99	119.61	6616.78
<i>Holacanthus</i> spp.	blue/queen angelfish		6.81	3.69	229.17	213.22	68.35	290.08	345.22	7.21		63.66	17.86	0.00	0.00	15.45	16.42	1277.15
<i>Holacanthus tricolor</i>	rock beauty		0.82		10.90	4.60		34.57	11.06	1.68		16.81	6.41			27.71	15.96	130.52
Holocentridae	unid soldierfish/ squirrelfish			0.89	148.25	73.35	1.97	143.86	99.29	31.09		17.90	25.79		0.40	84.26	51.64	678.70
<i>Holocentrus adscensionis</i>	squirrelfish				124.97	192.07	6.76	131.68	101.38	3.34		23.43	17.00			29.96	17.08	647.69
<i>Holocentrus rufus</i>	longspine squirrelfish								0.40				4.05					4.45
<i>Hypoplectrus</i> sp.	unid hamlet												0.40					0.40
<i>Hyporthodus flavolimbatus</i>	yellowedge grouper													0.40	0.67			1.07
<i>Hyporthodus mystacinus</i>	misty grouper																	
<i>Hyporthodus nigrinus</i>	warsaw grouper			0.77														0.77
<i>Hyporthodus niveatus</i>	snowy grouper		3.22	6.63										48.93	9.59			68.37
<i>Jeboehlkia gladiifer</i>	bladefin basslet														2.00			2.00
<i>Kyphosus</i> sp.	unid chub											8.41						8.41
Labridae	unid wrasse		1.94												1.76			3.69
<i>Lachnolaimus maximus</i>	hogfish			5.94	0.91	5.84		4.05	5.81			12.05	6.86			10.21	4.13	55.80
<i>Lactophrys trigonus</i>	trunkfish												0.63					0.63
<i>Laemonema</i> spp.	unid mora cod													12.23	16.32			28.56
<i>Liopropoma aberrans</i>	eyestripe bass																4.10	4.10
<i>Liopropoma eukrines</i>	wrasse bass	11.54	13.69	16.92	33.09	27.83	24.64	28.52	32.63	53.21		6.64	9.96	5.43		25.95	50.14	340.20
<i>Liopropoma mowbrayi</i>	cave basslet															1.21		1.21
<i>Lutjanus analis</i>	mutton snapper			6.19								0.40						6.59
<i>Lutjanus apodus</i>	schoolmaster			0.80				0.80										1.60

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		OECA	OHAPC	Inside	Outside	Outside	Inside	Outside	Inside	Inside	Outside	Inside	Outside	Inside	Outside		
<i>Lutjanus buccanella</i>	blackfin snapper			1.61	2.77			0.80	0.86					8.48	3.20	17.72	
<i>Lutjanus campechanus</i>	red snapper	19.15	5.54	8.80		125.20	5.22	0.61						3.08	1.88	169.47	
<i>Lutjanus cyanopterus</i>	cubera snapper			4.90												4.90	
<i>Lutjanus griseus</i>	gray snapper			86.12	13.13		152.58	4.63								256.45	
<i>Lutjanus</i> spp.	unid snapper		0.45	7.31	3.80		4.07	3.36			0.40				0.40	19.80	
<i>Malacanthus plumieri</i>	sand tilefish			1.38				0.51								1.89	
<i>Manta birostris</i>	manta ray								4.00					0.51		4.51	
mixed school	mixed school			159.09				470.00			100.00			636.75	257.58	1623.42	
Monacanthidae	unid filefish							0.61								0.61	
<i>Mulloidichthys martinicus</i>	yellow goatfish			29.80			103.15	60.84								193.79	
<i>Muraena retifera</i>	reticulate moray	2.60	0.54	0.62	0.53	0.41	3.16	0.40	8.00	0.40		1.20	2.76	1.46	0.61	22.67	
<i>Muraena robusta</i>	stout moray			2.42	2.32	1.06					0.45			1.44		7.69	
Muraenidae	unid moray eel	0.92	3.66	1.85	1.07	2.11	1.95			0.40	1.44	0.57	3.33	2.20	0.61	20.11	
<i>Mycteroperca interstitialis</i>	yellowmouth grouper						0.59	3.45			0.47			1.12		5.63	
<i>Mycteroperca microlepis</i>	gag grouper	0.77	2.43	14.50	3.84	4.41	14.63	18.10	0.84	1.28				4.95	1.01	66.76	
<i>Mycteroperca phenax</i>	scamp	19.40	5.85	51.35	17.24	44.26	126.37	78.80	35.90	38.78	8.08	2.51		66.32	61.35	556.22	
<i>Mycteroperca</i> spp.	unid grouper			0.85			0.54	0.40						0.61		2.40	
<i>Myrichthys breviceps</i>	sharptail eel							0.91								0.91	
<i>Myripristis jacobus</i>	blackbar soldierfish			298.51	160.80		95.00	115.63			8.73	0.63		9.06	0.42	688.77	
<i>Neomerinthe hemingwayi</i>	spinycheek scorpionfish		0.62													0.62	
<i>Ogcocephalus corniger</i>	longnose batfish	0.77	2.71						4.00							7.48	
<i>Ogcocephalus</i> spp.	unid batfish	3.03	5.22			0.65			0.68			0.40				9.97	
Ophichthidae	unid snake eel					0.61	0.40									1.01	
<i>Opsanus</i> sp.	unid toadfish		0.90	0.45		5.32										6.67	
<i>Opsanus tau</i>	oyster toadfish	0.77				0.61										1.38	
<i>Ostichthys trachypoma</i>	bigeye soldierfish									0.45		21.27	8.30			30.03	
<i>Pagrus pagrus</i>	red porgy	5.28	4.80	79.24	9.57	54.19	73.05	80.94		16.61		120.03	38.01	1.26		482.98	
<i>Paranthias furcifer</i>	creolefish			27.07	20.81		7.06	2.40	2.10		8.12			219.20		286.76	
<i>Pareques iwamotoi</i>	blackbar drum					33.63			7.02			25.73	5.61	1.32		73.32	
<i>Pareques</i> spp.	unid drum																
<i>Pareques umbrosus</i>	cubbyu	53.85	0.54	9.09	186.45	64.77	414.23	177.54	251.54	261.39	414.98	20.06	2.80	165.02	514.32	2536.58	
Phycidae	unid hake														1.26	1.26	
<i>Plectranthias garrupellus</i>	apricot bass	14.03	11.37						11.45			125.26	97.21			259.32	
<i>Plectrypops retrospinis</i>	cardinal soldierfish				0.57	1.94	4.36	2.83	36.10					11.65	14.90	72.35	
<i>Pomacanthus arcuatus</i>	gray angelfish			0.40			4.48	1.53		0.80						7.21	
<i>Pomacanthus paru</i>	french angelfish			4.08	2.37		5.67	10.76	0.84	1.76	2.51			1.12	1.21	30.31	
<i>Pomacanthus</i> spp.	unid angelfish			3.14	1.05		1.67	4.68		1.20						11.74	
Priacanthidae	unid bigeye								29.68							29.68	
<i>Priacanthus arenatus</i>	bigeye	0.77	4.18	5.53	9.26	2.16	14.49	23.29	56.60	14.58		4.66	2.54	191.61	20.89	350.55	
<i>Pristigenys alta</i>	short bigeye	8.37	73.15	154.73	1.60	1.87	170.84	92.72	85.39	48.34	14.58	2.89	24.09	0.80	11.96	49.55	740.86
<i>Prognathodes aculeatus</i>	longsnout butterflyfish			4.69	3.17		7.46	19.49	3.78	5.36				1.95	8.09	54.00	
<i>Prognathodes aya</i>	bank butterflyfish	41.49	81.67	126.28	72.67	33.65	77.10	49.25	69.63	59.76	14.90	8.15	4.00	9.91	39.50	687.94	
<i>Prognathodes guyanensis</i>	french butterflyfish								2.05			11.95	2.04	0.51		16.56	
<i>Prognathodes</i> spp.	unid butterflyfish								50.51			1.85	0.67			53.02	
<i>Pronotogrammus martinicensis</i>	rougthead bass	434.90	1.74	59.13	0.57				167.25		6.95	37.85	4.27	570.57	587.90	1871.11	
<i>Pseudocaranx dentex</i>	white trevally													9.70		9.70	
<i>Pseudupeneus maculatus</i>	spotted goatfish			10.25	3.12		134.86	116.90	3.36	45.04	0.80			42.53	31.46	388.32	
<i>Ptereleotris</i> spp.	unid dartfish									4.00					3.64	7.64	
<i>Pterois volitans</i>	lionfish	4.10	25.14	237.40	195.46	472.01	1065.57	624.32	55.78	156.44	79.85			353.38	124.36	3393.82	
<i>Rachycentron canadum</i>	cobia							1.03	0.42	3.62	2.80					7.87	
<i>Remora remora</i>	remora							0.51		0.90						1.42	
<i>Rhomboplites aurorubens</i>	vermillion snapper	10.17	170.92	6111.02	4452.52	196.30	6574.20	2267.39	31.51	36.86		1.14		50.58	484.79	20387.40	
<i>Rypticus maculatus</i>	whitespotted soapfish	0.77		0.92		3.23	2.36	3.54								10.82	
<i>Rypticus saponaceus</i>	greater soapfish			7.37	3.66		3.01	3.94	1.39	8.91	2.45			21.93	30.91	83.58	
<i>Rypticus</i> spp.	unid soapfish	1.78	0.44	0.54	0.41		2.28	1.12		0.80				1.54	0.60	9.51	
<i>Rypticus subbifrenatus</i>	spotted soapfish													1.03		1.03	
Scaridea	unid parrotfish				0.67		0.83	5.07								6.58	
<i>Schultzea beta</i>	school bass						6.00							33.94	9.09	49.03	
<i>Scorpaena plumieri</i>	spotted scorpionfish						5.60	4.57								10.17	
Scorpaenidae	unid scorpionfish	46.60	13.08	25.69	10.53	2.13	1.07	15.26	5.18	67.67	1.44	109.19	63.31	9.83	2.69	373.66	

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			OECA	OHAPC	Inside	Outside		Inside	Outside		Inside	Outside	Inside	Outside		Inside	Outside
<i>Seriola dumerilii</i>	greater amberjack	5.38	28.61	49.80	8.10	3.95	164.09	17.82	7.52	39.28	1.28		1.14	10.75	5.08	342.83	
<i>Seriola fasciata</i>	lesser amberjack								10.28				1.20			11.48	
<i>Seriola rivoliana</i>	almaco jack	1.54	3.20	8.00	32.14	13.45	17.66	91.19	75.41	68.24	16.38			26.15	16.68	370.04	
<i>Seriola</i> spp.	unid amberjack	184.66	2.43	11.69	21.12	12.21	54.91	40.77	72.88	21.71	13.39	1.96	3.26	8.73	55.10	24.33	529.15
Serranidae	unid grouper							1.44	1.65				0.40			3.49	
Serranidae	unid sea bass		1.63	1.19	0.54											3.36	
<i>Serranus annularis</i>	orangeback bass	0.77	18.17	10.38	30.92	18.38	37.87	45.30	35.70	7.11	19.44	14.95		13.56	27.41	279.97	
<i>Serranus baldwini</i>	lantern bass		10.71		13.25	10.74	8.93	11.64	18.27		27.57	7.25			2.96	111.32	
<i>Serranus chionaraia</i>	snow bass		0.77			0.80		1.08			0.78					3.43	
<i>Serranus notospilus</i>	saddle bass	0.77	65.26	2.08			5.92						41.03	3.07		118.13	
<i>Serranus phoebe</i>	tattler	23.81	134.91	290.55	71.48	33.01	147.29	151.31	41.25	21.58	96.43	48.19		96.05	32.95	1188.81	
<i>Serranus</i> spp.	unid sea bass				3.15	1.44	0.65	2.56	2.21							10.01	
<i>Serranus subligarius</i>	belted sandfish		0.97													0.97	
<i>Serranus tigrinus</i>	harlequin bass		0.97		3.43	2.10		4.12	1.03		0.47					12.11	
<i>Serranus tortugarum</i>	chalk bass		0.89					1.83						0.61	0.61	3.93	
Sparidae	unid porgy			0.77		1.58	5.65	0.54				2.32				10.86	
<i>Sparisoma atomarium</i>	greenblotch parrotfish		1.63		12.74	26.39		45.01	11.01	0.55	15.48	1.20		1.03		115.05	
<i>Sparisoma aurofrenatum</i>	redband parrotfish				1.77			1.65	0.91							4.33	
<i>Sparisoma</i> spp.	unid parrotfish				5.62			5.21	0.93							11.76	
<i>Sphoeroides spengleri</i>	bandtail puffer			1.85			22.07	9.06	16.33					3.28	4.52	57.10	
<i>Sphyaena barracuda</i>	barracuda							11.32	7.69	1.26	2.95			0.51		23.74	
<i>Stegastes partitus</i>	bicolor damselfish				17.13	1.58		32.12	33.16		4.97	1.03		2.47	1.21	93.67	
<i>Stephanolepis hispidus</i>	planehead filefish							0.59	2.37							2.96	
Syngnathidae	unid pipefish				0.53											0.53	
<i>Synodus intermedius</i>	sand diver				1.75						2.03		0.94			4.72	
<i>Synodus</i> sp.	unid lizardfish		11.11	1.69	1.58		1.06	1.22	2.09		0.40		3.66		0.43	23.24	
<i>Synodus synodus</i>	red lizardfish				0.54						0.40					0.94	
Tetraodontidae	unid puffer						4.93	1.60								6.53	
<i>Thalassoma bifasciatum</i>	bluehead wrasse				0.45			0.83	2.56							3.85	
Triglidae	unid searobin															0.89	
unknown	unknown	4.14	57.23	69.20	1024.93	72.52	32.57	64.27	1005.21	0.86	29.34	19.46	20.19	9.61	582.32	28.61	3020.46
<i>Urophycis</i> spp.	unid hake								1.19							1.19	
<i>Xanthichthys ringens</i>	sargassum triggerfish													9.13	12.97	22.10	
<i>Xyrichtys</i> spp.	unid razorfish						0.61									0.61	
Totals		2156	1027	1814	24240	12955	3005	43997	37423	16895	19329	1449	2839	5233	7423	12190	191976