NOAA CIOERT Final Cruise Report

Report Title: Characterization of Mesophotic Coral/Sponge Habitats and Fish Assemblages in the Regions of Pulley Ridge and Tortugas from ROV Dives during R/V *Walton Smith* Cruises of 2012 to 2015

R/V *F.G. Walton Smith*
UNCW *Super Phantom 2* ROV and NMSF *Mohawk* ROV

NOAA National Centers for Coastal Ocean Science award: NA11NOS4780045
"Connectivity of the Pulley Ridge - South Florida Coral Reef Ecosystem"
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April 26, 2017

Photo Album- Corals of Pulley Ridge

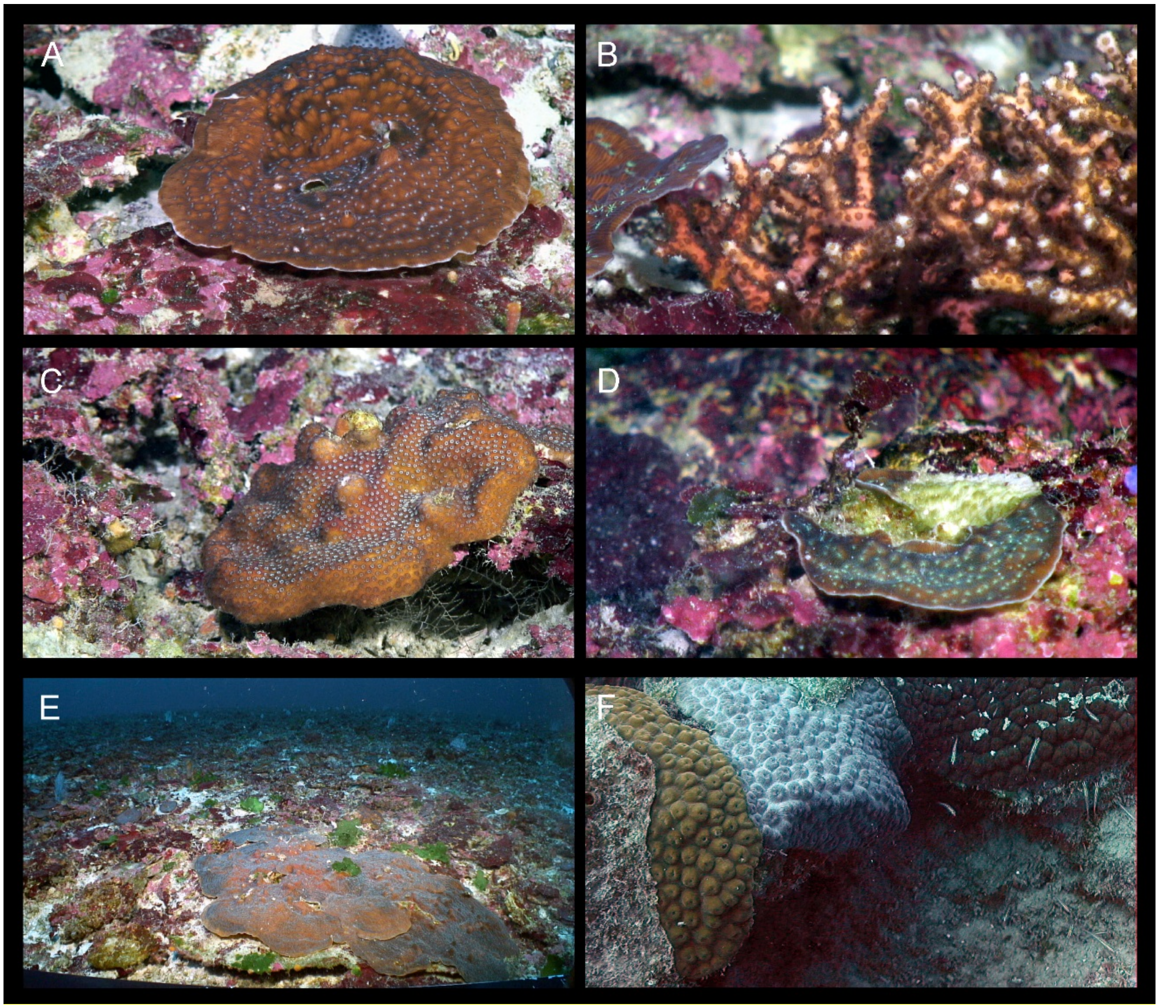

Plate 1. Photo Album- Corals of Pulley Ridge. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. *Helioseris cucullata*, Block 30, depth 74.2 m; B. *Madracis auretenra*, Block 30, depth 73.8 m; C. *Madracis decactis* f. *pharensis*, Block 76, depth 81.7 m; D. bleached or diseased *Agaricia* sp. coral, Block 31, depth 76.5 m; E. *Agaricia lamarcki*, Block 83, depth 82.5 m; F. three color morphs of *Montastraea cavernosa*, Block 61, 29.2 m, Tortugas.

Photo Album- Sponges of Pulley Ridge

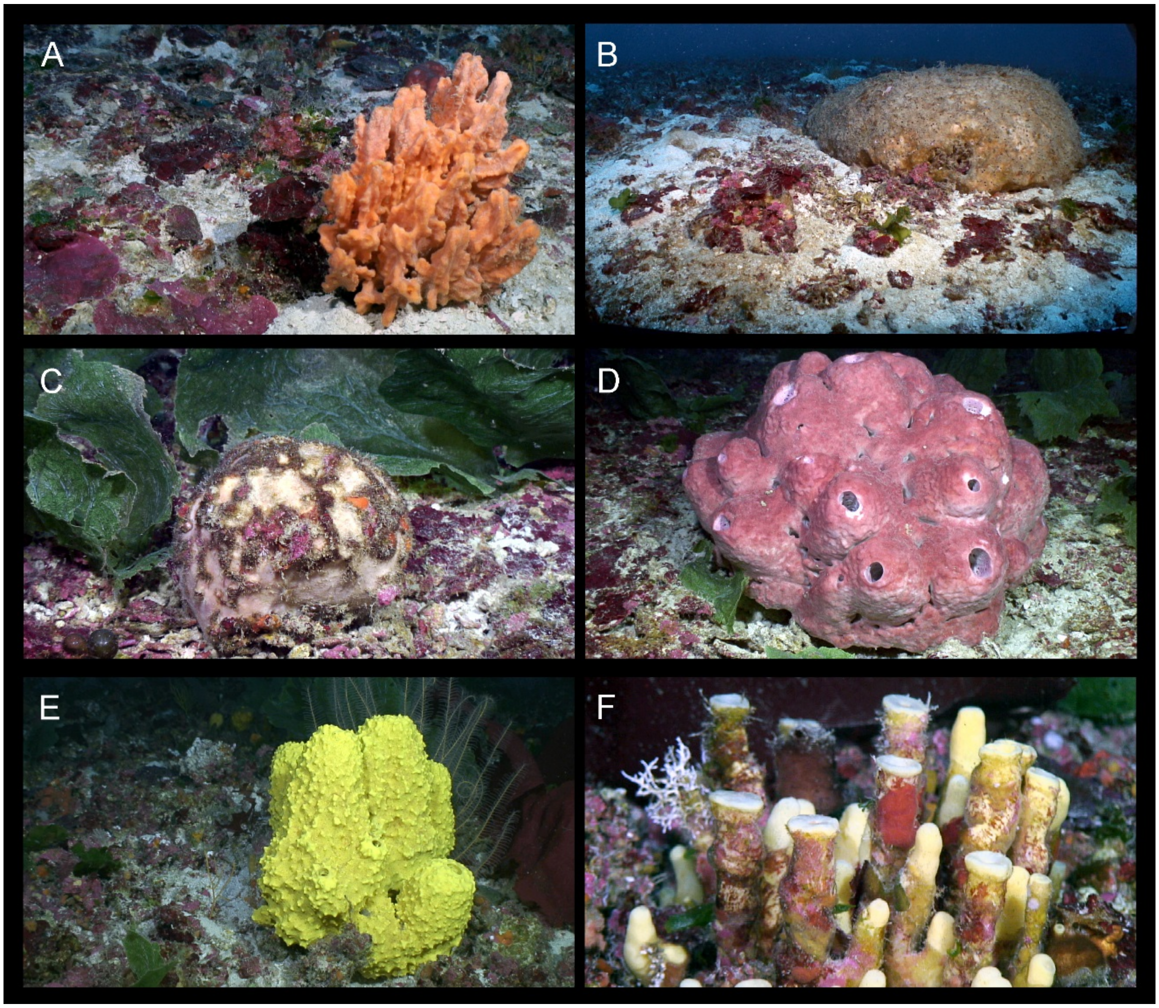

Plate 2. Photo Album- Sponges of Pulley Ridge. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. *Bubaris* sp., Block 25, depth, 79.4 m; B. *Spongosorites siliquaria*, Block 25, depth 77.3 m; C. *Geodia neptuni* complex, Block 30, depth 73.2 m; D. Petrosiidae, Block 30, depth 73.8 m; E. *Aiolochroia crassa*, Block 35, depth 79.3 m; F. *Oceanapia* sp., Block 35, depth 79.2 m.

Photo Album- Soft Corals and Black Corals of Pulley Ridge

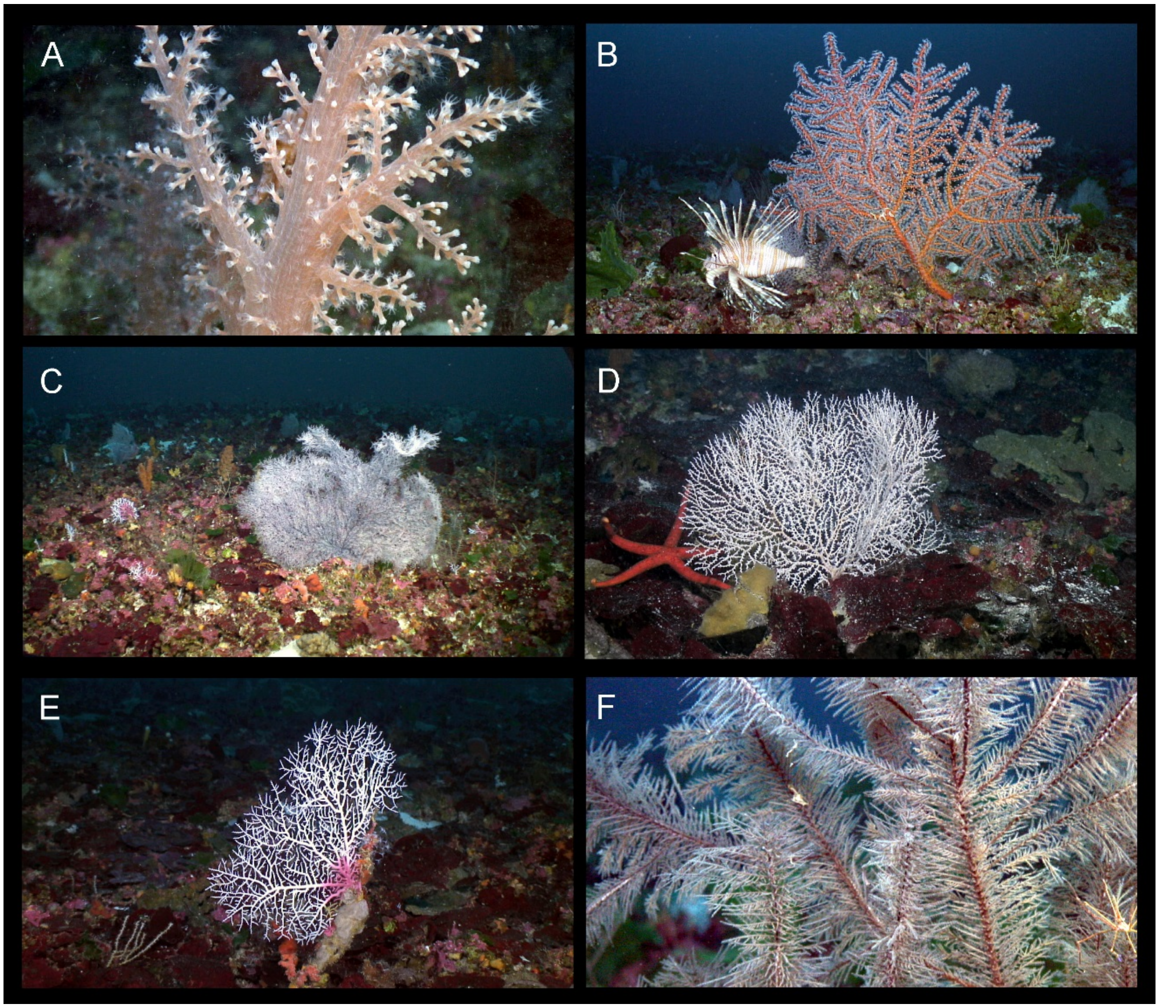

Plate 3. Photo Album- Soft Corals and Black Corals of Pulley Ridge. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. *Chironephthya caribaea*, Block 35, depth 79.6 m; B. *Swiftia exserta* (with lionfish), Block 35, depth 79.3 m; C. *Antipathes atlantica*, Block 34, depth 82.1 m; D. Primnoidae gorgonian, Block 34, depth 83.2 m; E. *Stylaster filogranus*, Block 34, depth 83.7 m; F. Antipatharia, Block 36, depth 79.

Photo Album- Algae of Pulley Ridge

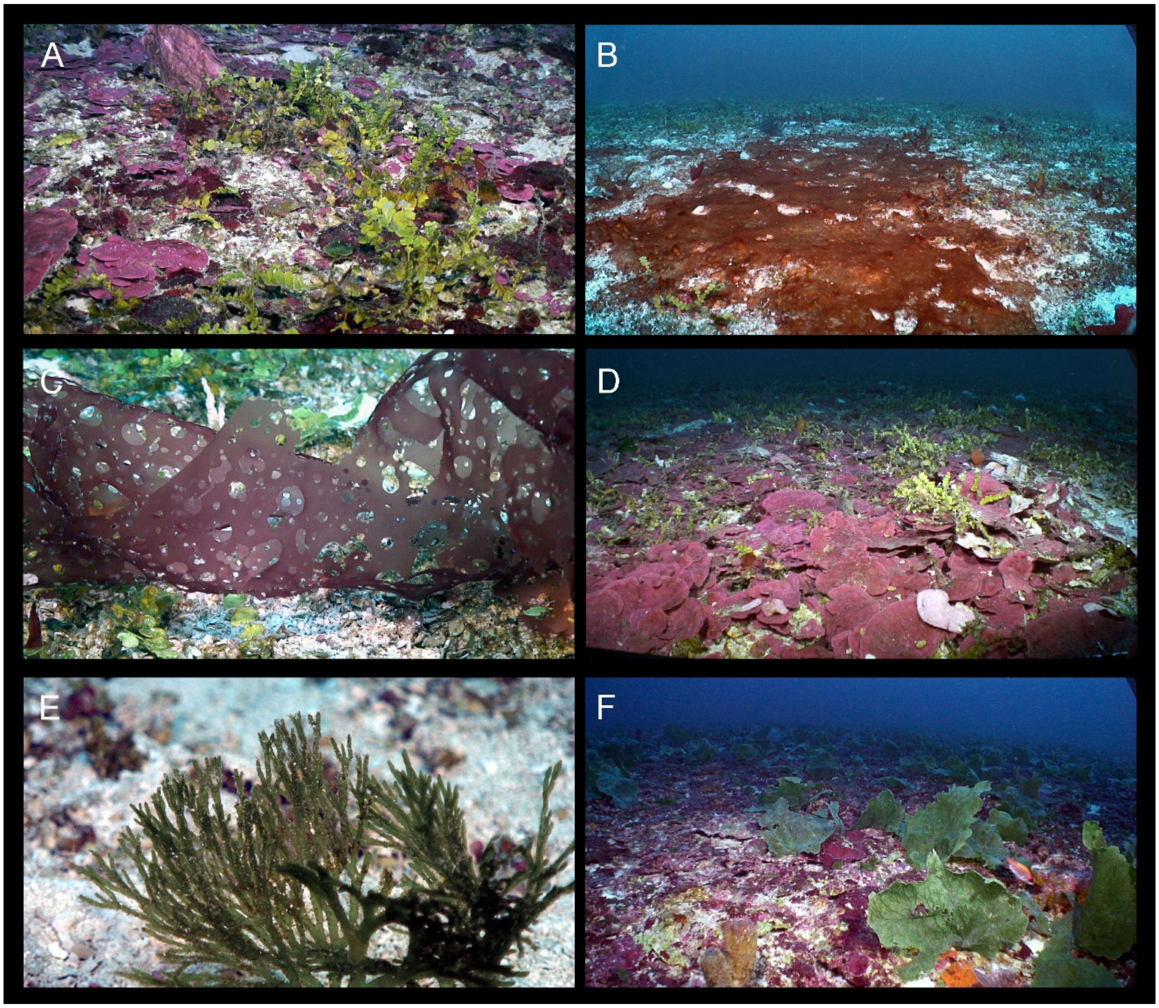

Plate 4. Photo Album- Algae of Pulley Ridge. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. *Halimeda* sp., Block 29, depth 79.1 m; B. Cyanobacterial mat; Block 27, depth 68.6 m; C. *Kallymenia westii*, Block 27, depth 67.9m; D. Crustose coralline algae, Block 28, depth 79.8 m; E. *Codium* sp., Block 32, depth 64 m; F. *Anadyomene menziesii* (leafy green), Block 30, depth 74.1 m.

Photo Album- Fishes of Pulley Ridge

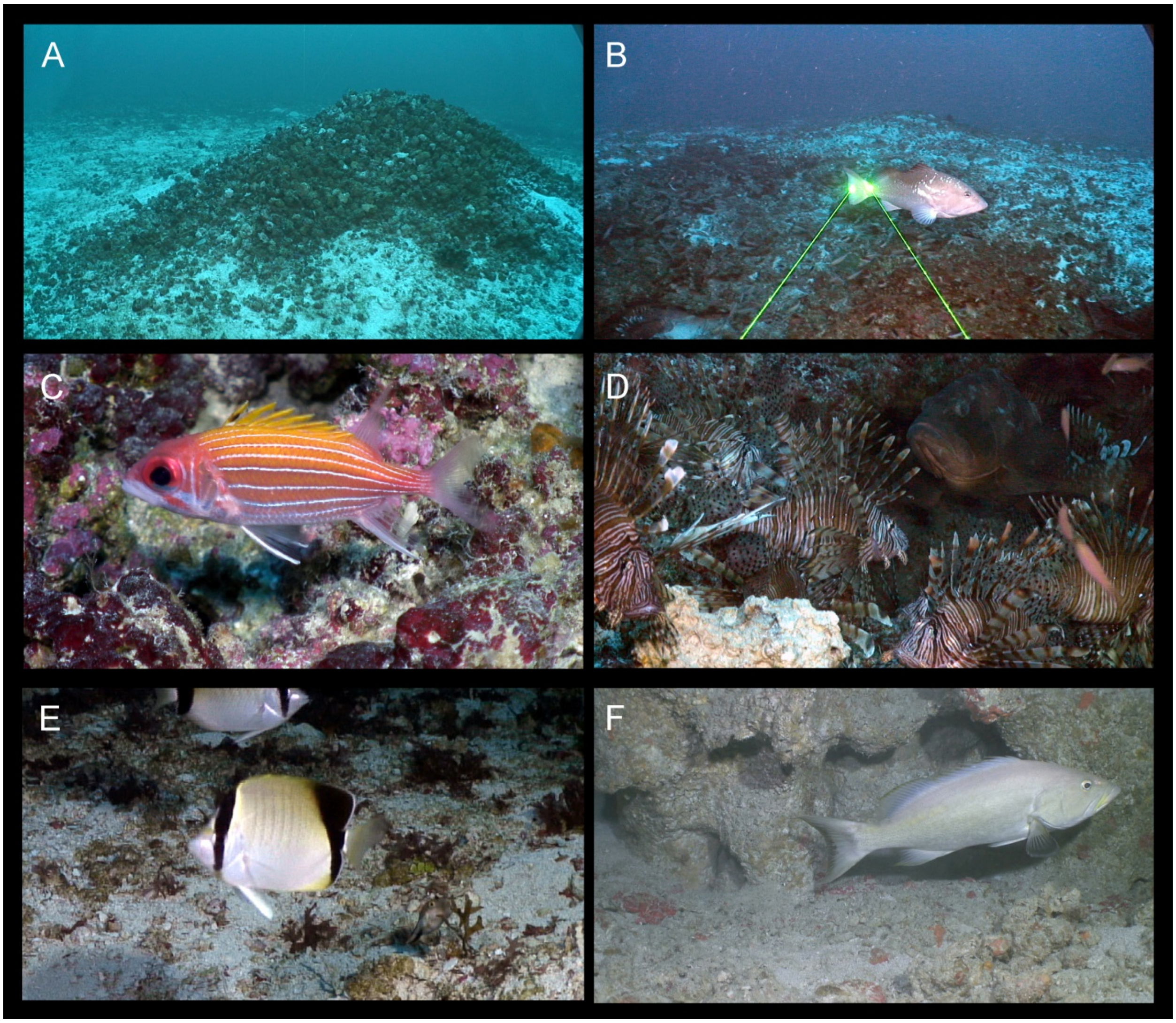

Plate 5. Photo Album- Fishes of Pulley Ridge. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. Sand tilefish burrow, Block 27, depth, 68.6 m; B. large red grouper (*Epinephelus morio*) guarding its burrow, Block 28, depth 79.8 m, laser scale- 10 cm; C. Longspine squirrelfish (*Holocentrus rufus*), Block 28, depth 80.1 m; D. school of lionfish (*Pterois volitans*) in red grouper burrow, Block 34, depth 81.6 m; E. Reef butterflyfish (*Chaetodon sedentarius*), Block 23, depth 67.1; F. Scamp grouper (*Mycteroperca phenax*), Block 75, depth 106.9 m (Miller's Ridge).

Photo Album- Miscellaneous Fauna of Pulley Ridge

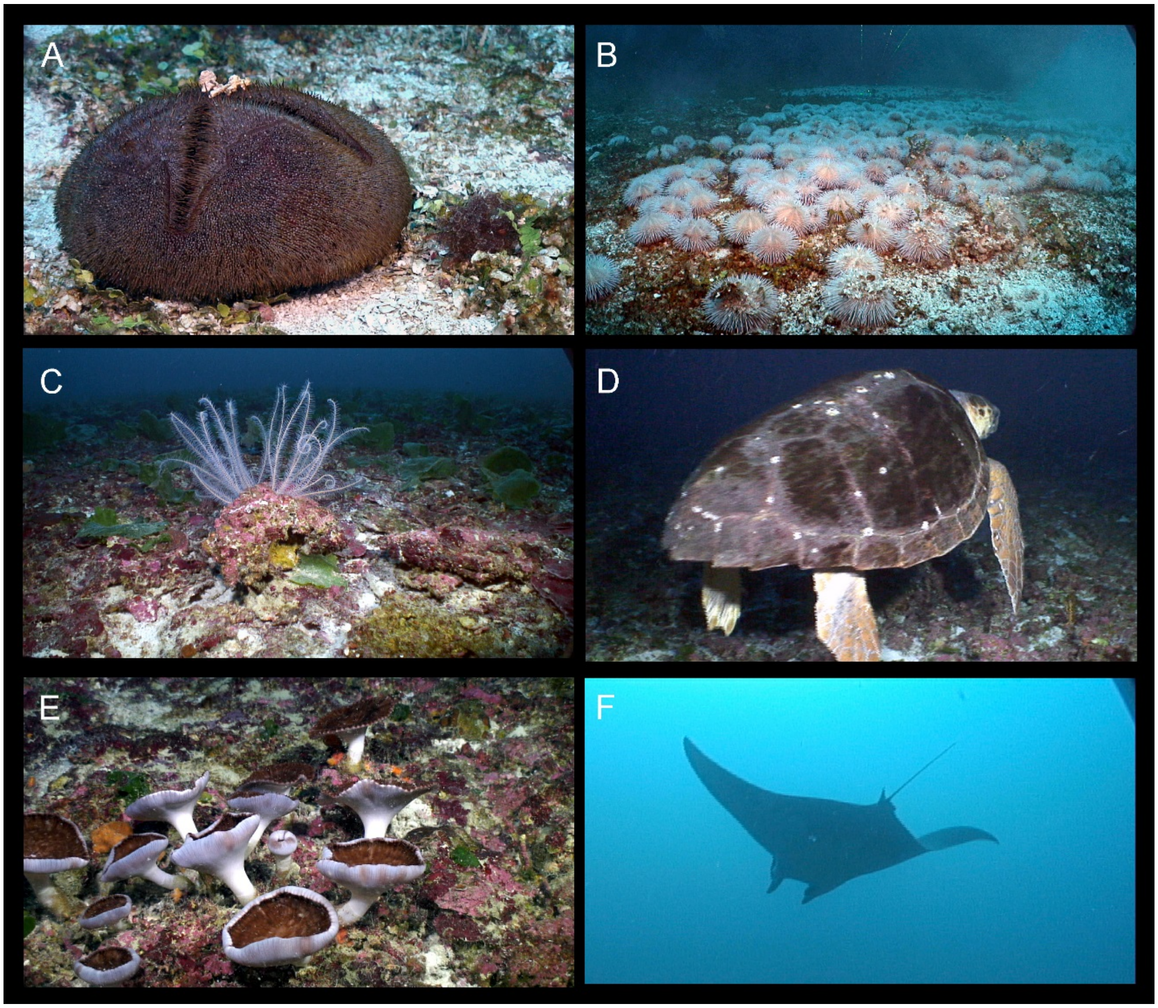

Plate 6. Photo Album- Miscellaneous fauna of Pulley Ridge. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. Sea biscuit (*Meoma ventricosa*), Block 27, depth 69.3 m; B. Aggregation of sea urchins (*Echinus* sp.), Block 27, 66.9 m; C. Long-armed crinoid (*Davidaster discoideus*), Block 30, depth 74.8 m; D. Loggerhead turtle (*Caretta caretta*), Block 79, depth 85.7 m; E. Sea pansies, Corallimorpharia, Block 77, depth 81.1 m; F. Manta ray (*Manta birostris*), Block 76, depth 78.6 m.

Photo Album- Miscellaneous Biota of Tortugas Mesophotic Reefs

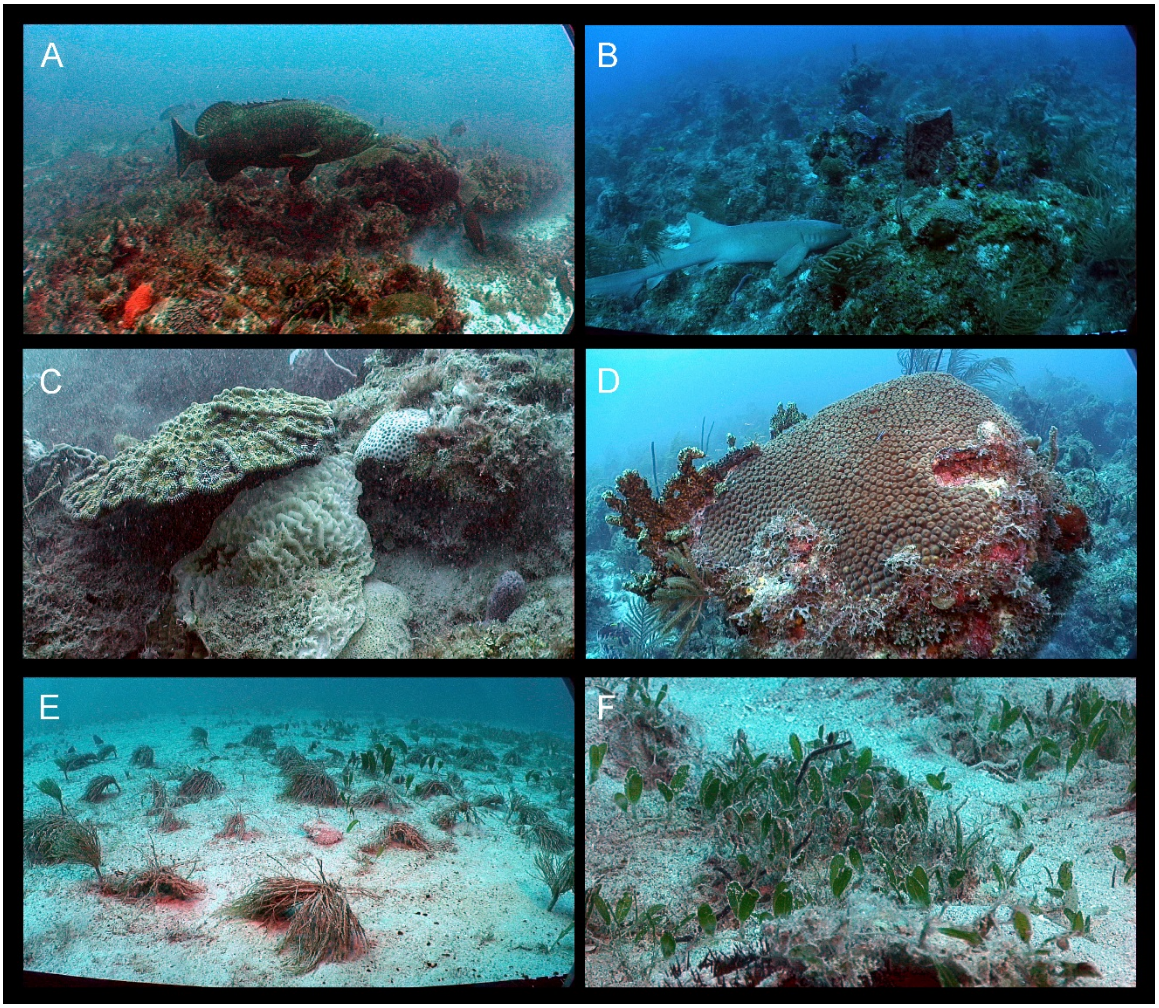

Plate 7. Photo Album- Miscellaneous biota of Tortugas mesophotic reefs. Images from FGNMS *Mohawk* ROV during 2014 R/V *Walton Smith* Cruise. A. Large goliath grouper (*Epinephelus itajara*) with large spawning aggregation of grey snapper on newly discovered patch reef; Block 66, depth 23.5 m; B. Nurse shark, *Montastraea cavernosa* coral, *Xestospongia muta* sponges, and *Pseudopterogorgia* gorgonians on fringing reef off north Tortugas Ecological Reserve, Block 46, depth 27.9 m; C. *Mycetophyllia aliciae* and bleached *Undaria* sp. coral on patch reef, Block 61, depth 30.8 m; D. Giant star coral *Montastraea cavernosa* on fringing reef, Block 46, depth 27.9 m; E. soft bottom with field of green algae- bottle brush algae *Penicillus dumetosus*, feather algae *Caulerpa sertularioides*, Block 61, depth 30.7 m; F. seagrass *Halophila decipiens* Block 69, depth 31.2 m.

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EXECUTIVE SUMMARY

This report summarizes the remotely operated vehicle (ROV) surveys during four cruises from 2012 to 2015 which characterizes the mesophotic coral reef ecosystems at Pulley Ridge and Tortugas. This research is part of a grant funded by the NOAA National Centers for Coastal Ocean Science award NA11NOS4780045: "Connectivity of the Pulley Ridge - South Florida Coral Reef Ecosystem". The University of Miami ship R/V *Walton Smith* was used along with the University of North Carolina at Wilmington (UNCW) *Super Phantom* ROV and the National Marine Sanctuary Foundation (NMSF) *Mohawk* ROV. The cruises were a collaboration of the University of Miami, HBOI-CIOERT, NOAA Fisheries, and the UNCW-CIOERT Undersea Vehicles Program.

This project documents and characterizes the mesophotic benthic habitat, benthic macrobiota, and fish populations within and adjacent to Pulley Ridge Habitat Area of Particular Concern (PR HAPC) and at sites adjacent to, but outside, of the North and South Tortugas Ecological Reserves (TERs), and the Florida Keys National Marine Sanctuary (FKNMS).

Ultimately these data may be used to better understand the long-term health and status of these important mesophotic ecosystems. These data will be of value to the regional Fishery Management Councils, NOAA OER, NOAA NCCOS, NOAA Fisheries, NOAA Mesophotic Reef Ecosystem Program, NOAA Deep-sea Coral Research and Technology Program (DSCRTP), NOAA Coral Reef Conservation Program (CRCP), and NOAA Marine Sanctuaries for management decisions on these habitats and managed key species.

This report summarizes the ROV data that were collected within 68 1-km^2 random Blocks that were surveyed over all 4 years at the Pulley Ridge (PR) mesophotic reef, and 23 Blocks in the region of the Tortugas (TOR) during our cruises in 2013 and 2014. Individual cruise reports (Reed et al. 2012a, 2012b, 2012c, 2014, 2015, 2016a, 2017) for each cruise provided detailed SEADESC (Southeastern United States Deep-Sea Corals) characterization of the benthic habitat, benthic macrobiota, and fish populations for each dive site.

A total of 91 ROV dives surveyed 91 random blocks at the PR and TOR regions (Figs. 1 and 2, Appendix 1), and covered a distance of 150 km at depths from 22.9 to 114.4 m. A total of 237 hours of ROV video were recorded and 17,888 in situ digital images were taken which included quantitative transect images (16,071), and video frame grabs of general habitat images and species documentation images. Sample collections with the ROV included 10 Porifera, 40 Cnidaria (including, 19 Scleractinia, 15 gorgonian Octocorallia, 1 Antipatharia), 3 Echinodermata, 1 Arthropoda, 1 Mollusca, 20 macroalgae, and 2 geological (rock/sediment) specimens.

A total of 199 benthic macrobiota were identified from the quantitative image analysis at Pulley Ridge (Table 3, Appendix 2). The most diverse taxa by far were sponges (92 taxa). The other sessile benthic taxa included 29 macroalgae, 12 Scleractinia (hard corals), 15 gorgonian octocorals, and 7 Antipatharia. A total of 153 benthic macrobiota were found at the Tortugas sites (Table 3, Appendix 3) which were dominated by sponges (57 taxa), macroalgae (32), corals

(19), and gorgonians (16). However, the benthic communities and habitats were quite different between the two regions. The Pulley Ridge sites were primarily at deep mesophotic depths of 59-94 m, whereas the patch reefs and fringing reef sites at the Tortugas were comparatively shallow (23-55 m). A total of 12 hard coral species were identified at Pulley Ridge. The most common species at Pulley Ridge included *Agaricia fragilis, A. lamarcki/grahamae, A. undata, Helioseris cucullata, Madracis brueggemanni* (previously identified as *M. auretenra*), *M. formosa, M. decactis*, and *Oculina diffusa*. Unfortunately, we found a shocking 93.6% loss of coral cover in 10 years within the Pulley Ridge Habitat Area of Particular Concern (PR HAPC) (Reed et al. 2016). Previous surveys on the Main Ridge reported an average coral cover of 12.83% (USGS 2005; data collected in 2003) whereas we found 0.82% coral cover (2012-2015 data). On a positive note, in 2014 and 2015 more blocks were added which were outside of the PR HAPC and in the relatively unstudied West Ridge and Central Basin, where we discovered some of the highest coral cover that we have seen to date in our cruises. A total of 51,814 living scleractinian corals were counted. Overall, the density of all scleractinian coral species was 6.83 colonies m^{-2}; plate coral density (*Agaricia* spp. and *H. cucullata*) was 4.89 colonies m^{-2}. The Central Basin-South region which is outside the PR HAPC had the greatest coral density overall (15.82 m^{-2}), and Block 120 had the greatest density of agariciid corals of 30.3 colonies m^{-2}. A great majority of *Agaricia* were <5 cm in diameter, indicating they were relatively recent recruits and may be recovering from whatever die-off occurred after 2003.

All fish were identified for each ROV dive, counted, and densities determined. A total of 86 fish taxa were identified from Pulley Ridge (Appendix 4) and 96 taxa from Tortugas (Appendix 5). The fish assemblages of the two regions were significantly different, primarily due to higher densities of yellowtail reeffish (*Chromis enchrysurus*), chalk bass (*Serranus tortugarum*), purple reeffish (*Chromis scotti*), greenblotch parrotfish (*Sparisoma atomarium*), sunshinefish (*Chromis insolatus*), and lionfish (*Pterois volitans*) at Pulley Ridge. A total of 29 managed species were observed; 20 at Pulley Ridge and 17 at Tortugas (Table 12). The most abundant species at Pulley Ridge were almaco jack (*Seriola rivoliana*), vermilion snapper (*Rhomboplites aurorubens*), and red grouper (*Epinephelus morio*). Lionfish (*Pterois volitans/miles*) were first discovered on Pulley Ridge during submersible dives in 2010 when six fish were observed and their densities have been significantly increasing since then. We observed a total of 1,885 lionfish during the course of this project; 1,814 of these were observed at Pulley Ridge while only 71 were observed at the Tortugas. Most of these at Pulley Ridge were associated with active red grouper pits in close proximity to the resident large red grouper and numerous small reef fish that assemble in masses in these holes as an oasis. Using all the ROV data, both on and off transect times, 66 fish taxa were observed in the grouper pits, 16 of which were managed species.

Marine Protected Areas

In 2005, the Gulf of Mexico Fishery Management Council (GMFMC) and Department of Commerce through the Magnuson-Stevens Fishery Management Act established the PR HAPC. In December 2014, the data compiled from our cruises to Pulley Ridge, including CIOERT cruises of 2010 and 2011 (FloSEE I and II), and the UM cruises of 2012-2014, were presented to the Coral Advisory Panel of the Gulf of Mexico Fishery Management Council as a proposal to extend the boundaries of the Pulley Ridge HAPC to the west to include the coral rich Central Basin and the West Ridge (Reed and Farrington 2014b). Also our data compiled on the mesophotic reefs at Tortugas in 2013-2014 were presented to the Florida Keys National Marine Sanctuary (FKNMS) as a proposal for extending the boundaries of the sanctuary to include these newly discovered coral/sponge habitats (Reed and Farrington 2014d). These data will be critical to the various agencies and researchers by documenting deep-water coral/sponge habitat and Essential Fish Habitat (EFH) that are currently unprotected and are under consideration for expansion of the marine protected areas.

ACKNOWLEDGEMENTS

This project is a unique collaboration of more than thirty scientists pooling the expertise from within two NOAA CI's: the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) at the University of Miami (UM), and the Cooperative Institute for Ocean Exploration Research and Technology (CIOERT) at Harbor Branch Oceanographic Institute/Florida Atlantic University (HBOI-FAU), as well as the wider Gulf of Mexico scientific and management communities. This research was a collaboration of University of Miami (Drs. Robert Cowen, Peter Ortner), CIOERT-HBOI (Dr. Shirley Pomponi, Dr. Dennis Hanisak, John Reed, Dr. Joshua Voss), NOAA Fisheries (Andy David, Stacey Harter, Heather Moe), Florida State University Coastal and Marine Laboratory (Drs. Felicia Coleman and Chris Koenig), the University of North Carolina at Wilmington (Lance Horn, Jason White), the Florida Keys National Marine Sanctuary, and the Gulf of Mexico Fishery Management Council. We thank CIOERT for continued support of the mesophotic reef research program at HBOI-FAU. The crew of University of Miami's ship R/V *F.G. Walton Smith* provided excellent support for the four cruises. ROV pilots Lance Horn and Jason White, University of North Carolina at Wilmington (UNCW-CIOERT) Undersea Vehicle Program, are especially thanked for their support and effort which made these ROV dives a success. UNCW provided the *Super Phantom 2* ROV in 2012 and 2013 and the U.S. National Marine Sanctuary Foundation provided the *Mohawk* ROV in 2014 and 2015. The cruises, ROV dives, and benthic analyses were led by CIOERT-HBOI. NOAA's National Marine Fisheries Service/Southeast Fisheries Science Center (NMFS/SEFSC), Panama City Laboratory, provided at-sea support and video analysis of fishes. This research was funded by the NOAA National Centers for Coastal Ocean Science under award NA11NOS4780045 (Project Title: "Understanding Coral Ecosystem Connectivity in the Gulf of Mexico – Pulley Ridge to the Florida Keys") to CIMAS at UM, and the NOAA Office of Ocean Exploration and Research under awards NA09OAR4320073 and NA14OAR4320260 to CIOERT at HBOI-FAU. This is Harbor Branch Oceanographic Institute Technical Report Number 178.

STUDY AREAS

Pulley Ridge and Tortugas Mesophotic Ecosystems- Background

Pulley Ridge is the deepest known photosynthetic coral reef in continental U.S. waters (USGS 2005; Hine et al. 2008; Halley et al. 2013; NOAA 2013). It lies in the Gulf of Mexico, 100 miles west of the Dry Tortugas at the far end of the Florida Keys (Fig. 1). Pulley Ridge is a submerged 100 km x 5 km barrier island that was originally discovered in 1950. It has less than 10 m of relief across the 5 km wide ridge at depths of 65 to 75 m. According to USGS (2005), the coral on Pulley Ridge was "considerably healthier then coral from shallow water reefs nearly worldwide". This is of particular interest because research shows that shallow water reefs worldwide are stressed due to climate change, habitat loss, human impact, and coral diseases.

Southern Pulley Ridge has an atypical array of photosynthetic hard corals, macroalgae, sponges, and a large variety of tropical fishes (Halley et al. 2013). These reefs are termed mesophotic reefs which are relatively deep compared to shallow water reefs. At depths of 50 to about 100 m, mesophotic reefs still receive enough sunlight to support photosynthetic algae and corals with zooxanthellae (algal symbionts). Based on photographs collected by the USGS's SeaBOSS camera system in 2003, Hine et al. (2008) reported that Pulley Ridge is dominated by coralline algae which covers 45-65% of limestone bottom. Pulley Ridge is also home to a wide variety of fleshy macroalgae including *Halimeda tuna*, *Dictyota* sp., *Kallymenia* sp., and the endemic species *Anadyomene menziesii*, which look like large heads of lettuce and can be as dense as tens of plants per square meter. Halley et al. (2013) also reported *Agaricia* spp. and *Helioseris cucullata* as the two most abundant species of scleractinian coral which form flat plates as large as 50 cm in diameter and make up almost 60% of the live coral cover in some locations. These species are typically found only on the deeper slopes of shallow water reefs in the Caribbean and Florida. *Montastraea cavernosa* (the giant star coral) is another species found on Pulley Ridge but is also common on shallow water reefs. Pulley Ridge is home to more than 80 species of fish including both shallow water and deep reef species. These include the commercially caught species *Epinephelus morio* – the red grouper. Red grouper form large 8-15 m wide and 1-2 m deep pits in the sand and rubble bottom that provide an oasis-like shelter for numerous smaller reef fish. Unfortunately lionfish are also showing up here recently in virtually every red grouper burrow. Since CIOERT-HBOI discovered the first lionfish on Pulley Ridge in 2010, our research cruises in 2011 and 2012 have shown the population to have exploded (Reed et al. 2012).

The second area of study was near the Tortugas Bank, and adjacent to but outside of the western boundary of the Florida Keys National Marine Sanctuary (FKNMS) and the North and South Tortugas Ecological Reserves (TER). No benthic surveys have been made previously of these mesophotic reef habitats outside of the protected areas. However, areas within the TERs such as Miller's Ledge, Riley's Hump, and Sherwood Forest have been mapped, and are relatively well studied (Lee et al. 1999, Schmidt et al. 1999, Cowie-Haskel and Delaney 2003, Weaver et al. 2006, Ault et al. 2013).

OBJECTIVES

Objectives for this NOAA-NOS-NCCOS grant "Connectivity of the Pulley Ridge - South Florida Coral Reef Ecosystem: Processes to Decision-Support Tools" are:

1. Population Dynamics:
   To estimate the spatial distribution, abundance, and size structure of key economically and ecologically important reef-fish species in Pulley Ridge compared to those regionally located on the west Florida shelf and the Dry Tortugas-Florida Keys areas.
2. Community Structure:
   To quantify preliminarily two key reef processes: benthic primary productivity and settlement/recruitment potential of corals.
3. Decision Support Toolkit:
   To create software specific for the Pulley Ridge dataset that will organize and integrate the data, models and other information products produced by the project

PURPOSE

It is well known that shallow-water reefs worldwide are increasingly stressed and losing habitat due to climate change, human impact, and coral diseases. However, how well are deep reefs doing in comparison? Deep mesophotic coral ecosystems such as Pulley Ridge are of particular interest and may provide clues to the future of coral reefs. Questions asked include: do mesophotic reefs act as refugia for shallow-water reef species; what connectivity, if any, exists between mesophotic and shallow reef species? Understanding the ecology of mesophotic reefs and the connectivity of the mesophotic and shallow-water reefs may provide a baseline denoting impacts of coral bleaching and other effects of climate change (NOAA 2013). These are some of the questions we hope to answer. These different sub-themes within the grant will produce outputs that are vital to providing managers with knowledge to make informed decisions about the spatial scales of connectivity and functioning of the overall South Florida coral reef ecosystem, and whether specific actions are warranted for the Mesophotic Coral Ecosystem within the area.

METHODS

ROV Operations

Remotely Operated Vehicle (ROV) operations were conducted by the Underwater Vehicles Program of UNCW (operators- Lance Horne, Glenn Taylor, and Jason White). In 2012 and 2013, the UNCW *Super Phantom S2* ROV was used (described in Reed et al. 2014 cruise report); in 2014 and 2015 the *Mohawk* ROV, owned by the NOAA National Marine Sanctuaries Foundation, was used. ROV video and photographic surveys were made at each site to ground-truth multibeam sonar maps, quantify and characterize the benthic habitats, benthic macrobiota, fish populations, and coral/sponge/algal cover. Prior to each ROV dive, georeferenced sonar maps were overlaid with random 1 km^2 blocks (described below) and uploaded to the ROV navigation software. Five 100-m radius circles were added within each random block for the quantitative transects. Typically one 4-hour ROV dive would complete five 100-m transects per random block, and two ROV dives were made each day. In addition to the ROV dives, other shipboard operations included continuously recorded surface water chemistry, CTD shipboard casts, ISIS plankton surveys, plankton light trap collections, and grouper trap collections but these results are not included in this report.

ROV Video Cameras

During the 2012 and 2013 cruises, the *Super Phantom* ROV used a Sony standard resolution, single-chip color video camera (410x380 pixels). The video footage was recorded continuously throughout each dive from surface to surface, and were recorded to 2 TB hard drives with copies to DVDs. During the 2014 and 2015 cruises, the *Mohawk* ROV used a high-definition video camera (*Insite* Pacific Mini Zeus HD CMOS color zoom video camera). 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. In addition, frame grabs were taken from the high definition video to document species and habitat.

ROV Digital Still Cameras

Still images were taken to document habitat and benthic macrobiota and for the quantitative photo transects. The *Super Phantom* ROV used an *Insite* Pacific Inc. Scorpio Plus with a Nikon Coolpix 995 digital still color camera and strobe (approximately 1.0 Mb per image). The *Mohawk* ROV used a Kongsberg OE14-408 (Canon G11) high-definition digital still camera (10 megapixels). Each photo filename was coded with corresponding EDT time and date code (using Stamp 2.8 by Tempest Solutions©) which was imported into the MS Access database and linked to the ROV navigation data for site specific data of coordinates and depth and then imported into ArcGIS^{tm} 10.02.

ROV Navigation

The ROVs used an integrated navigation system consisting of Hypack Max 2014 software on a 64-bit, 3.4 GHz, rack-mounted computer running Windows 7. Data from an ORE Offshore 4410C Trackpoint II USBL Acoustic Tracking System, Northstar 951XD differential GPS, Azimuth 1000 digital compass, and the *Mohawk* ROV data feed to this computer. The Trackpoint II system communicates acoustically to an ORE Offshore 4377A transponder with depth telemetry on the ROV to provide slant range, bearing, and depth from the support vessel so that latitude and longitude can be assigned to the ROV. The integrated navigation system provides real time tracking and orientation of the ROV and ship to the ROV pilot and the support vessel's bridge for navigation. Geo-referenced TIFF files obtained with multibeam sonar were entered into Hypack as background files to display target sites and features of interest to aid in ROV and ship navigation. Hypack also exports ROV position data in real time as a NMEA data string. Ship and ROV positions, 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) were geo-referenced to ROV position by matching the time and date to the ROV navigation files.

ROV CTD

No CTD data were available on ROV during the 2012 and 2013 cruises. A temperature/depth sensor (Sea-Bird Electronics 39) was attached to the ROV in 2014. A Sea-Bird Electronics 49 FastCAT CTD sensor was used in 2015 which recorded depth (m), temperature (^{o}C), conductivity (uS/cm), salinity (PSU), density (Kg/m^3), sound velocity (m/s), oxygen saturation (ml/l), and nitrogen saturation (ml/l). These data are provided in SEADESC data for the individual cruise reports.

ROV Sample Collections

A tool sled designed and built by HBOI-FAU was attached to the *Mohawk* ROV in 2015 for sample collections. This sled includes a Hytec™ 5-function manipulator with jaws and suction hose, five suction buckets (2 L each), and a larger bin with removable partitions (61cm x 23 cm x 17 cm). Collections of scleractinian corals, gorgonian corals, sponges and algae were made for molecular analyses and taxonomy.

ROV Survey Protocol

During each dive the primary objectives 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. Each ROV dive was ~1 km in length, lasting ~3-4 hours, which documented 1 km x 1 km randomly selected Blocks (described below) with continuously recording digital video and digital still images. Five random 100-m video/photo transects were conducted within each Block. Generally, the ROV was kept <1 m off bottom with a speed over ground of ~¼ knot (12.5 cm s^{-1}). The video was viewed in real time on the support vessel by PIs familiar with the local deep-water biota; audio annotations describing habitat, benthic biota, and fish were recorded onto the video and transcribed into Microsoft Access (CIOERT At-Sea Database, Reed and Farrington 2013).

2. Fish Surveys- Video was recorded continuously throughout each dive from surface to surface; video transects were used for analysis of fish populations and general habitat characterization. The camera was typically angled down ~30^{o} to view both near and far to the horizon for fish aggregations and habitat and had 10-cm parallel lasers for scale. All fish within the 100-m transects were identified to the lowest taxonomic level possible from video, emphasizing commercially and recreationally important species. Fish species were counted within each transect, summed for the entire block and then divided by the total distance of all transects within a block. This resulted in the linear density of each species by block (# individuals/m). Fish densities per 1000 m^2 were then calculated as (linear density / 5) * 1000 (based on an average 5-m width field of view with the ROV).

3. Benthic Surveys- Digital still images were used for quantitative analysis of habitat and benthic macrobiota within the 100-m transects throughout the dive. The camera was

pointed down 90° with 10-cm parallel lasers for scale. Images were taken every 30 seconds throughout the dive at a height of 1.3 m to provide relatively consistent area for each image (~1-2 m^2). Each photo filename was coded with corresponding EDT time and date code (using Stamp 2.8 by Tempest Solutions©) which was imported into CIOERT At-Sea Database and linked to the ROV navigation data for site specific data of coordinates and depth and then imported into ArcGIS® 10.2. In addition, frame grabs were taken from the high definition video to document species and habitat. Non-transect photos, such as purposeful images to document a specific species, were not included in the quantitative analyses. Poor and unusable photos (blurred, black, off bottom) were also removed from the quantitative analyses. Still images were analyzed using CPCe© 4.1 (Kohler and Gill 2006) software to determine relative percent cover of benthic biota and habitat types as well as coral colony diameter and density.

4. All data documentation (digital images, video, and dive annotations) were geo-referenced to ROV position after the cruise by matching the date and time to the ROV navigation files in our CIOERT At-Sea Database.

Selection of Random Blocks and Transects for ROV Surveys

A statistically rigorous sampling protocol was used for the ROV surveys at Pulley Ridge and Tortugas. In ArcGIS a fishnet grid of 1 km x 1 km Blocks were overlaid on the available bathymetry maps at both regions from which 89 random Blocks were selected for the surveys over the 4 year period. In 2012 and 2013 the emphasis was on the Main Ridge of Pulley Ridge. In 2014 and 2015, additional Blocks were added outside of the PR HAPC in the region of the Central Basin and West Ridge. The purpose of the surveys was to characterize the extent of mesophotic habitat in the region of Pulley Ridge, so as new areas were discovered with deep-sea coral ecosystem (DSCE) habitat, additional blocks were added. Areas such as the Off Reef sites to the east of Pulley Ridge, which were found to be primarily soft bottom habitat, were not surveyed further. Also, it was not the purpose to look at short term variability within the sites; therefore, individual Blocks were not revisited (except for one site, Block 18). Within each sampling Block ("site"), we conducted five random 100-m transects with the ROV to characterize that Block. The direction of each transect was haphazardly selected based on flip of coin, and the ship's maneuverability due to wind/current. Then a 100-m radius circle was placed on the ROV navigation screen with the ROV in the center. Each 100-m transect was conducted at ~12.5 cm s^{-1} until the ROV passed through 100 m radius; usually taking ~15 minutes. Off transects were interspersed between the photo transects, lasting 10-15 minutes, also with the heading determined again by flip of coin and maneuverability. The five transects generally covered the length and breadth of the 1-km block.

Use of ROVs for surveys for community structure analysis can be challenging (Harter et al. 2009, Karpov et al. 2010). Transects were randomized as much as possible, but transect headings were constrained in part by wind and current which often determines the heading of the ship and ROV. Randomization of our photo samples was also achieved by examining photographic images taken at set intervals (30 sec) rather than only using images from 'good' habitat areas along a transect.

Protocol for Benthic Habitat Characterization

The following defines the habitat and regional categories that were used to define and characterize the benthic habitats of Pulley Ridge and Tortugas. These categories are the result of the ROV video observations and multibeam sonar maps. The habitat categories were entered into the CIOERT At-Sea Database every 1-2 minutes and for every habitat change throughout each ROV dive. These data were then used to characterize the benthic habitat and distribution of benthic biota, and also used with the video data for the fish population analyses.

[Region]: The regions were defined in part from the geology apparent in the multibeam maps and the from the ROV dive data. The Pulley Ridge (PR) region included: Main Ridge (North, Middle, South), Off Reef (eastern base of Main Ridge), Central Basin (North, South), and West Ridge (North, South). The Tortugas (T) region included: Mesophotic Reefs (patch and fringing reefs), Miller's Ledge, and Soft Bottom Blocks.

[*MPA Status*]: Defines whether the 1-km^2 Block is within a marine protected area (e.g., Pulley Ridge Habitat Area of Particular Concern, or Tortugas Ecological Reserve); or the Block is unprotected.

[*Depth*]: Depth range (m) of the transects within the Block.

[*Relief*]: LR= Low Relief (0- <1.0 m), MR= Moderate Relief (1-3 m), HR= High Relief (>3 m). This is modified from the NOAA Southeast Area Monitoring and Assessment Program (SEAMAP) designations of outer continental shelf benthic habitat. This category is dependent on the distance over which the depth change occurs. We define relief as the relative height of rock ledges, boulders, or rock outcrops in the field of view.

[*Slope*]: Slope was estimated from the ROV video: Flat = 0-5^{o}, Low = 5-30^{o}, Moderate = 30-60^{o}, High (Wall) = 60-90^{o}. Slope was estimated from the ROV video field of view.

[*Rugosity*]: LRu= Low Rugosity, HRu= High Rugosity. Rugosity is defined here as a relative term of the ruggedness of the rock bottom based on the ROV video. Rugosity is relative to the size of rock ledges, holes, and crevices which tend to provide the greatest fish habitat. The background multibeam map (Fig. 1, Naar 2000) was of relatively low resolution (5-10 m) and cannot be used to quantify rugosity and slope in ArcGIS at this scale. For the present, this will be an unquantified relative term. However, high resolution (<2 m) multibeam maps were collected on the Nancy Foster Cruise in 2010 (Reed 2011), but these only cover 38 km^2 on the Main Ridge. These high resolution maps are able to show the locations and density of red grouper pits which are not visible in the low resolution multibeam.

[*Substrate*]: SEADESC Habitat Categories (Table 1). This is a modified subset of SEADESC Habitat Categories which was developed by the NOAA Office of Ocean Exploration and Research for use in analysis of deep-sea coral surveys (Partyka et al. 2007). These categories which are useful for characterizing deep coral habitat were modified to make them useful for these mesophotic habitats. The presence of fauna was not included as it is quantified in the Point Count analyses. In the region of this survey, substrate categories included: soft bottom (unconsolidated sand, mud) and hard bottom which was subdivided into rock (pavement, boulder, ledge), and rock rubble/cobble (generally, 5-20 cm diameter). 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). Coral is defined by NOAA (Lumsden et al. 2007) as hard corals (stony corals- Scleractinia) and other taxa with solid calcareous skeletons (e.g., Stylasteridae), as well as non-accreting taxa such as octocorals (Alcyonacea- "gorgonacea") and black corals (Antipatharia).

Table 1. SEADESC Benthic Habitat Category Codes (modified).

ID	Code	Habitat Name	Habitat Description
1	S	Soft Substrate	Unconsolidated sand/mud, unlithified
2	SR	Soft Substrate/Rubble/Rock	Soft substrate (>50% cover) with rubble and/or rock
3	R	Rubble	Rubble/cobble (~5-20 cm sized rock or coral)
4	RL	Rock/Ledges	Rocks and/or ledges
5	P	Pavement	Rock pavement
6	C	Hard Corals	Live and/or dead colonial scleractinian coral; standing individual colonies, bushes, or thickets.
7	TF	Tilefish (blueline or golden; not sand tile) burrows	Soft bottom with visually identifiable burrows
8	ST	Sand tilefish mounds	Rubble/cobble piles forming sand tilefish burrows
9	RG	Red grouper pits	Hard bottom grouper pits
10	A	Artificial Substrate	Any artificial structure that provides habitat for fishes and/or invertebrates

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, deep-water surveys in this region. For each random block, a total of 120 images were randomly selected and each was overlaid in CPCe with 50 stratified random dots to identify the substrate and biota.

To determine how many images and points were needed for CPCe point count analysis, we first tested Dive 14 from 2012 which had the most images as well as *Agaricia* coral colonies. Using PRIMER 6® v 6.1.13 statistical software, we plotted the species curves using four different tests: 180 images/50 points, 120/50, 120/25 and 60/50. The data were tested for percentage cover of sessile species only. The two statistical models were analyzed in PRIMER 6; CHAO2 and Michaelis-Menten (MM) both approached asymptotic values. Although, the results showed no difference in the PRIMER test between 50 and 25 points, and both were asymptotic below 120 images, we decided to use the larger number of images, since we have used that number for several previous deep-water and mesophotic surveys. Also, we attempted to take ~30 images per transect, resulting in ~150 images per block. Once poor and purposeful images were removed, in order to keep samples size similar, we randomly selected 120 images from each block for the point count analysis (24/ 100-m transect). Fifty random points overlaid on each image were then identified as substrate type and benthic taxa using CPCe point count. All benthic macrobiota (usually >1 cm) were identified to the lowest taxa level possible.

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 a, b). We included all benthic algae; sessile macroinvertebrates including Porifera, Scleractinia, Alcyonacea-gorgonians, Antipatharia, Corallimorpharia, Alcyoniina soft corals, other non-coral Cnidaria (hydroids), and ascidians; and all mobile benthic macroinvertebrates including: echinoderms, mollusks, arthropods, and annelids. The following taxonomists have helped with some of the species verifications:

Porifera- S. Pomponi, C. Diaz, P. Cardenas
Cnidaria- S. Cairns, P. Etnoyer, C. Messing, J. Voss, M. Nuttall, D. Opresko, C. Moura
Algae- S. Hanisak, S. Reed, M. and D. Littler.
Echinoderms- D. Pawson, C. Messing
Fish- A. David, S. Harter

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, gorgonians, and black coral are especially difficult to identify without a specimen in hand. In some cases general descriptive taxa were 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 deep-water species in this region look nearly identical, such as fan sponges which are polyphyletic and may actually include different orders or classes.

Coral Analyses

In CPCe, every point that landed on a scleractinian coral was identified to species level if possible and percent cover was calculated for each 1-km^2 Block. Example images were sent to various coral experts who all agreed that many of these species are nearly impossible to tell apart without a specimen. The samples that we were able to collect with the ROV were verified by S. Cairns (Smithsonian Institution).

<u>Density Analysis of Plate Corals</u>
Density of all plate corals (i.e., *Agaricia* spp., *H. cucullata*), *M. cavernosa*, and branching species i.e., *Madracis* and *Oculina* were calculated for all transect photos. Density was calculated by the following protocol. All transect images with lasers visible were used, and filtered by the 120 random filter for each Block. All corals (smallest visible was 0.24 cm) were counted and diameter measured using CPCe Area Analysis (ARA) tool. For each Block, the area of every transect image with lasers was calculated with CPCe ARA. Then the total number of corals for a Block was divided by the total photo area of the Block to get density (# coral colonies m^{-2}). Density (ρ) by Block= Sum of Coral Count per Block $\div$ Sum of Image Area by Block:

$$\rho = \frac{\sum Count\ of\ Corals\ by\ Block}{\sum Image\ Area\ by\ Block}$$

Size of Plate Corals
To calculate coral size, the CPCe ARA tool was used to measure the maximum diameter of each plate coral. Coral colonies that were only partially visible in a photograph were measured if it appeared that >50% of the colony was visible; otherwise they were marked as “cut off” and only used in the density counts and removed from the size analysis.

Statistical Analyses

Species Assemblages
Multivariate analyses were used to determine differences in benthic fauna assemblages and fish assemblages among blocks and regions. All analyses were conducted in PRIMER® 6 v 6.1.13 and based on guidelines of Clarke and Warwick (2001) and Clarke and Gorley (2006). The dive sites were compared by Block and their Geographic Location (Pulley Ridge vs Tortugas) and by Region (e.g., Main Ridge- North, Central Basin, etc.). For the benthic analysis, images were analyzed using CPCe 4.1 for percent cover of benthic biota. The CPCe percent cover data were then averaged by block. Then these data were square-root transformed to reduce the dominate influences of copious species to the similarity matrix. For the fish analysis, densities (# individuals/1000 m^2) were fourth- root transformed to reduce the dominate influences of copious species to the similarity matrix. Similarities between samples for both fish and benthic biota were then calculated separately using S17 Bray-Curtis similarity in PRIMER® 6 v 6.1.13. A non-metric multidimensional scaling ordination (MDS) plot and a dendrogram with group-average linking were created showing the results of a concurrently run SIMPROF (similarities profile) which finds statistically significant evidence of genuine clusters in samples which are *a priori* unstructured (i.e., samples that group together are statistically similar to each other (Clarke and Gorley 2006). SIMPER (Similarity Percentages) was utilized to determine which species contributed to the dissimilarities among group pairs. ANOSIM (Analysis of Similarities) compared the mean of ranked dissimilarities between groups to the mean of ranked dissimilarities within groups, returning an R value. An R value close to "1.0" suggests dissimilarity between groups while an R value close to "0" suggests an even distribution of high and low ranks within and between groups. R values below "0" suggest that dissimilarities are greater within groups than between groups (Clarke and Gorley 2006). PERMANOVA (Permutational MANOVA) was used for multivariate analyses. In addition, species diversity of fish assemblages was examined using the DIVERSE routine. Parameters examined include: total number of species, diversity, and evenness. The Shannon-Weiner function (*H’*) for the fish was used to estimate diversity as - $£_i\, p_i \log(p_i)$ where p_i is the proportion of the total count arising from the *i*th species. Evenness (*J’*) was estimated as *H’*/log (*S*) where *S* is the total number of taxa.

Environmental and Abiotic Data
Gridded ASCII multibeam sonar data was available for most of the PR sites (but none at Tortugas) and were used to compare benthic macrobiota distribution based on depth and latitude/longitude, and Region. In addition, a temperature recorder was attached to the ROV

during the 2014 cruise, and a FastCAT CTD was attached to the ROV during the 2015 cruise. The CTD and temperature data were incorporated into the Access database and connected to each image based on date/time. These data were then imported into PRIMER 6, averaged by Block, ranked and normalized. These data were analyzed using the BEST (BIO-ENV) procedure which finds the 'best' match between the multivariate among-sample patterns of an assemblage and that form the Environmental data associated with those samples. The extent to which these patterns match one another reflects the degree the abiotic data explains the biotic pattern (Clarke and Gorley 2006). These data were then plotted with distance based redundancy analysis (dbRDA) using a distance-based linear model (distLM, PRIMER 6 with PERMANOVA+ add-on). Three data sets were analyzed: 1) depth, latitude and longitude were available for all sites, 2) depth and temperature was available for all sites in 2014 and 2015, 3) the complete CTD data from the 2015 cruise.

RESULTS

ROV Dive Summary

This report summarizes the results of the ROV dives conducted during the four R/V *Walton Smith* cruises of 2012, 2013, 2014, and 2015, which mapped and characterized the benthic habitat, macro-biota and fish populations at Pulley Ridge and Tortugas regions. A total of 91 ROV dives surveyed a total of 91 1-km^2 random Blocks (68 at Pulley Ridge and 23 at Tortugas; Figs. 1, 2). The 91 ROV dives covered 150 km, at depths from 23 to 114 m. A total of 237 hours of ROV video were recorded, and 17,888 *in situ* digital images included quantitative transect images (16,071), general habitat images, and species documentation images. Sample collections with the ROV included 10 Porifera, 40 Cnidaria (including, 19 Scleractinia, 15 gorgonian Octocorallia, 1 Antipatharia), 3 Echinodermata, 1 Arthropoda, 1 Mollusca, 20 macroalgae, and 2 geological (rock/sediment) specimens. Appendix 1 lists the metadata for each Block including, year of survey, ROV dive number, central coordinates of Block, and depth ranges. Previous individual cruise reports provided detailed ROV dive data and SEADESC results for each individual ROV dive (Reed et al. 2012a; Reed et al. 2012b; Reed et al. 2012c; Reed et al. 2014; Reed et al. 2015; Reed et al. 2016a; Reed et al. 2017).

Study Areas

<u>Pulley Ridge</u>

Based on the geomorphology of the multibeam maps (Fig. 1), Pulley Ridge was *a-priori* divided into "Region": Main Ridge, Central Basin, West Ridge, and Off Reef (area of predominately sediment east of the Main Ridge). The regions were further divided into North to South sub-regions. The random Blocks were then overlaid on these regions (described below). The Blocks in Figure 1 are color coded according to region. Only the Main Ridge had been surveyed previously (Halley et al. 2013) and is entirely within the Pulley Ridge Habitat Area of Particular Concern (PR HAPC). Our surveys added for the first time, data for the Central Basin and West Ridge, which were discovered to have mesophotic coral/sponge habitat at depths ranging from 72 to 94 m. The majority of the Central Basin and all of the West Ridge regions are outside of the protected PR HAPC, but these areas have been proposed to the Gulf of Mexico Fishery Management Council (Reed and Farrington 2014d) to be included in the HAPC.

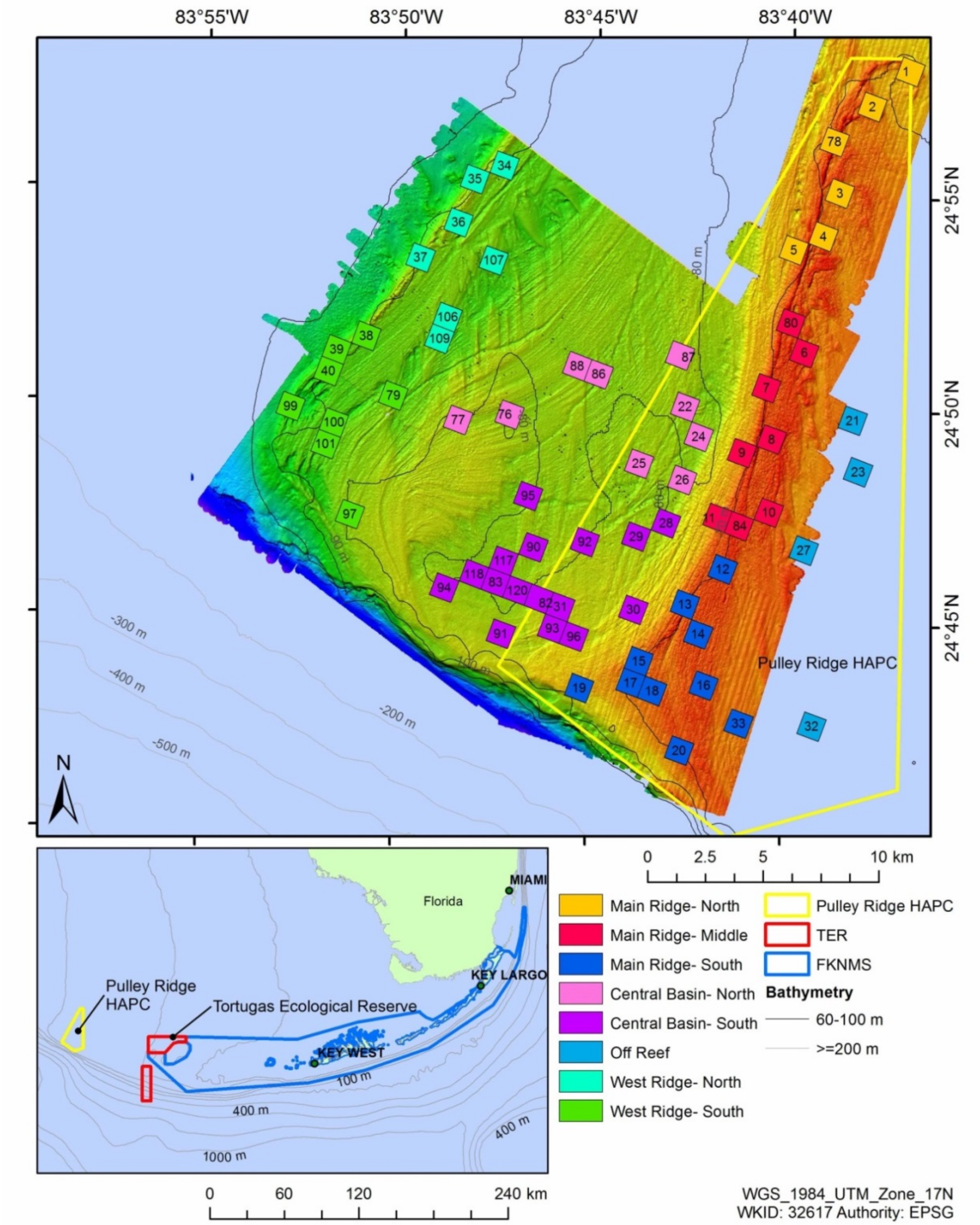

Figure 1. Random 1-km^2 Blocks surveyed with ROVs during 2012-2015 R/V *Walton Smith* cruises at Pulley Ridge mesophotic coral reef ecosystem. Habitat regions color coded. Pulley Ridge Habitat Area of Particular Concern (PR HAPC) boundaries in yellow; Tortugas Ecological Reserves (TER) in red; Florida Keys National Marine Sanctuary (FKNMS) in blue. Background multibeam sonar map: Naar, D.F. 1999, Cross et al. 2005, NOAA 2013.

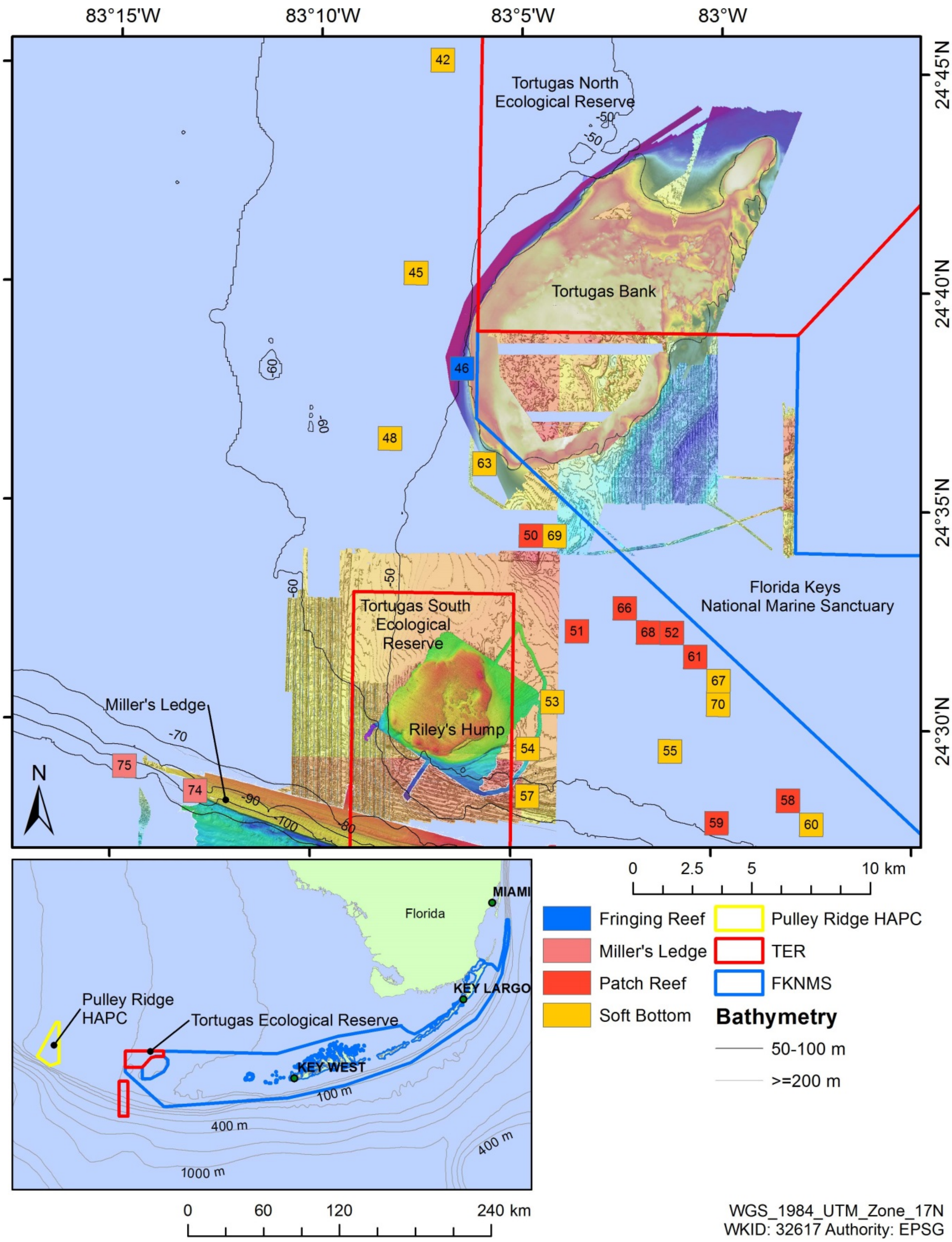

Figure 2. Random 1-km^2 Blocks surveyed with ROVs during 2012-2015 R/V *Walton Smith* cruises at Tortugas region. Habitat zones color coded. Tortugas Ecological Reserves (TER) in red; Florida Keys National Marine Sanctuary (FKNMS) in blue. Background multibeam sonar map: Miller's Ledge- Multibeam Bathymetry Survey, Robertson 2002; TER- Multibeam Bathymetry Survey, NF-11-06-FKNMS, Donahue 2011.

Tortugas
Since there were limited multibeam maps of the Tortugas region outside of the Tortugas Ecological Reserves (TERs), we categorized the Blocks by habitat type after the ROV surveys were conducted (Fig. 2). The Blocks were randomly selected from areas outside of the TERs and Florida Keys National Marine Sanctuary (FKNMS) that appeared to be within mesophotic depths (>30 m to 100 m) based on available bathymetric contour charts. Four habitat types were found from the ROV dives: Soft Bottom (12 Blocks), Fringing Reef (1 Block), Patch Reefs (8 Blocks), and Miller's Ledge (2 Blocks). These are color coded in Figure 2. The mesophotic reef sites include the newly discovered patch reefs west of FKNMS, and the fringing reef which is the west slope of the Tortugas Bank. These areas have been proposed to the FKNMS (Reed and Farrington 2014c) to be included in the Sanctuary boundaries.

Benthic Habitat

Pulley Ridge- Benthic Habitat
The depth range of all the Blocks surveyed at Pulley Ridge was 59.3 to 93.9 m (Fig. 1, Table 2). The Main Ridge was generally the shallowest region ranging from 59.3 m on top of the ridge to 75.5 m at the base; the Central Basin ranged from 72.4 m to 83 m, and the West Ridge was the deepest of the mesophotic reef regions at 76.8 m on top of the ridge to 93.9 m at the base.

Table 2. Habitat characterization by region from ROV surveys at Pulley Ridge and Tortugas during 2012 to 2015 R/V *Walton Smith* cruises. Percent cover of benthic macrobiota from CPCe Point Count. HB= % cover of hard-bottom substrate (rock, coral, rubble) and % SB= soft bottom cover from CPCe Point Count notes.

General Area/Region	Rugosity	Relief	Slope	Habitat Type	Biota	%HB/ %SB	Depth Range (m)
Pulley Ridge (All Sites)					49.88%	87/13	59.3-93.9
Main Ridge	Low	LR	0-10^{o}	Rubble/Pavement	60.03%	94/6	59.3-75.5
Main Ridge- North	Low	LR	0-10^{o}	Soft/Rubble	45.38%	87/13	59.3-73.2
Main Ridge- Middle	Low	LR	0-10^{o}	Rubble	55.47%	97/3	61-72.2
Main Ridge- South	Low	LR	0-10^{o}	Rubble/Pavement	72.52%	97/3	63.5-75.5
Central Basin	Low	LR	0-10^{o}	Rubble/Pavement	46.93%	91/9	72.4-83
Central Basin- North	Low	LR	0-10^{o}	Soft/Rubble	34.44%	80/20	76.5-83
Central Basin- South	Low	LR	0-10^{o}	Rubble/Pavement	53.96%	98/2	72.4-82.1
West Ridge	Low	LR	0-10^{o}	Rubble/Pavement	46.67%	88/12	76.8-93.9
West Ridge- North	Low	LR	0-10^{o}	Rubble	47.35%	91/9	76.8-85.7
West Ridge- South	Low	LR	0-10^{o}	Rubble/Pavement	46.08%	84/16	78.5-93.9
Off Reef	Low	LR	0-10^{o}	Soft	19.79%	12/88	63.1-68.9
Tortugas (All Sites)					26.55%	21/79	22.9-114.4
Fringing Reef	High	MR	10-60^{o}	Rock Ledge	58.06%	98/2	26-31.5
Patch Reef	Low	LR	0-10^{o}	Rock Ledge	26.26%	27/73	22.9-55.3
Soft Bottom	Low	LR	0-10^{o}	Soft	27.76%	0/100	27.3-56.8
Miller's Ledge	Low	LR	0-10^{o}	Pavement	4.69%	63/37	79.7-114.4

The Off Reef Blocks which are east of the Main Ridge were at depths of 63.1 to 68.9 m, but were predominantly soft sediment habitat (88% soft bottom), and will not be discussed further. All three regions of Pulley Ridge (Main Ridge, Central Basin, and West Ridge) are mesophotic reef habitat, and are fairly similar (Table 2). All sites were of low rugosity, low relief (<1/2 m), low slope (0-10^{o}), and primarily rock rubble and rock/coral pavement substrate. The percent cover (CPCe Point Count substrate notes) of hard-bottom substrate ranged from 80 to 98% (including both bare substrate and substrate underlying the biota). The Main Ridge averaged 94% hard bottom, Central Basin was 91%, and West Ridge was 88%. The habitat at all three regions was of relatively low rugosity. That is, there were few ledges, or rugged surfaces except for the red grouper pits. These pits (discussed below) were the only regions of Pulley Ridge which provide habitat of relatively high rugosity, moderate relief (1-2 m), and moderate slope (10-30^{o}). Only when the pits are maintained by a red grouper do they maintain this rugosity which provides essential habitat for a variety of fishes (Coleman et al. 2010). Once the grouper leaves a pit (fished off or dies), the pit fills in with sediment which covers the exposed rock ledges.

Tortugas- Benthic Habitat

Since we did not have multibeam maps of the Tortugas region *a priori* for the ROV surveys, we could not pinpoint sites that showed potential hard-bottom, or rocky habitat (Fig. 2, Table 2). As such, the majority of random Blocks selected were found to be primarily soft-bottom habitat (12 Blocks, 100% soft bottom). Two Blocks were placed on Miller's Ledge which had never been surveyed outside of the South Tortugas Ecological Reserve (TER). Within the TER, both Miller's Ledge and Riley's Hump had been extensively characterized by Weaver et al. (2006). These two Blocks were placed to see the extent of the Miller's Ledge to the west of the TER. These Blocks were predominately hard bottom (63%), but were deeper (to 114 m) than the other reef Blocks, and were primarily heterotrophic habitat and not mesophotic. One Block was on the west slope of the Tortugas Bank (Block 46), but outside of the FKNMS and TER boundaries. This site was at depths of 26-31.5 m, and is the deep fore reef of the bank. The base of the reef flattens out into flat sand at 31 m. This reef was primarily hard bottom, reef habitat (98% hard bottom). The remaining Blocks (8) were discovered to be low relief, patch reef habitat at depths of 23-57 m, just to the west of the FKNMS boundary (red Blocks in Fig. 2).

Benthic Macrobiota

Appendices 2 and 3 list all of the benthic macro-invertebrates and macroalgal taxa that were identified from the quantitative photo transects for each Block surveyed during the 2012 to 2015 cruises at Pulley Ridge and Tortugas, respectively; the percent cover is based on CPCe Point Count of the photo images. A total of 199 benthic taxa were identified from the ROV dives at Pulley Ridge and 153 at Tortugas (Table 3). The actual species count will be much higher than this as many of the taxa were only identified to genus or higher taxonomic level and are likely to consist of more than one species. Taxonomic work is continuing on the sponges and algae.

Pulley Ridge- Benthic Macrobiota

The benthic macrobiota at Pulley Ridge consisted of 92 taxa of demosponges, 15 gorgonian octocorals, 12 scleractinian corals, 7 black corals (Antipatharia), and 29 macroalgae (Table 3, Appendix 2). The percent cover of benthic biota (CPCe Point Count) averaged 49.88% at all sites, and ranged from 60.03% on the Main Ridge, 46.93% on the Central Basin, and 46.67% on the West Ridge (Table 2). Coverage of biota at Pulley Ridge was dominated by various algae (46.47% cover overall; Table 3) and was highest on the Main Ridge (57.20%). Red algae (34.55% cover overall) was the primary cover in all of the mesophotic regions (Main Ridge, Central Basin, and West Ridge) (Fig. 3). Red algae were dominated by crustose coralline algae, and averaged 28.53% cover overall but had highest cover in the deeper region at Central Basin and West Ridge (maximum 63.39% in Block 82, Central Basin South; Fig. 4). The Rhodophyta were also dominated by large fleshy reds taxa, *Halymenia* sp. and *Kallymenia* sp., and also *Peyssonnelia* sp. In contrast, green algae (10.58% cover overall) were predominate on the Main Ridge which is shallowest of the sites. The lettuce-like green algae *Anadyomene menziesii* (8.11% overall and up to 34.55% in block 18) were the most common (Fig. 4). Clearly the slight difference in depths from 59 m on top of the Main Ridge to 76 m on top of the West Ridge changed the overall cover of green algal abundance compared to the red algae. The other common green algae included *Codium* spp., *Caulerpa racemosa* and *C. sertularioides, Halimeda* spp., *Valonia ventricosa*, and *Verdigellas peltata*. The brown algae were less common (0.99% cover overall), and were dominated by *Dictyota* sp. (0.50% cover) and *Lobophora variegata* (0.42%), along with *Sargassum* sp. and *Padina* sp. Cyanobacteria, although not common (0.35% cover overall), were patchy and up to 1.93% cover at the Off Reef Blocks.

Table 3. Percent cover (CPCe Point Count) and number of taxa of benthic macrobiota from ROV surveys at Pulley Ridge and Tortugas during 2012 to 2015 R/V *Walton Smith* cruises.

	Percent Cover					No. Taxa					
Region	Coral	Gorgo-nacea	Anti-patharia	Por-ifera	Algae	Coral	Gorgo-nacea	Anti-patharia	Por-ifera	Algae	Total
Pulley Ridge	**1.46%**	**0.10%**	**0.14%**	**1.18%**	**46.47%**	**12**	**15**	**7**	**92**	**29**	**199**
Main Ridge	0.87%	0.03%	0.05%	1.23%	57.20%	9	5	4	65	23	135
North	0.16%	0.06%	0.09%	1.12%	43.19%	9	5	3	39	21	101
Middle	0.28%	0.02%	0.04%	1.24%	53.24%	9	4	3	38	18	92
South	1.77%	0.01%	0.04%	1.29%	68.83%	9	2	3	51	23	107
Central Basin	2.54%	0.03%	0.15%	1.02%	42.79%	11	8	6	53	23	131
North	0.84%	0.04%	0.21%	2.06%	30.83%	7	5	5	44	22	107
South	3.50%	0.02%	0.12%	0.44%	49.51%	11	6	5	35	18	100
West Ridge	0.97%	0.38%	0.28%	1.61%	42.95%	10	14	7	67	19	145
North	0.98%	0.36%	0.40%	1.68%	43.47%	8	12	6	44	18	108
South	0.95%	0.40%	0.18%	1.55%	42.49%	8	13	6	57	16	121
Off Reef	0.03%	0.00%	0.00%	0.28%	18.70%	2	0	0	15	23	60
Tortugas	**0.31%**	**1.66%**	**0.00%**	**1.25%**	**20.56%**	**19**	**16**	**0**	**57**	**32**	**153**
Miller's Ledge	0.01%	0.13%	0.00%	2.70%	0.73%	1	2	0	12	7	37
Fringing Reef	3.96%	8.82%	0.00%	6.22%	38.73%	14	4	0	29	11	64
Patch Reef	0.38%	3.59%	0.00%	1.82%	16.83%	13	15	0	45	31	117
Soft Bottom	0.00%	0.02%	0.00%	0.21%	24.88%	1	2	0	17	26	67

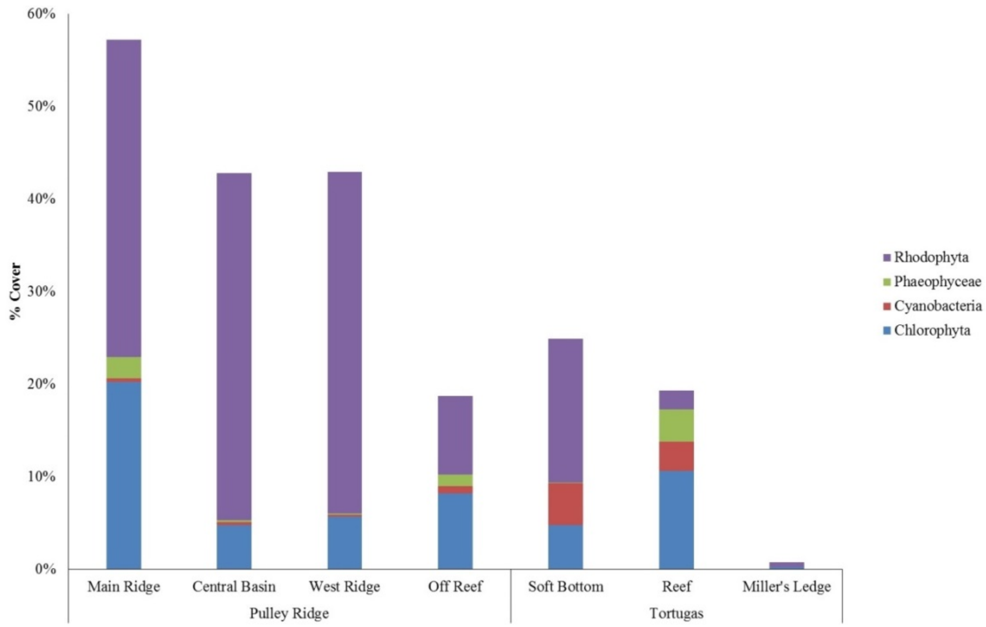

Figure 3. Percent cover (CPCe Point Count) of major macroalgal groups by region from ROV surveys at Pulley Ridge and Tortugas during 2012 to 2015 R/V *Walton Smith* cruises.

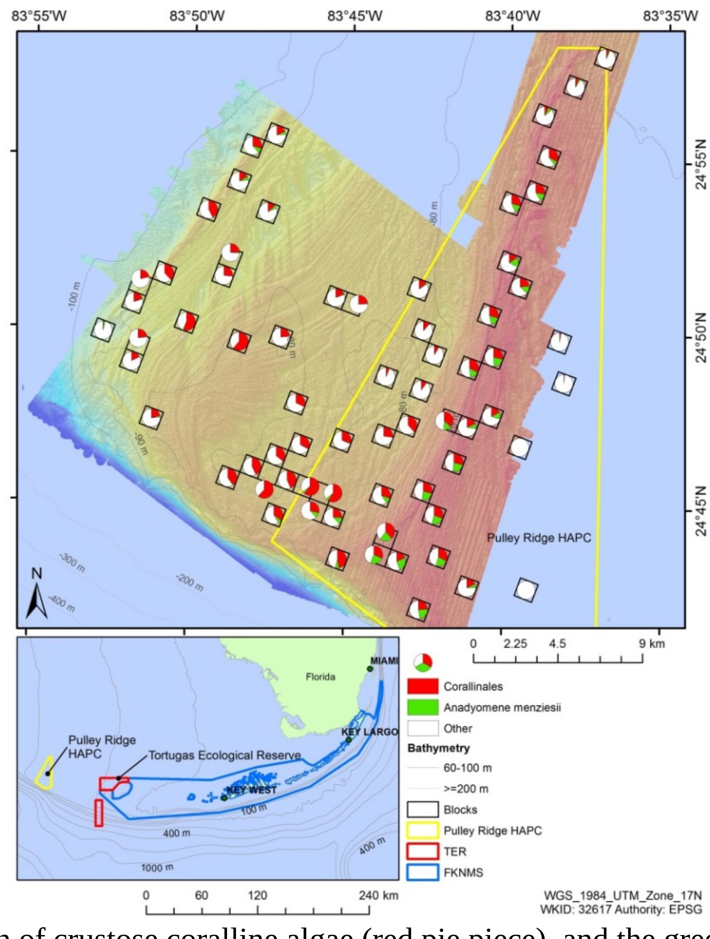

Figure 4. Distribution of crustose coralline algae (red pie piece), and the green alga *Anadyomene menziesii* (green piece), from CPCe Point Count percentages for all Blocks at Pulley Ridge.

Excluding the macroalgae, the dominant sessile biota at Pulley Ridge were scleractinian corals (1.46% cover overall), sponges (1.18%), black corals (0.14%), and gorgonians (0.10%) (Table 3). It is apparent that the greatest cover of scleractinian corals was within the Central Basin (Fig. 5). Also gorgonians and black corals were more common at the deeper sites of the West Ridge. The corals are described in more detail below. Sponges were somewhat similar in cover across the three main regions of Pulley Ridge (1.02-1.61% cover; Fig. 6) and were the most species rich of all sessile taxa (92 taxa). The dominate taxa included *Agelas clathrodes, A. conifer*, various other species of *Agelas, Aiolochroia crassa, Amphimedon compressa, Aplysina lacunosa, Auletta* sp., *Axinella corrugata, Callyspongia vaginalis, Chondrilla* sp., *Cinachyrella* sp., *Discodermia* sp., *Erylus* sp., *Geodia gibberosa*, *G. neptuni*, *Ircinia campana*, *I. felix*, *I. strobilina, Monanchora arbuscula, Neofibularia nolitangere*, *Niphates erecta*, *Oceanapia* sp., *Placospongia* sp., *Polymastia* sp., *Scopalina ruetzleri*, *Siphonodictyon coralliphagum*, *Spheciospongia vesparium, Spongosorites siliquaria, Tethya* sp., *Theonella* sp., *Xestospongia muta*, and numerous unidentified species of demosponges. Large hemispherical colonies (>100 cm diameter) of *Spongosorites siliquaria* were very common on Pulley Ridge. This unusual species is densely embedded with the corkscrew shaped gastropod *Siliquaria* sp. which lives inside the sponge with only the end of the shell exposed on the surface where it filter feeds. Large *X. muta* (20-50 cm) were also relatively common.

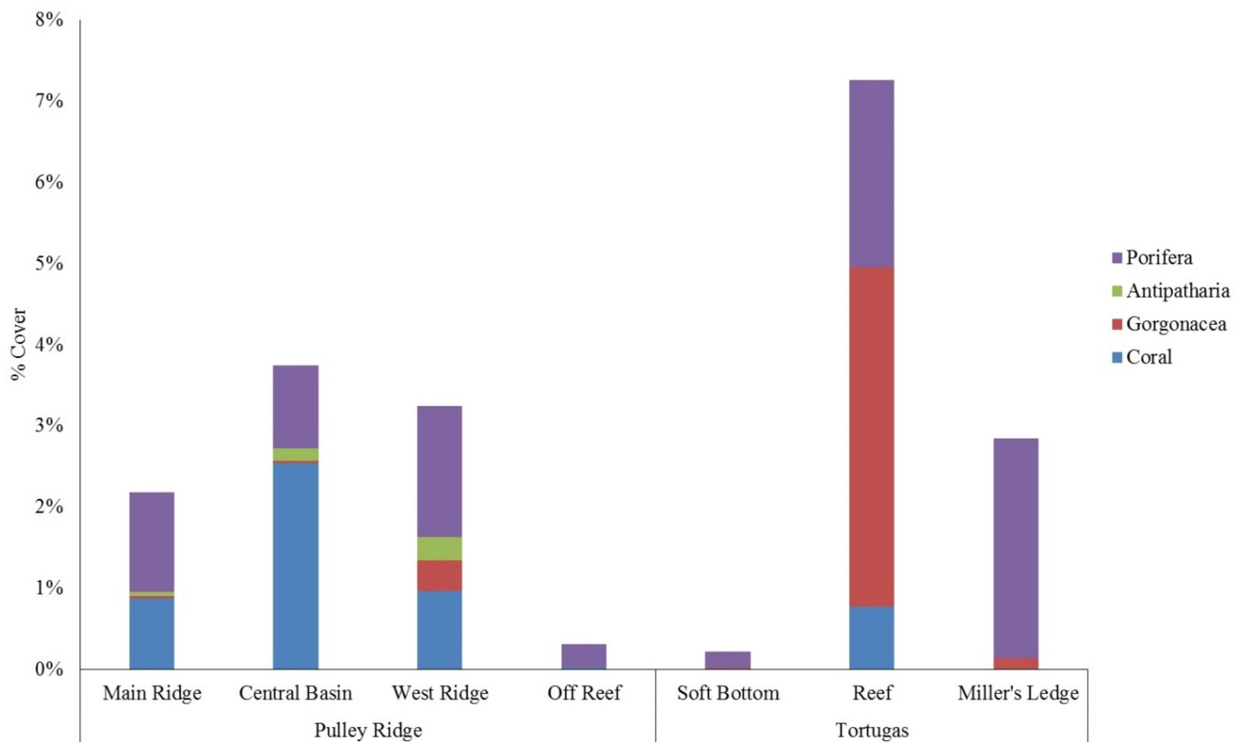

Figure 5. Percent cover (CPCe Point Count) of major benthic macrobiota (excluding algae) by region from ROV surveys at Pulley Ridge and Tortugas during 2012 to 2015 R/V *Walton Smith* cruises.

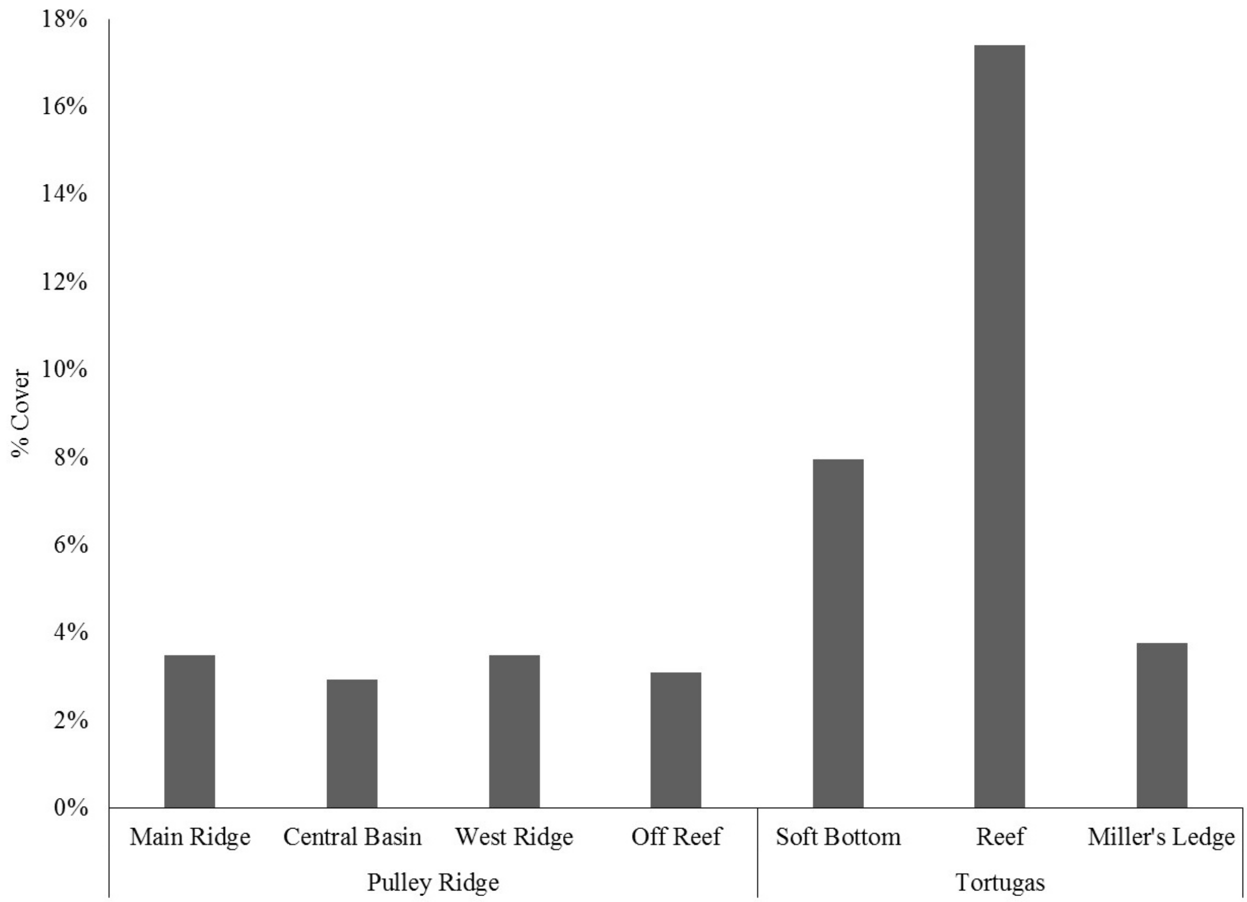

Figure 6. Percent cover (CPCe Point Count) of all demosponges by region from ROV surveys at Pulley Ridge and Tortugas during 2012 to 2015 R/V *Walton Smith* cruises.

Other common sessile invertebrates at Pulley Ridge included the Cnidaria: *Chironephthya caribbea, Nidalia* sp., *Condylactis gigantea*, Stylasteridae, Zoanthidae, and various Corallimorpharia and hydroids. Bryozoa were present and dominated by white fans and *Schizoporella* sp. Ascidians were common on the sponges and rock and were dominated by Didemnidae and *Eudistoma* sp. Mobile invertebrates included Annelida such as *Filograna* sp., the fire worm *Hermodice carunculata*, and numerous Sabellidae and Serpulidae. Mollusks were seen but not common. Arthropods included various brachyuran crabs, hermit crabs, Pycnogonida, and arrow crabs *Stenorhynchus seticornis*. Echinoderms were fairly common and included the crinoids *Analcidometra armata* and *Davidaster discoideus* which were commonly seen on the *Anadyomene* green algae. Urchins included *Arbacia punctulata, Centrostephanus longispinus, Echinus* sp., *Eucidaris tribuloides*, and *Stylocidaris affinis*. Brittlestars such as *Asteroschema* sp. and *Gorgonocephalus* sp. were common along with starfish including *Narcissia trigonaria*. Human debris was not abundant but included discarded or lost fishing lines and long lines, ghost lobster/crab pots, remains of trawl nets, anchor lines, various bottles and cans, and other debris.

<u>Tortugas- Benthic Macrobiota</u>

A total of 153 benthic macrobiota were identified from the ROV dives at Tortugas and consisted of 57 taxa of demosponges, 16 gorgonian octocorals, 19 scleractinian corals, and 32 macroalgae

(Table 3, Appendix 3). The percent cover of benthic biota (CPCe Point Count) averaged 26.55% for all Blocks (Table 2). Excluding the soft bottom sites, the densest cover was at the mesophotic reef sites which consisted of the Fringing Reef site (58.06% cover) and the Patch Reef Blocks (26.26%). The deeper Miller's Ledge Blocks only had 4.69% cover of macrobiota and included very few algae. Although the soft bottom Blocks had 27.76% cover, these were mostly loose macroalgae, often consisting of massive drifts unattached red algae *Martensia pavonia*. It is unknown where the source of these drift algae were, possibly from Tortugas Bank or Riley's Hump. In general, the dominant sessile fauna and macroalgae were species typically found on shallow reefs. Since the mesophotic reef Blocks (Fringing Reef and Patch Reef Blocks) were relatively shallow compared to Pulley Ridge and have been discussed more in detail in the previous Tortugas Cruise Reports (Reed et al. 2014, 2015), these Tortugas data will not be discussed further.

Coral Community- Pulley Ridge

For the non-scleractinian corals, 15 taxa of gorgonian octocoral taxa were identified from the ROV dives at Pulley Ridge and were dominated by Primnoidae, Ellisellidae, Plexauridae, *Nicella* spp., *Hypnogorgia pendula*, and *Carijoa riisei* (Table 4, Appendix 2). Gorgonians averaged 0.10% cover, ranging from 0.01% to 0.40% within the regions, but had their greatest cover at the West Ridge (average 0.38%; maximum 1.32% at Block 37). Black corals (Antipatharia) cover averaged 0.14% cover overall and by region ranged from 0.04 (Main Ridge-South) to 0.40% (West Ridge-North), and had the greatest cover by Block at the West Ridge (0.62% at Block 37). The dominant species included *Antipathes atlantica*, *A. furcata*, *Elatopathes abietina*, *Tanacetipathes* spp., and *Stichopathes lutken*i (may be several species per Murissa Nuttall, FGNMS).

A total of 12 Scleractinia taxa were identified from the ROV dives (Table 4, Appendix 2). The dominant colonial scleractinian corals at Pulley Ridge were the agariciid plate corals (*Agaricia* spp., *Helioseris cucullata*), *M. cavernosa*, and also several species of *Madracis* and *O. diffusa*. The samples that we were able to collect with the ROV were verified by S. Cairns (Smithsonian Institution) as *Agaricia fragilis*, *A. grahamae*, *H. cucullata*, *M. cavernosa*, *Madracis brueggemanni*, *M. decactis*, *M. formosa*, *M. myriaster*, and *O. diffusa*. The smaller specimens of agariciids were impossible to identify to species level from the photographs, therefore, our analyses simply grouped all *Agaricia* as *A.* spp. The other agariciid *H. cucullata* could usually be distinguished from *Agaricia* by the raised corallites. At these depths *M. cavernosa* also forms plate-like colonies, whereas in shallow water they are conical to mound shaped. *Madracis* spp. were also difficult to impossible to differentiate from photos alone. Several species are differentiated by the number of septa per corallite (8-10), which is not distinguishable in the images. The species confirmed from specimens (S. Cairns, Smithsonian Institution) were the branching forms *M. brueggemanni* and *M. formosa*; also a flat to mound-like form of *M. decactis* was common. In our earlier cruise reports we had identified *M. brueggemanni* as *M. auretenra*. Elsewhere in deeper water on the West Florida shelf is the azooxanthellate species *M. myriaster*.

Table 4. Species list of Cnidaria (scleractinian corals, gorgonian octocorals, soft corals, black corals, and non-coral Cnidaria) observed on ROV dives at Pulley Ridge and Tortugas mesophotic reef sites during 2012 to 2015 R/V *Walton Smith* cruises.

Cnidarian Taxa	Pulley Ridge	Tortugas
Scleractinia		
Agaricia agaricites (Linnaeus, 1758)		X
Agaricia fragilis Dana, 1848	X	
Agaricia grahamae Wells, 1973	X	
Agaricia sp. Lamarck, 1801	X	X
Colpophyllia natans (Houttuyn, 1772)		X
Helioseris cucullata (Ellis & Solander, 1786)	X	X
Madracis brueggemanni (Ridley, 1881)	X	
Madracis decactis (Lyman, 1859)	X	
Madracis formosa Wells, 1973	X	
Madracis sp. Milne Edwards & Haime, 1849	X	
Manicina areolata (Linnaeus, 1758)		X
Meandrina meandrites (Linnaeus, 1758)		X
Millepora alcicornis Linnaeus, 1758		X
Montastraea cavernosa (Linnaeus, 1767)	X	X
Mycetophyllia aliciae Wells, 1973		X
Mycetophyllia sp. Milne Edwards & Haime, 1848		X
Oculina diffusa Lamarck, 1816	X	
Orbicella faveolata (Ellis & Solander, 1786)		X
Orbicella franksi (Gregory, 1895)		X
Porites astreoides Lamarck, 1816		X
Scleractinia- unid colonial	X	X
Scleractinia- unid solitary		X
Scolymia sp. Haime, 1852	X	
Siderastrea radians (Pallas, 1766)		X
Siderastrea siderea (Ellis & Solander, 1768)		X
Solenastrea bournoni Milne Edwards & Haime, 1849		X
Stephanocoenia intersepta (Lamarck, 1836)		X
Gorgonacea		
Alcyonacea- gorgonian	X	X
Bebryce sp. Philippi, 1841	X	
Briareum asbestinum (Pallas, 1766)		X
Carijoa riisei (Duchassaing & Michelotti, 1860)	X	X
Diodogorgia sp. Kuekenthal, 1919	X	
Ellisella barbadensis (Duchassaing & Michelotti, 1864)		X
Ellisella sp. Gray, 1858	X	X
Ellisellidae	X	

Erythropodium caribaeorum (Duchassaing & Michelotti, 1860)		X
Eunicea sp. Lamouroux, 1816		X
Hypnogorgia pendula Duchassaing & Michelotti, 1864	X	
Iciligorgia schrammi Duchassaing, 1870		X
Leptogorgia sp. Milne Edwards, 1857	X	
Muricea sp. Lamouroux, 1821		X
Muriceopsis sp. Aurivillius, 1931		X
Nicella goreaui Bayer, 1973	X	
Nicella sp. Gray, 1870	X	
Plexaura kukenthali Moser, 1921		X
Plexauridae	X	
Primnoidae	X	X
Pseudoplexaura sp. Wright & Studer, 1889		X
Pseudopterogorgia sp. Kükenthal, 1919	X	X
Pterogorgia anceps (Pallas, 1766)		X
Pterogorgia citrina (Esper, 1792)		X
Swiftia exserta (Ellis & Solander, 1786)	X	
Thesea sp. Duchassaing & Michelotti, 1860	X	
Antipatharia		
Antipatharia	X	
Antipathes atlantica Gray, 1857	X	
Antipathes furcata Gray, 1857	X	
Elatopathes abietina (Pourtalès, 1874)	X	
Stichopathes lutkeni Brook, 1889	X	
Tanacetipathes sp. (Pourtalès, 1880)	X	
Tanacetipathes tanacetum (Pourtalès, 1880)	X	
Cnidaria- Non Coral		
Actiniaria	X	X
Alcyoniina	X	X
Cerianthidae		X
Chironephthya caribaea (Deichmann, 1936)	X	
Condylactis gigantea (Weinland, 1860)	X	
Corallimorpharia	X	
Hydroidolina	X	X
Hydroidolina- TER1		X
Hydroidolina- TER2		X
Nidalia sp. Gray, 1834	X	
Palythoa caribaeorum (Duchassaing & Michelotti, 1860)		X
Ricordea florida Duchassaing & Michelotti, 1860	X	
Stylasteridae	X	
Zoanthidae	X	X

Scleractinian corals averaged 1.46% cover overall and by zone was greatest in the newly discovered Central Basin-South zone outside of the PR HAPC (average 3.50% cover; maximum- 6.71% in Block 91) (Tables 3 and 5, Fig. 6, Appendix 2). Main Ridge-South within the HAPC averaged 1.77% (maximum- 7.44% in Block 18). Agariciid plate corals (*Agaricia* spp. + *H. cucullata*) were clearly the dominant species overall (0.94% cover) followed by *Madracis* spp. (0.51%) and then *M. cavernosa* (0.01%) (Table 5). There were also some regional differences in the distribution of these species. Except for a few sporadic occurrences, *M. cavernosa* was only found on the Main Ridge, and primarily on the Main Ridge-Middle zone (Figs. 7, 8). The agariciid plate corals were present in every Block except the Off Reef sites and Block 99 at the southern end of the West Ridge, and were the dominant coral both on the Main Ridge and Central Basin. *Madracis brueggemanni* and *M. formosa* were the dominant coral on the West Ridge, but were also common on the Central Basin and Main Ridge. The northern-most *Agaricia* occurred at Block 1 on Main Ridge-North, and the northern-most *M. cavernosa* was found on Block 3 of Main Ridge-North (Figs. 1, 4).

Table 5. Average percent coral cover (CPCe Point Count) and densities (# colonies m^{-2}) from ROV surveys at Pulley Ridge during 2012 to 2015 R/V *Walton Smith* cruises. Agariciid plate corals included *Agaricia fragilis*, *A. grahamae*, unidentified *Agaricia* spp., and *Helioseris cucullata*. *Madracis* spp. included *M. decactis, M. brueggemanni,* and *M. formosa*.

	Percent Cover				Density (no. m^2)			
Region	**Plate Corals (*Agaricia / Helioseris*)**	***Mont-astraea cavernosa***	***Madracis* spp.**	**All Hard Coral**	**Plate Corals (*Agaricia / Helioseris*)**	***Mont-astraea cavernosa***	***Madracis* spp.**	**All Hard Coral**
Pulley Ridge	**0.94%**	**0.01%**	**0.51%**	**1.46%**	**4.893**	**0.002**	**1.713**	**6.829**
Main Ridge	**0.73%**	**0.02%**	**0.12%**	**0.87%**	**2.708**	**0.010**	**0.565**	**3.290**
Main Ridge- North	0.07%	0.03%	0.06%	0.16%	0.274	0.003	0.263	0.540
Main Ridge- Middle	0.19%	0.04%	0.05%	0.28%	0.396	0.020	0.203	0.620
Main Ridge- South	1.56%	0.00%	0.21%	1.77%	5.191	0.003	1.005	6.215
Central Basin	**1.81%**	**0.00%**	**0.73%**	**2.54%**	**9.435**	**0.000**	**2.280**	**11.717**
Central Basin- North	0.14%	0.00%	0.70%	0.84%	0.843	0.000	1.981	2.829
Central Basin- South	2.74%	0.00%	0.75%	3.50%	13.403	0.000	2.418	15.822
West Ridge	**0.07%**	**0.00%**	**0.89%**	**0.97%**	**0.506**	**0.000**	**2.297**	**2.804**
West Ridge- North	0.08%	0.00%	0.90%	0.98%	0.432	0.000	2.157	2.589
West Ridge- South	0.07%	0.00%	0.88%	0.95%	0.600	0.000	2.475	3.075
Off Reef	**0.00%**	**0.00%**	**0.02%**	**0.03%**	**0.078**	**0.000**	**0.108**	**0.189**

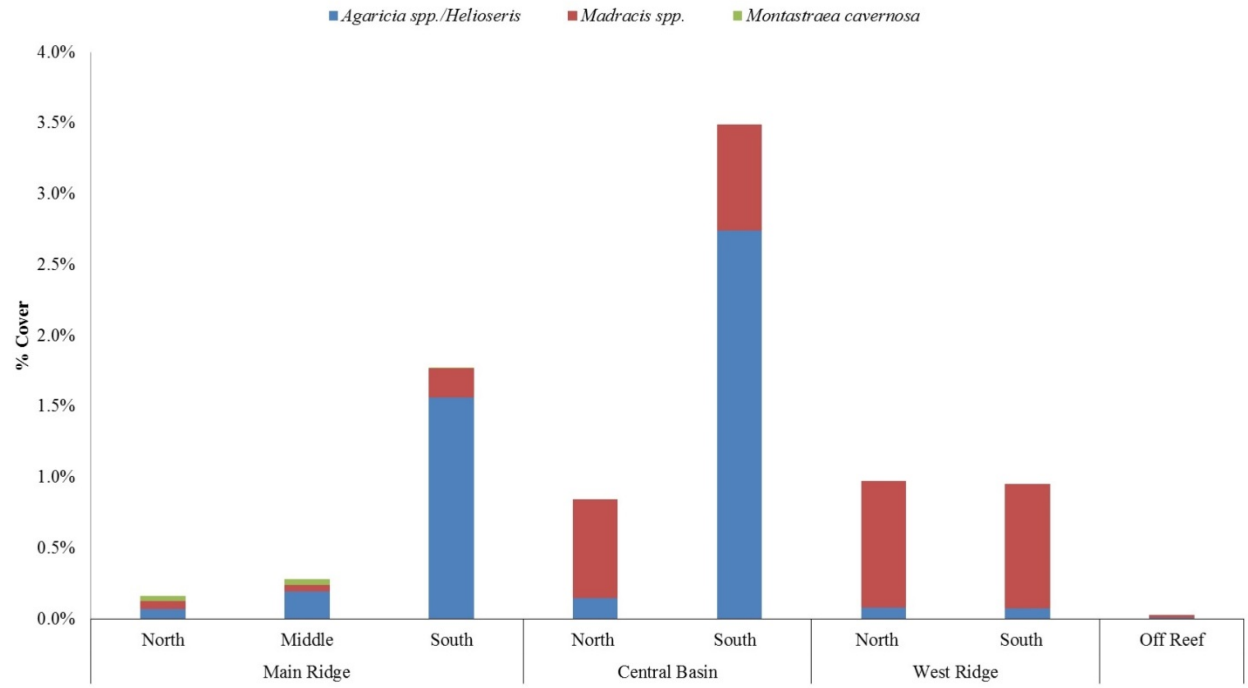

Figure 7. Average percent coral cover (CPCe Point Count) by region from ROV surveys at Pulley Ridge during 2012 to 2015 R/V *Walton Smith* cruises.

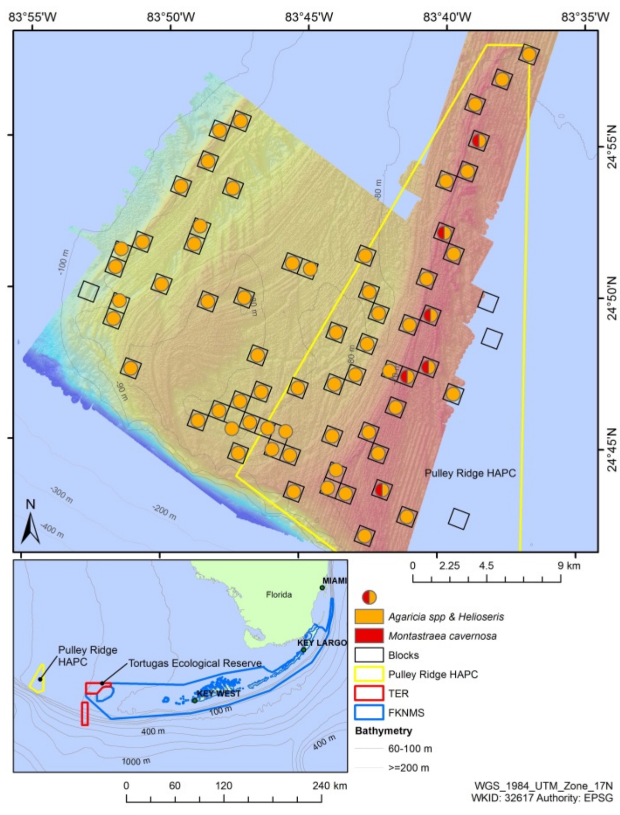

Figure 8. Distribution of agariciid (*Agaricia* spp. and *H. cucullata*) and *M. cavernosa* based on presence/absence from ROV transects for all Blocks at Pulley Ridge.

Coral Density
A total of 8,072 images were analyzed for density and 51,814 living scleractinian corals were counted. Overall, the density of all scleractinians was 6.829 colonies m^{-2}; plate coral density (*Agaricia* spp. and *H. cucullata*) was greatest at 4.89 colonies m^{-2}, *M. cavernosa* was 0.002, and the three *Madracis* species was 1.71 (Table 5, Fig. 9). Clearly the Central Basin-South region had the greatest hard coral density overall (15.82 m^{-2}), followed by Main Ridge-South (6.21), and West Ridge-South (3.07).

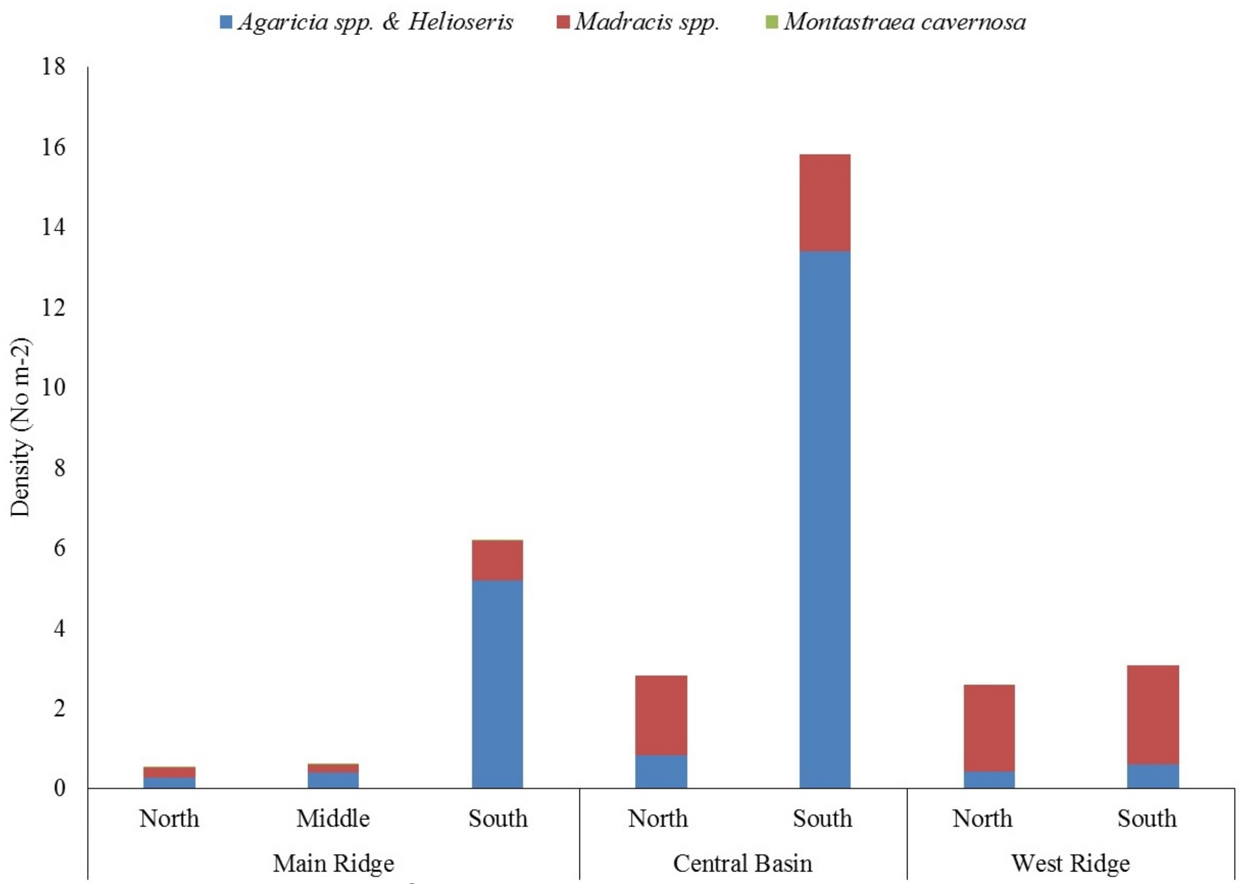

Figure 9. Density (# colonies m^{-2}) of scleractinian corals from ROV surveys at Pulley Ridge during 2012 to 2015 R/V *Walton Smith* cruises. *Montastraea cavernosa* was present but had too low density to show in plot.

Coral Size
Using the CPCe ARA tool to measure the maximum diameter of each agariciid plate coral for all Blocks, a histogram was created by counting the number of coral colonies within 5-cm size classes (<5 cm, 5 to 9 cm, 10- 14 cm, etc.) (Fig. 10). The histogram clearly shows the corals are greatly dominated by relatively newly settled colonies; 68.18% were <5 cm diameter and 93.94% were <10 cm diameter. Although we do not have growth rates for these corals at mesophotic depths, the growth rate of *Montastraea annularis* in shallow water is 6.6-8.9 mm/yr and *Porites astreoides* is 3.0-3.5 mm yr^{-1} (Gladfelter et al. 1978). So if we assume a maximum growth rate of 10 mm yr^{-1}, these small corals of <5 cm diameter are less than 5 years old. Minimum coral diameter measured was 0.24 cm and maximum diameter measured was 284 cm (*A. grahamae*; Plate 8).

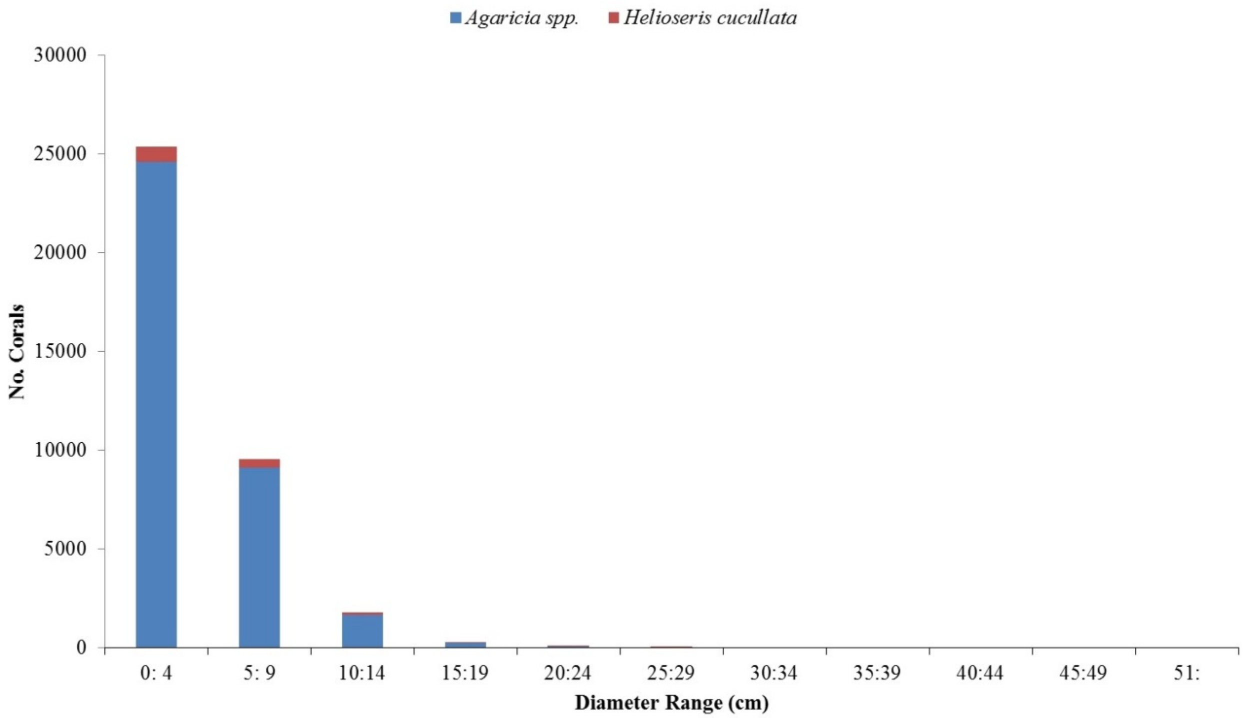

Figure 10. Size distribution of live plate corals (*Agaricia* spp. and *Helioseris cucullata*) from ROV surveys at Pulley Ridge during 2012 to 2015 R/V *Walton Smith* cruises. Size in cm of maximum diameter.

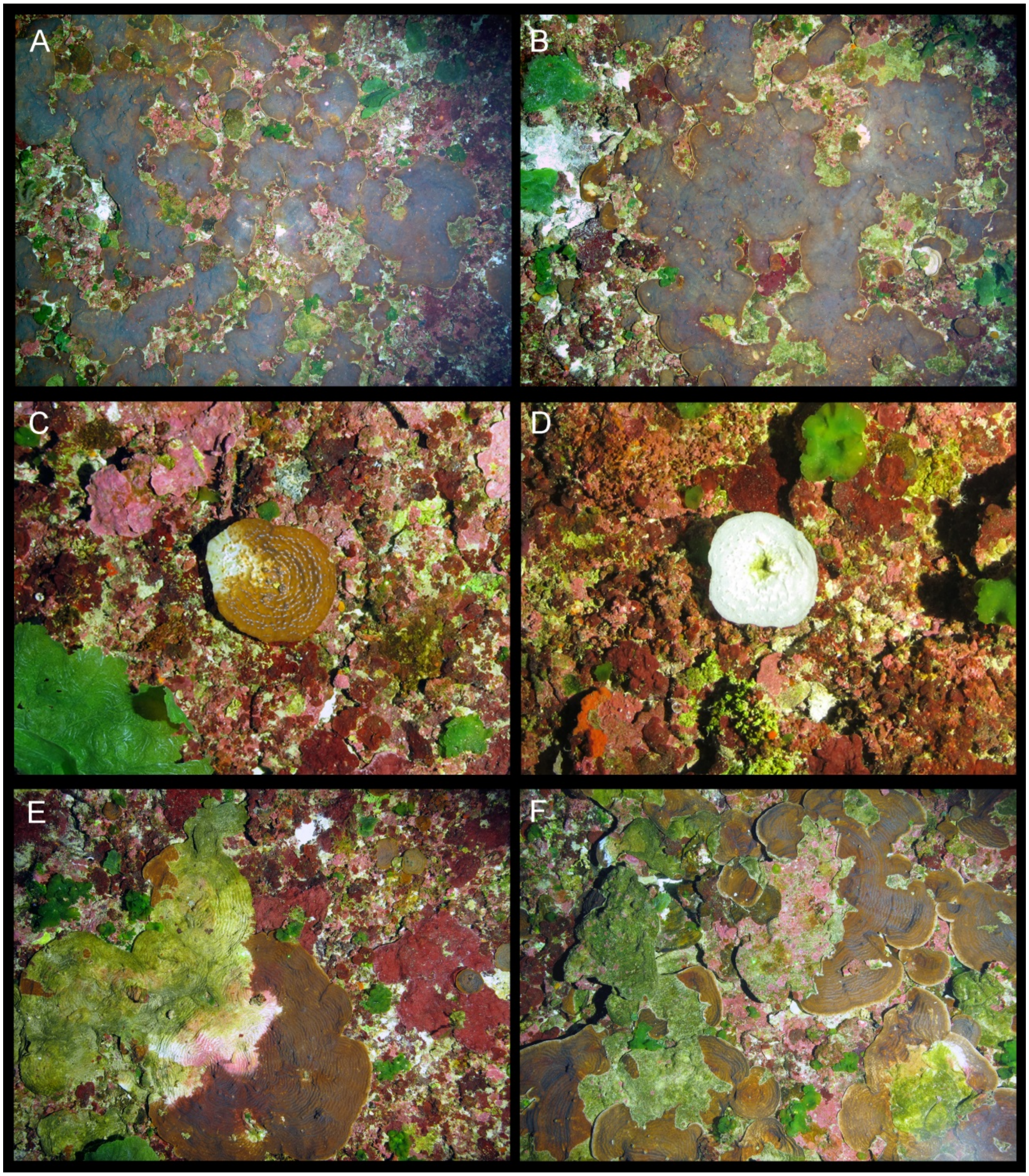

Plate 8. Agariciid corals from the Central Basin of Pulley Ridge. A. The largest plate coral (*Agaricia grahamae*) documented on Pulley Ridge from the 2012-2015 R/V *Walton Smith* cruises (284 cm maximum diameter, 16,618 cm^2 area; Block 31, Central Basin, depth 75.2 m); B. Second largest *A. grahamae*, 207 cm diameter; Block 31, depth 74.8 m; C.to F. Series of coral images showing various stages of mortality on Pulley Ridge: C. *Agaricia* sp. partially diseased or dying, Block 31, depth 77.1 m; D. *Agaricia* sp. 100% New Mortality with no algal growth, Block 82, depth 77.1 m; E. Large plates of *Agaricia* sp. showing New Mortality white skeletal, Transitional Mortality coral with fairly recent infestation of green algae, and Old Mortality showing growth of crustose coralline algae; Block 82, depth 78.1 m; F. Large plates of *Agaricia* sp. with parts showing signs of Old Mortality, but still recognizable coralline ridges; Block 82, depth 77.7 m.

Coral Mortality

In an attempt to determine the degree of coral mortality, we analyzed all plate corals from the 2012-2015 ROV dives at Pulley Ridge. A total of 38,368 individual living plate corals (*Agaricia* spp. and *H. cucullata*) and *M. cavernosa* were counted from the transect photos. Each coral was noted with the following descriptors of mortality: bleached, partially bleached, diseased, and partially dead coral. The percentage of plate corals (*Agaricia* spp., *H. cucullata*) and *M. cavernosa* showing signs of disease (White Syndrome), bleaching and fish bites was calculated for each Block and region based on actual counts (not CPCe percent cover) (Table 6).

A total of 0.88% of the total colonies counted had signs of partial to total bleaching. The greatest percentage of bleaching occurred on the Main Ridge-North (3.00%), Main Ridge-South (2.10%), Main Ridge-Middle (1.71%) and Central Basin-North (1.49%). A total of 1.21% showed signs of disease. We can only classify the apparent disease as a general term of White Syndrome which appear as irregular patches of recently dead, white skeleton, and usually but not always extending from the outer rim (Plate 8C). Specimens were collected and the interface between the healthy tissue and the diseased tissue were examined. No specific disease could be identified (JV). White Syndrome disease was highest along the Main Ridge (3.16%) and lowest on the West Ridge (0.42%). Within the Main Ridge, the Middle region had the highest disease rate of all (4.10%) followed by Main Ridge-North (4.00%). An interesting observation is that the apparent fish bites on the coral occurred almost exclusively on the West Ridge (1.87%), compared to zero on Main Ridge.

Table 6. Percentage of total population of plate corals (*Agaricia* spp., *Helioseris cucullata*) and *Montastraea cavernosa* showing signs of disease (White Syndrome), bleaching, and fish bites (based on total counts of all individual corals; not CPCe percent cover).

Region	Bleaching	White Disease Syndrome	Fish Bites
Main Ridge	**2.10%**	**3.16%**	**0.00%**
Main Ridge- North	3.00%	4.00%	0.00%
Main Ridge- Middle	1.71%	4.10%	0.00%
Main Ridge- South	2.10%	3.06%	0.00%
Central Basin	**0.73%**	**0.99%**	**0.03%**
Central Basin- North	1.49%	0.96%	0.11%
Central Basin- South	0.71%	0.99%	0.02%
West Ridge	**0.73%**	**0.42%**	**1.87%**
West Ridge- North	0.87%	0.44%	2.40%
West Ridge- South	0.60%	0.40%	1.39%
Grand Total	**0.88%**	**1.21%**	**0.07%**

Partially dead coral were noted as New Mortality (white, no sign of tissue), Transitional Mortality (dead coral, with some green algae overgrowth), and Old Mortality (dead coral encrusted with crustose coralline algae). For each category, the percentage of the total coral population for that region was calculated (Fig. 11). If a colony had more than one type of mortality, it was coded as whichever type covered the greatest area of the colony. The time of transition from new to old is unknown; it is estimated that the green algal infestation on the newly dead coral could be a matter of weeks to months, the crustose coralline algal stage could be within months to a year, and the completely overgrown but with skeletal colline ridges still visible (still can tell it is coral from rock) may last for several years (Plate 8 E, F). Over all regions, 9.94% of the coral population showed some sign of death. Recently dead (New and Transitional Mortality) accounted for 7.61%, and 2.34% were Old Mortality. The greatest percentages of partially dead coral were found at Main Ridge-Middle (12.96%) and West Ridge-North (12.97%); the least was the Central Basin-North (5.27%).

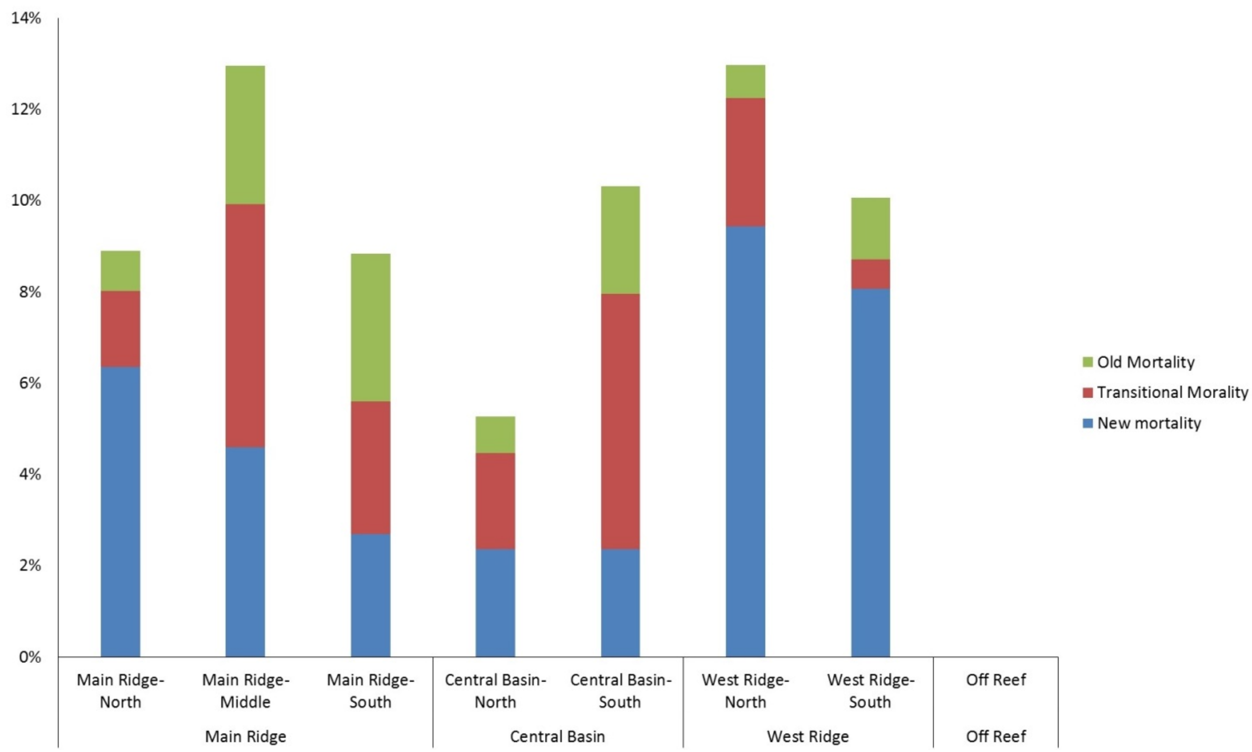

Figure 11. Various stages of mortality of plate corals (*Agaricia* spp. and *Helioseris cucullata*) and *Montastraea cavernosa* on Pulley Ridge. The proportion of the total coral population for each region that showed evidence of tissue loss was noted as New Mortality (white, no sign of tissue or algae), Transitional Mortality (dead coral with some green algae overgrowth), and Old Mortality (dead coral encrusted with crustose coralline algae).

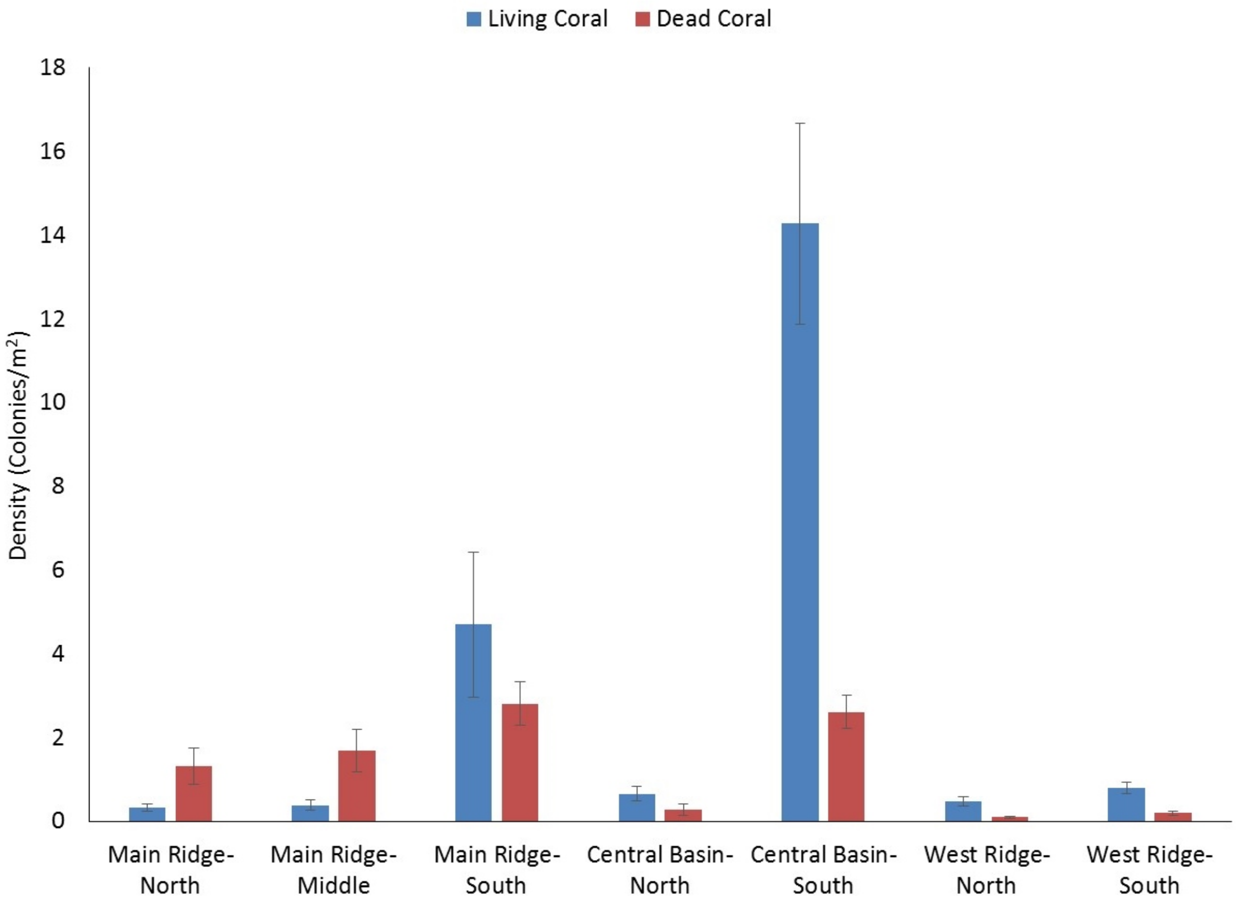

Figure 12. Mean densities (±1 SE) of plate corals (*Agaricia* spp. and *Helioseris cucullata*) by region on Pulley Ridge comparing living (blue) versus 100% dead corals (red).

The mean densities of the living and 100% dead plate corals (*Agaricia* spp. and *Helioseris cucullata*) were also compared by region on Pulley Ridge (Fig. 12). The mean densities of living corals were significantly different by region (ANOVA: $F_{62}=11.825$, $p<0.001$). A post-hoc Tukey test showed significant differences ($p<0.001$) between the Central Basin-South versus all other regions. The mean densities of corals that were 100% dead were also significantly different by region (ANOVA: $F_{62}=8.597$ $p<0.001$), and a post-hoc Tukey test showed significant differences ($p<0.001$) between the Central Basin-North and -South. Central Basin-South was also significantly different from West Ridge-North and -South. Main Ridge-South was significantly different from Central Basin-North and West Ridge-North and -South.

Coral Communities- Change Over Time

Comparison of the scleractinian coral cover at Pulley Ridge over time shows the substantial loss of coral in the past 10 years (Figs. 13). The mean percent coral cover on the Main Ridge dropped from 12.83% in 2003 to 0.82% by 2015, which is a significant 93.6% loss of coral (ANOVA: $F_{34}=89.885$; $p< 0.001$). In addition there was a significant loss between 2003 and 2015 for all three sub-regions of the Main Ridge (ANOVA: F34=27.244, $p<0.05$). The greatest loss was on the Main Ridge-Middle region which lost 98.30% of the coral population (16.49 to 0.28%). It appears that coral cover increased on the Main Ridge-Middle region between 1981 and 2003; however, since there was only block surveyed on 1981 we cannot complete a statistical analysis.

A Kernel Smoothing Model was plotted in ArcGIS which shows this dramatic loss of coral percent cover from the North and Middle regions of the Main Ridge between 2003 and 2015 (Fig. 14). Although we do not have 2003 data from the Central Basin region, the area of highest coral cover had clearly shifted to the southwest by 2015.

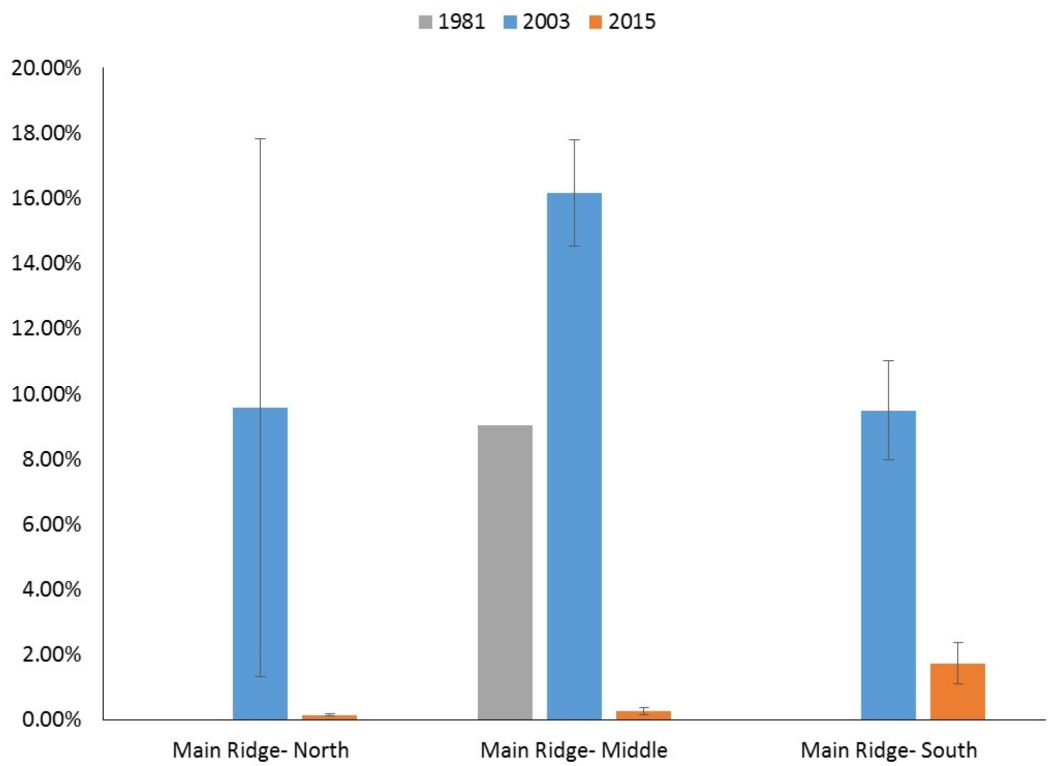

Figure 13. Mean percent cover (1 SE) from CPCe Point Count of all scleractinian corals including plate corals (*Agaricia grahamae*, *A. fragilis*, and *Helioseris cucullata*), *Montastraea cavernosa*, and *Madracis* spp. (*M. brueggemanni*, *M. decactis*, and *M. formosa*), comparing historical data (CSA- 1981 and USGS- 2003) with 2012-2015 R/V *Walton Smith* cruises. There was a significant loss between 2003 and 2015 for all three sub-regions of the Main Ridge (ANOVA: F_{34}=27.244, p<0.05).

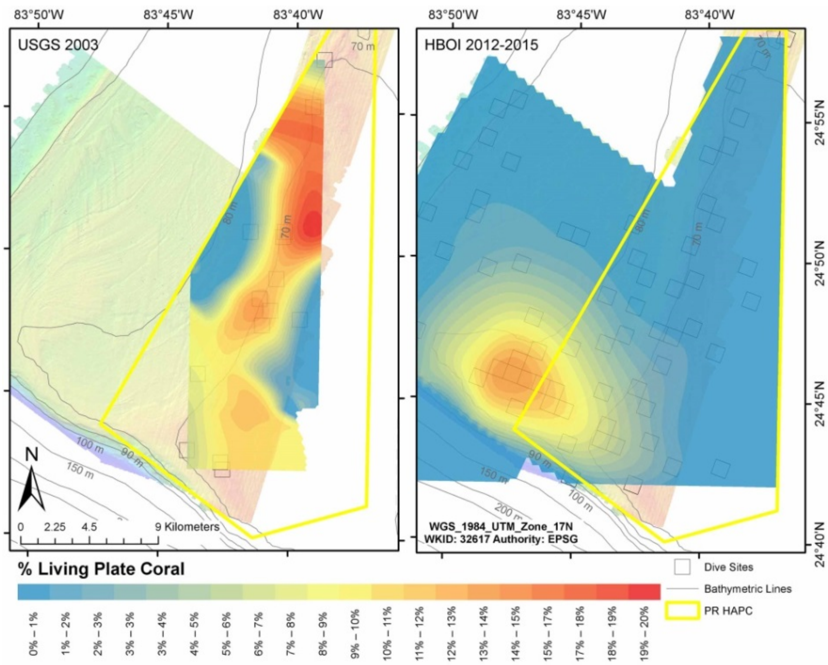

Figure 14. Kernel Smoothing Models (plotted in ArcGIS) of percent coral cover of plate corals (*Agaricia* spp., *Helioseris cucullata*) and *Montastraea cavernosa* at Pulley Ridge based on USGS- 2003 data (left) and 2012-2015 R/V *Walton Smith* cruises (right).

Benthic Biota and Habitat Relationships

Dive sites at Pulley Ridge and the Tortugas were compared using a MDS plot of Bray-Curtis Similarity (using square root transformations) for benthic macrobiota percent cover (Fig. 15). The letter designations in the plot show statistically different groups (SIMPROF, $p<0.05$). This plot shows that the mesophotic reef Blocks at PR (Main Ridge, Central Basin and West Ridge) are significantly different from all the Tortugas sites (ANOSIM: Global R = 0.96, sample statistic = 0.1%). A PERMANOVA shows a statistically significant difference between Pulley Ridge and Tortugas (pseudo-F = 6.1146; P = 0.001). Within the Tortugas, the mesophotic reefs (patch reef and fringing reef Blocks) are relatively similar (ANOSIM Pairwise test R = 0.143) but are significantly different from Miller's Ledge Blocks, which are heterotrophic hard-bottom habitat, rather than mesophotic (R=0.983). Within the soft bottom Blocks the 'a' cluster Blocks were different from the other sites because they were essentially barren, (< 3% biota cover, Appendix 3).

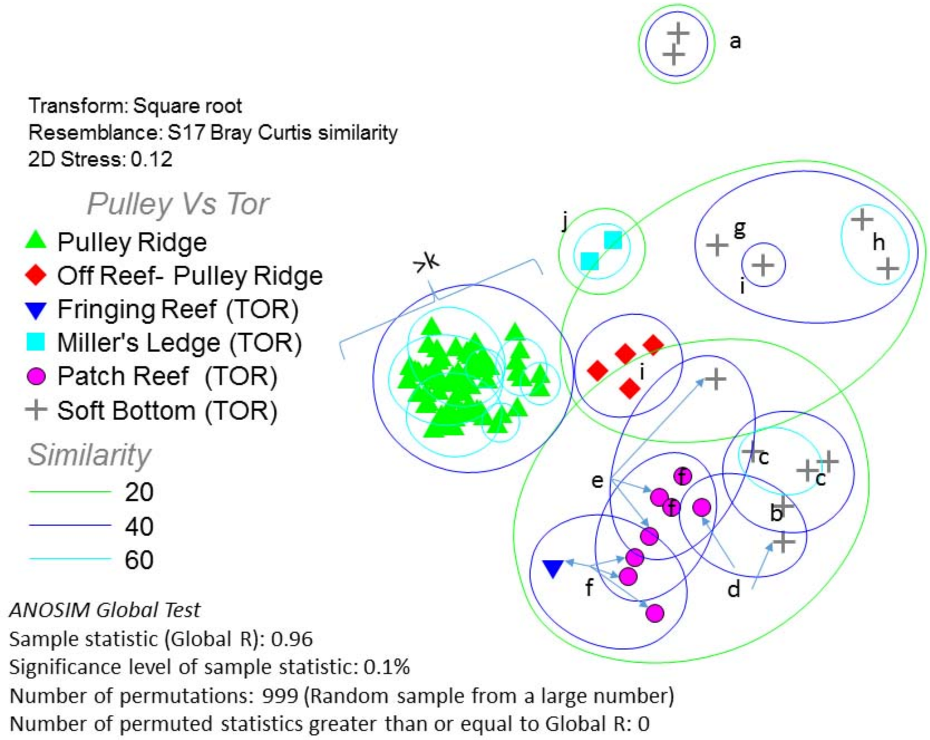

Figure 15. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Pulley Ridge and Tortugas regions based on Bray-Curtis similarity matrix of percent cover of benthic macrobiota. Assemblage similarities at 20-60% are indicated with the statistically significant groups based on SIMPROF analysis (<0.05) identified by letters.

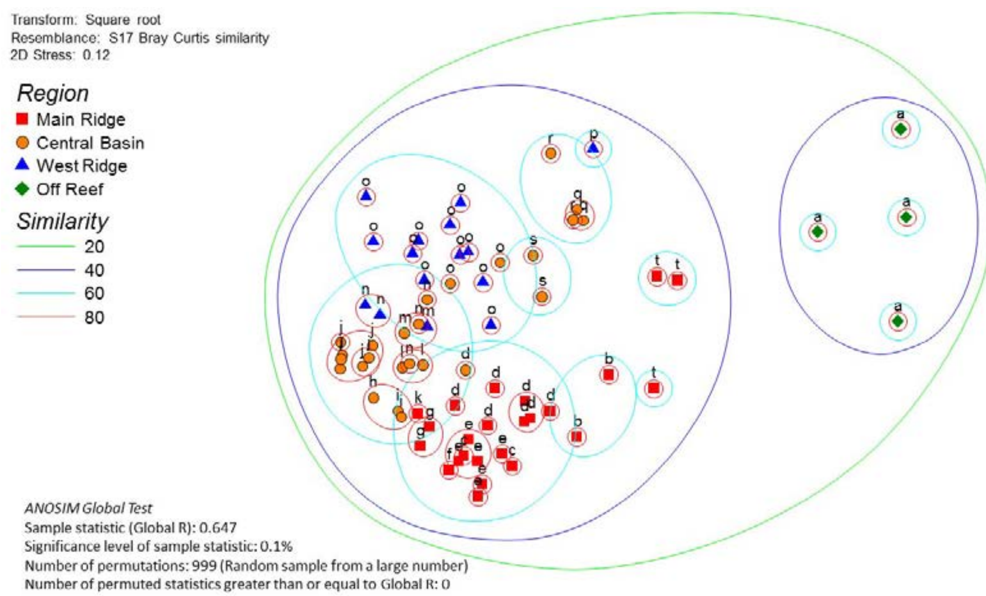

Figure 16. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of percent cover of benthic macrobiota. Assemblage similarities at 20-80% are indicated with the statistically significant groups based on SIMPROF analysis (<0.05) identified by letters.

Within Pulley Ridge, the Off Reef Blocks were statistically significantly different from all the mesophotic reef Blocks (Main Ridge, Central Basin, West Ridge) (Fig. 16; ANOSIM: Global R = 0.647, sample statistic = 0.1%). ANOSIM pairwise tests also verified large dissimilarity between the Off Reef and Mesophotic Reef Blocks (R Statistic = 0.97 to 1.0, Significance level 0.1%). Within the mesophotic reef Blocks, the West Ridge region (Blue Triangles) are generally clustered separately from the Main Ridge (Red Squares) and Central basin Blocks (Fig. 16). ANOSIM Pairwise Tests (Table 7) shows the Main Ridge and West Ridge are most dissimilar (R= 0.713) whereas the Central basin and West Ridge are more similar (R=0.276).

Table 7. ANOSIM Pairwise comparisons of the mesophotic reef blocks (percent cover of benthic macrobiota) at Pulley Ridge.

Groups	R Statistic	Significance Level %
Main Ridge, Central Basin	0.484	0.1
Main Ridge, West Ridge	0.713	0.1
Central Basin, West Ridge	0.276	0.2

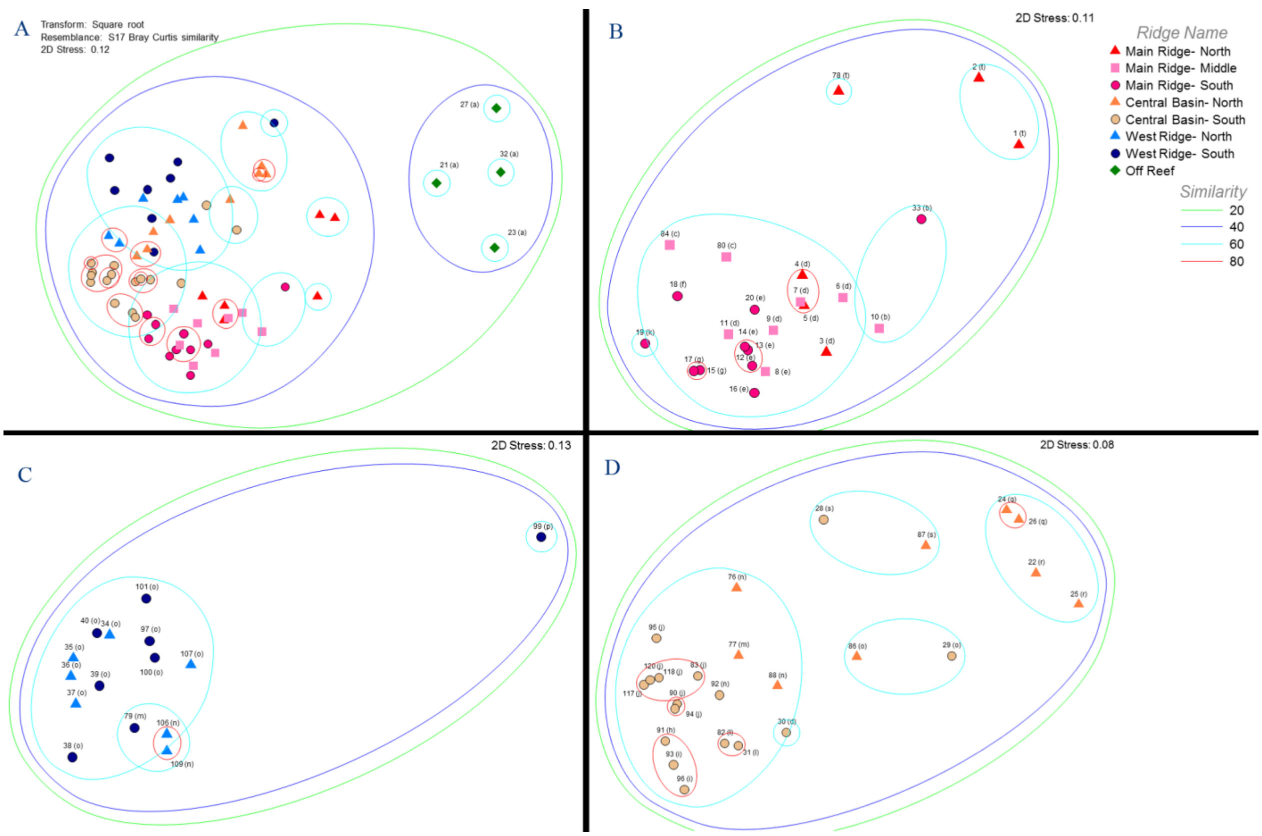

Figure 17. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of percent cover of benthic macrobiota. Assemblage similarities at 20-80% are indicated with the statistically significant groups based on SIMPROF analysis (<0.05) identified by letters. Plots A – D show individual regions. A. all sub regions. B. Main Ridge sub-regions- North, Middle, South. C. West Ridge sub-regions- North, South. D. Central Basin sub-regions- North, South.

MDS plots of the benthic communities for each of the main mesophotic reef regions (Main Ridge, Central Basin, and West Ridge) shows some sub-regional differences (Fig. 17). Within the Main Ridge (Fig. 17 B), the Central and Southern regions tended to cluster together (60%) where the three northern most Blocks are most dissimilar. ANOSIM Pairwise Tests shows the Main Ridge- North and Main Ridge- South are most dissimilar (R= 0.494) whereas Main Ridge Middle and South are more similar (R=0.176). Within the West Ridge (Fig. 17 C), the northern and southern regions are relatively similar except for one outlier (Block 99) which was predominately soft bottom (72%) and had relatively fewer biota (13.93% cover). Within the Central Basin (Fig. 17 D), the northern and southern Blocks are relatively similar and tended to cluster together at 60% similarity (ANOSIM R= 0.586). However, four of the Blocks in the northern region (Blocks 22, 24-26) tended to cluster separately, and in general, these had fewer corals but more sponges then the other regions of the Central Basin.

<u>Benthic Biota and Environmental Relationships</u>

From 2012 to 2015, the University of Miami and NOAA/AOML deployed an ADCP/CTD mooring at a depth of 69 m within the Pulley Ridge HAPC (Fig. 18). Overall, the 34-month record of hourly bottom temperatures at this mesophotic depth ranged from 18.47^{o}C to 28.48^{o}C, with the maximum and minimum observations occurring within less than three months of each other in late 2013 (Aug – Nov). However, physical environmental data was collected within the random Blocks only during the ROV dives of 2014 and 2015. A temperature recorder was attached to the ROV during the 2014 cruise and a CTD was attached to the ROV during the 2015 cruise. Table 8 shows the range of temperature, salinity and oxygen within the mesophotic reef regions at Pulley Ridge from these ROV dives. Since all of the cruises were in August, these data do not show the true variability of the bottom environmental conditions over the year and entire survey period. The overall temperature range from the ROV dives was 18.45 to 22.53^{o}C at depths ranging from 58.49 to 93.00. Surprisingly, the peak temperatures were recorded in November at the mooring site whereas the minimum temperatures were April to September. Salinity ranged from 36.20 to 36.51 PSU, and oxygen was 4.90 to 5.22 ml/l.

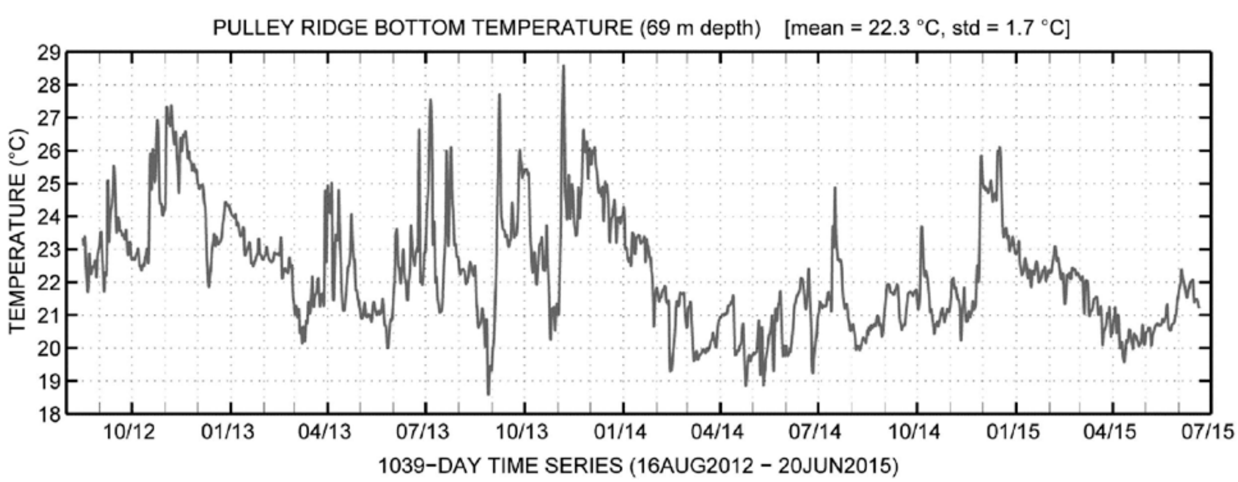

Figure 18. ADCP/CTD mooring at a depth of 69 m within the Pulley Ridge HAPC from 2012 to 2015, the University of Miami and NOAA/AOML (courtesy of Ryan H. Smith).

Table 8. Range of bottom temperature, salinity and dissolved oxygen within the mesophotic reef regions at Pulley Ridge during the ROV dives in 2014 and 2015.

Region	Depth (m)	Temperature (°C)	Salinity (PSU)	Oxygen (ml/l)
Pulley Ridge	58.49-93.00	18.45-22.53	36.20-36.51	4.90-5.22
Main Ridge	58.87-65.97	19.51-21.21	36.38-36.43	5.02-5.18
Main Ridge- North	58.87-65.78	19.55-21.21	36.38-36.43	5.02-5.18
Main Ridge- Middle	61.21-65.94	19.51-20.22	36.4-36.43	5.11-5.18
Main Ridge- South	63.77-65.97	20.52-20.88	36.42-36.43	5.05-5.08
Central Basin	58.49-81.69	19.08-22.53	36.33-36.51	4.90-5.22
Central Basin- North	58.49-81.12	19.08-21.54	36.39-36.43	4.99-5.22
Central Basin- South	62.05-81.69	19.31-22.53	36.33-36.51	4.90-5.17
West Ridge	70.75-93.00	18.45-21.90	36.20-36.50	4.96-5.15
West Ridge- North	76.79-85.55	18.45-20.99	36.39-36.48	5.04-5.11
West Ridge- South	70.75-93.00	19.02-21.90	36.20-36.50	4.96-5.15

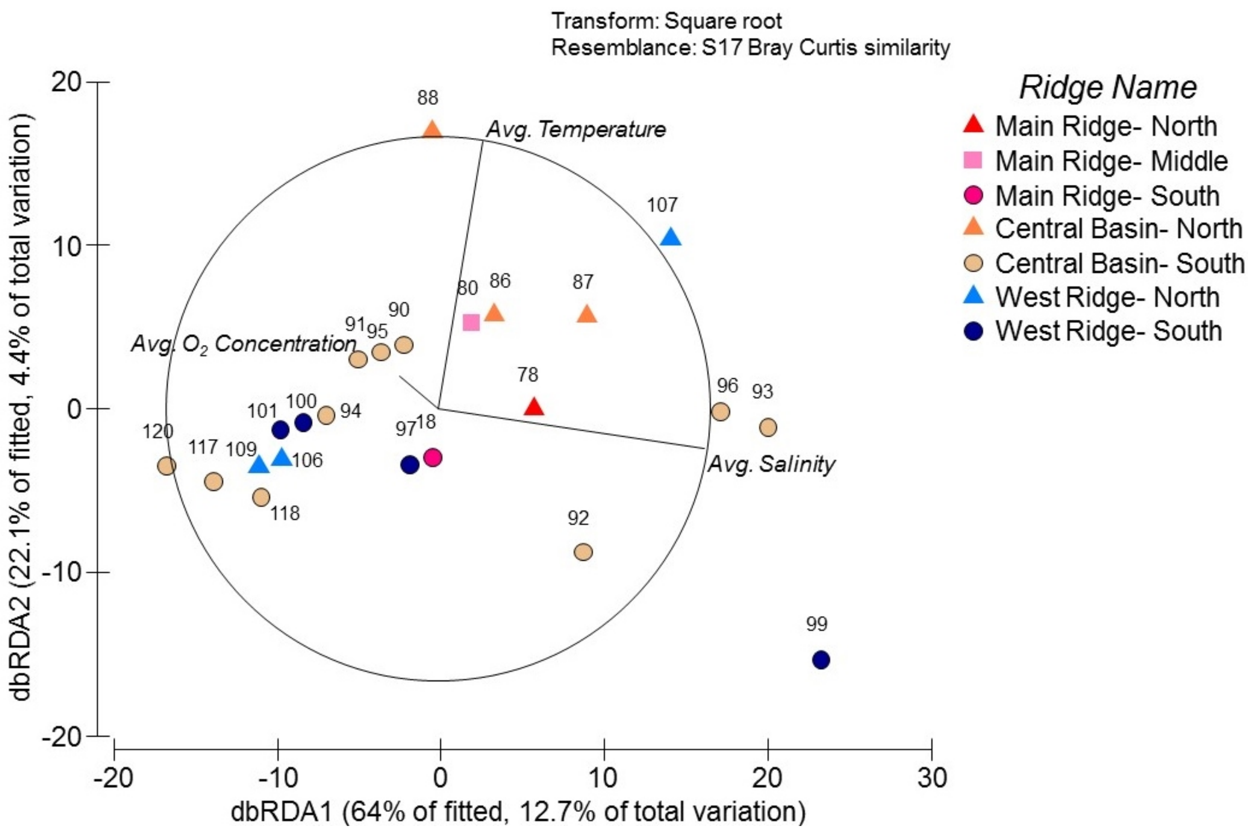

Figure 19. dbRDA model plot of all Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of percent cover of benthic macrobiota compared to average salinity, average oxygen concentration, and average temperature. Salinity was the only significant covariate (Pseudo-F= 2.8413, P=0.01).

The BEST (BIO-ENV), DistLM and dbRDA was used to compare benthic macrobiota distribution with ROV CTD data, which were only available for 2015 (Fig. 19). Of the three environmental parameters (temperature, salinity, and dissolved oxygen), only salinity was significantly correlated with the benthic community (Pseudo-F= 2.8413, P=0.01). When comparing only *Agaricia* spp. corals using temperature, salinity, and dissolved oxygen from 2015 data, none of the environmental factors was statistically significant.

<u>Benthic Biota and Abiotic Relationships</u>

The distLM model shows that all three abiotic factors (latitude, longitude and depth) were statistically significant when comparing abiotic data to fauna assemblages over all 4 years (Pseudo-F: latitude = 5.2162, longitude = 14.7, depth = 14.2, all p=0.001). The dbRDA model (Figure 20) shows the X-axis accounted for 18.7% of the variation mostly from depth and longitude and Y-axis accounted for 11.9 %, with latitude determining most of the variation. The depth differences from the Main Ridge to the West Ridge, which is correlated with longitude, was the main driver in the biotic communities; this was especially apparent in the green and red algal populations described previously (Fig. 4), with the top 50% contributions to the Bray-Curtis similarity coming entirely from algae for all the Ridge groupings.

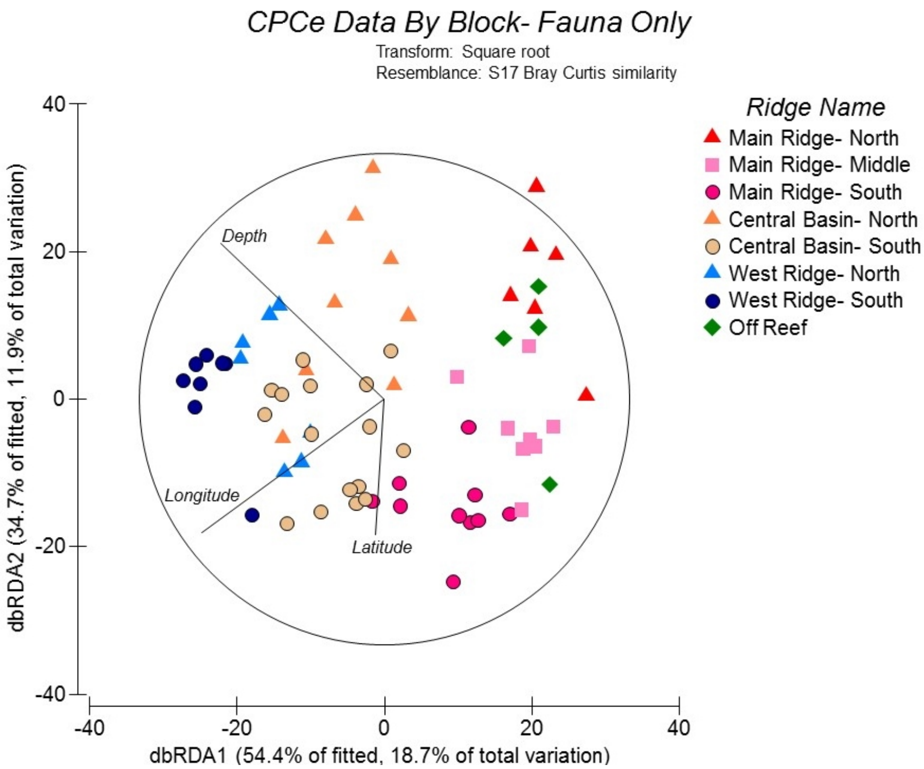

Figure 20. dbRDA model plot of all Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of percent cover of benthic macrobiota compared to average Location (center point latitude and longitude of the block) and average depth across all photographs analyzed. (Specified solution results of distLM: R^2= 0.34458, RSS = 56926, Variables = latitude, longitude and depth).

<u>Coral and Abiotic Relationships</u>

The mean depth at which the agariciid corals (*Agaricia* spp and *H. cucullata)* were observed (Mean = 74 m, SE = 1.632) is greater than the mean depth of *M. cavernosa* (Mean = 64.6 m, SE = 0.882) (T-Test: F_{30} = 17.714, p<0.01). The depth range for the agariciid corals ranged from

59.5 m to 105.2 m, and appeared to be multimodal, peaking at depths of ~75 m and 80 m (Fig. 21). Of the agariciids, 46.58% were between 73-77 m and 9.99% were at 80 m.

The distribution of *Montastraea cavernosa* was also plotted by depth (Fig. 22). Colonies ranged from depths of 62.6 to 68 m, but since there were such few specimens (17) a valid correlation analysis cannot be run. The greatest known depth distribution of scleractinian coral in the western Atlantic is much deeper, with *Agaricia* sp. reported to 119 m, *A. grahamae* 115 m, *H. cucullata* 108 m, and *M. cavernosa* 113 m (Reed 1985). These were all in the Bahamas on the steep slopes of San Salvador Island.

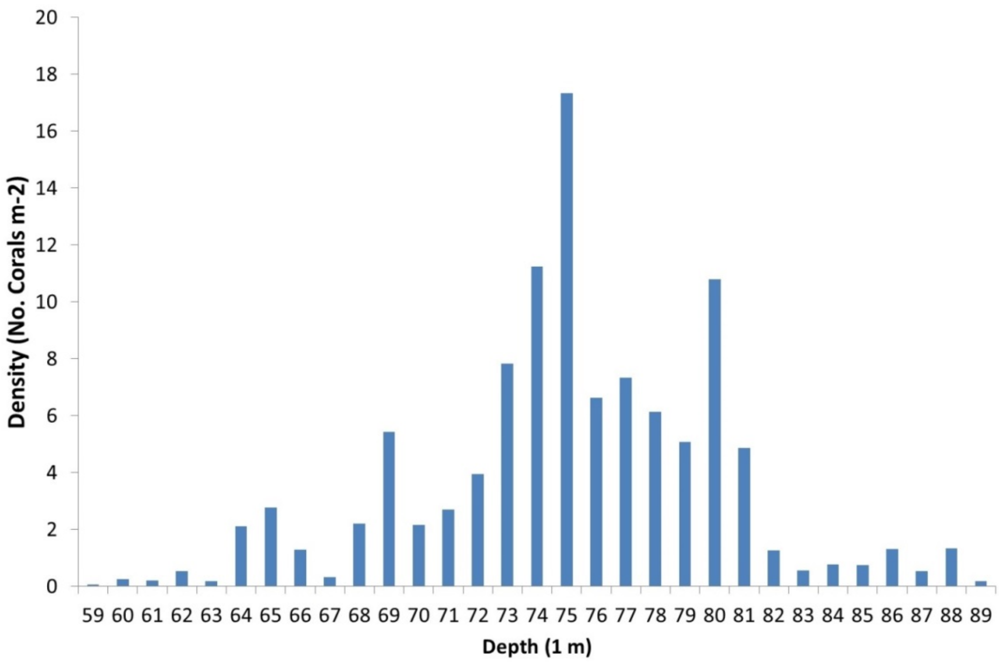

Figure 21. Distribution of density of agariciid corals (*Agaricia* spp. and *Helioseris cucullata*) by depth (1-m increments) from ROV surveys at Pulley Ridge during 2012 to 2015 R/V *Walton Smith* cruises.

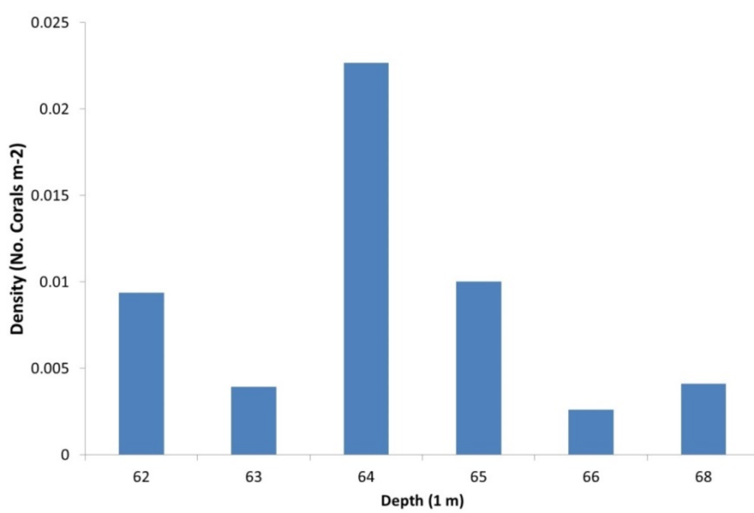

Figure 22. Distribution of density of *Montastraea cavernosa* by depth (1-m increments) from ROV surveys at Pulley Ridge during 2012 to 2015 R/V *Walton Smith* cruises.

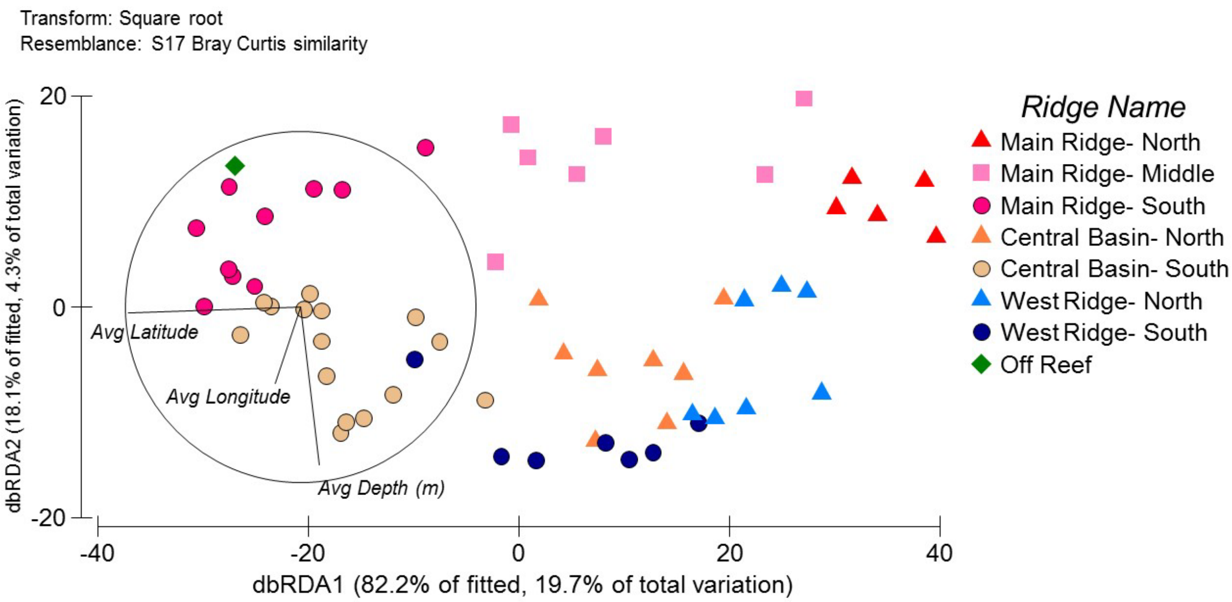

Figure 23. dbRDA model plot of all Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of percent cover of *Agaricia* spp. compared to average location (center point of Blocks) and average depth from image depths (m). (Specified solution results of distLM: R^2= 0.24017, RSS = 94968, Variables = latitude, longitude and depth).

The BEST (BIO-ENV), DistLM and dbRDA was used to compare distribution of *Agaricia* spp. based on depth and latitude/longitude. When looking at the distLM, only, latitude (Pseudo-F= 13.939, p = 0.001) and depth (Pseudo-F= 6284.5, p = 0.036) were statistically significant. As seen in dbRDA plot (Fig. 23), latitude was the largest contributor to the variation along the X-axis (19.7%), and depth contributed 4.3% of the variation along the Y-axis. (Blocks 7, 21, 23, 26-28, 78 and 99 were removed because of absence of all species, creating undefined variables).

Analysis of Fish Video Surveys

Pulley Ridge versus the Tortugas

A total of 86 fish species from Pulley Ridge (Appendix 4) and 96 from Tortugas (Appendix 5) were identified from video transects. Fish assemblages at Pulley Ridge and the Tortugas were compared using a MDS plot of Bray-Curtis Similarity (using fourth-root transformations) of fish densities (Fig. 24). This plot shows the fish species composition of the two locations was significantly different from one another (ANOSIM: Global R = 0.611, sample statistic = 0.1%). Most of the Pulley Ridge blocks clustered together at the 30% similarity level. According to SIMPER tests, this difference was primarily due to higher densities of yellowtail reeffish (*Chromis enchrysurus*), chalk bass (*Serranus tortugarum*), purple reeffish (*Chromis scotti*), greenblotch parrotfish (*Sparisoma atomarium*), sunshinefish (*Chromis insolatus*), and lionfish (*Pterois volitans*) at Pulley Ridge and higher densities of wrasses (*Halichoeres* spp.), bicolor damselfish (*Stegastes partitus*), and blue chromis (*Chromis cyanea*) at Tortugas. Species diversity was higher for the Tortugas (H' ($\log_e$) = 2.21) compared to Pulley Ridge (H' ($\log_e$) = 1.581).

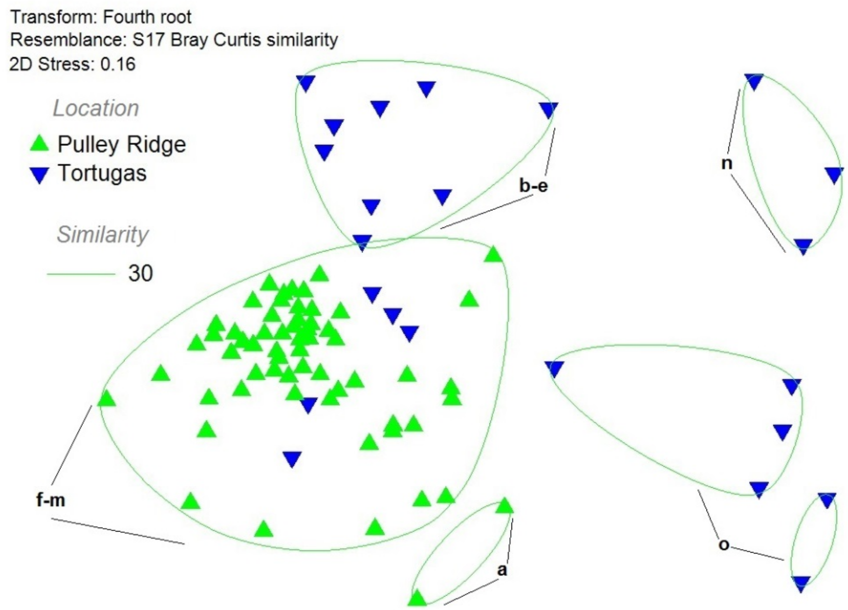

Figure 24. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Pulley Ridge and Tortugas based on Bray-Curtis similarity matrix of fish densities. Assemblage similarities at 30% are indicated with the statistically significant groups based on SIMPROF analysis (< 0.05) identified by letters.

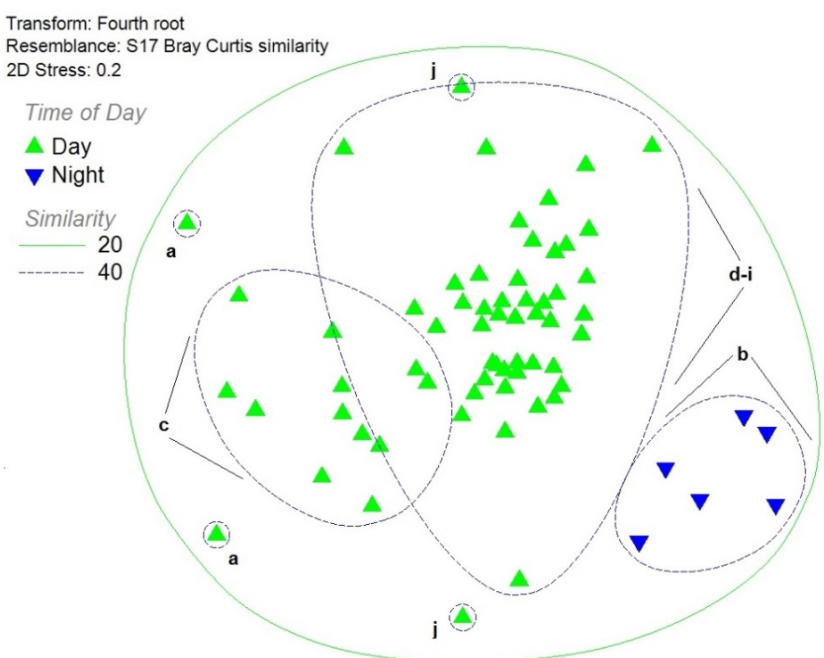

Figure 25. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of fish densities, comparing day and night ROV dives. Assemblage similarities at 20% and 40% are indicated with the statistically significant groups based on SIMPROF analysis (< 0.05) identified by letters.

Six blocks examined at Pulley Ridge in 2012 were night dives which resulted in a significantly different composition of fish species compared to Pulley Ridge day dives (Fig. 25; ANOSIM: Global R = 0.645, sample statistic = 0.1%). All blocks had fish assemblages that were 20% similar, but at the 40% similarity level, the night dives separated from the day dives. SIMPER revealed that several schooling species were abundant at night that typically weren't observed during the day. These included schools of vermilion snapper (*Rhomboplites aurorubens*) and mackerel scad (*Decapterus macarellus*), as well as mixed schools of bonnetmouths (Inermiidae) and school bass (*Schultzea beta*). This is the only analysis which included the night dives because of their distinct fish assemblages.

Within Pulley Ridge, fish assemblages were slightly different among regions (Main Ridge, Off Main Ridge, Central Basin, and West Ridge) (Fig. 26; ANOSIM: Global R = 0.321, sample statistic = 0.1%). ANOSIM pairwise tests (Table 9) indicated fish assemblages of the Main Ridge and Off Reef regions were most dissimilar (R = 0.833) while fish assemblages of the Central Basin and West Ridge regions were most similar (R = 0.193). The species most responsible for the difference between the Main Ridge and Off Reef regions were higher densities of purple reeffish, cherubfish (*Centropyge argi*), and sunshinefish on the Main Ridge. Species diversity, however, was slightly lower for the Main Ridge region compared to all others at Pulley Ridge (Table 10).

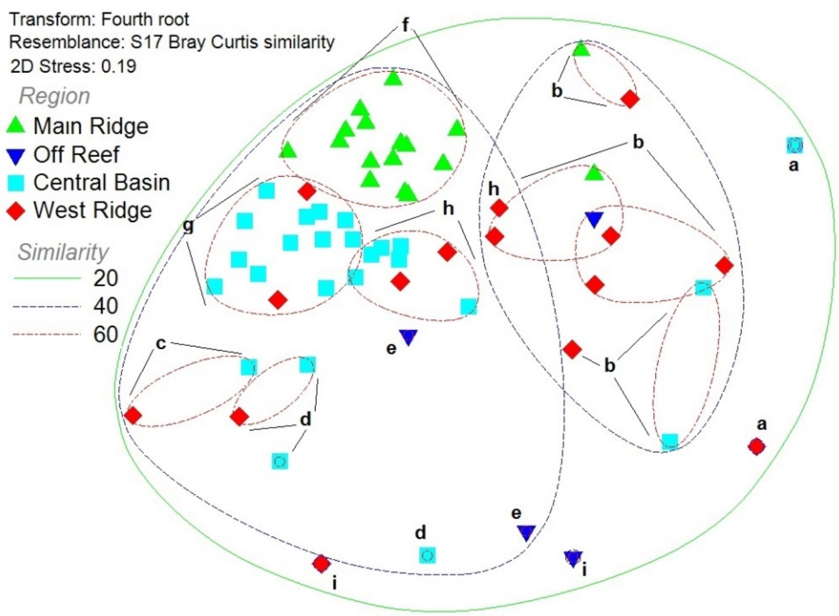

Figure 26. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of fish densities. Assemblage similarities at 20-60% are indicated with the statistically significant groups based on SIMPROF analysis (<0.05) identified by letters.

Table 9. ANOSIM pairwise comparisons of Pulley Ridge regions.

Groups	R Statistic	Significance Level %
Main Ridge, Off Reef	0.833	0.1
Main Ridge, Central Basin	0.315	0.1
Main Ridge, West Ridge	0.426	0.1
Off Reef, Central Basin	0.465	1.2
Off Reef, Central Basin	0.207	10.4
Central Basin, West Ridge	0.193	0.5

Table 10. Species diversity indices using DIVERSE based on fish densities. S = total number of species, J' = evenness, and H' = Shannon-Weiner index.

Region	Location	S	J'	H' ($\log_e$)
Main Ridge	Pulley Ridge	44	0.5083	1.924
Off Reef	Pulley Ridge	30	0.7102	2.416
Central Basin	Pulley Ridge	41	0.6569	2.439
West Ridge	Pulley Ridge	42	0.6197	2.316
Soft Bottom	Tortugas	37	0.5817	2.1
Fringing Reef	Tortugas	42	0.5059	1.891
Patch Reef	Tortugas	52	0.6614	2.613
Miller's Ledge	Tortugas	30	0.4863	1.654

Fish assemblages were also slightly different among the Tortugas regions (Soft Bottom, Patch Reef, Fringing Reef, and Miller's Ledge) (Fig 27; ANOSIM: Global R = 0.364; sample statistic = 0.5%). With the exception of three blocks, all Soft Bottom blocks clustered together in two groups with one group having high densities of scad (*Decapterus* spp.) and jacks (Carangidae) and the other group having higher densities of lizardfish (Synodontidae), filefish (*Monacanthus* spp.), and blue goby (*Ioglossus calliurus*). Blocks 57, 60, & 69 clustered together with the hard bottom blocks because even though these dives were primarily characterized as soft bottom, patch reefs and low relief outcrops were interspersed throughout providing fish habitat. The two blocks examined at Miller's Ledge had fish assemblages that were 60% similar at which point they separated from clustering with the other hard bottom sites. ANOSIM pairwise tests (Table 11) confirmed the most significant differences in fish assemblages were between Fringing Reef and Miller's Ledge as well as Patch Reef and Miller's Ledge regions. These differences were primarily due to higher densities of roughtongue bass (*Pronotogrammus martinicensis*) at Miller's Ledge and higher densities of bicolor damselfish on Fringing and Patch Reefs. Species diversity for the Tortugas was highest for the Patch Reef region, followed by Soft Bottom and Fringing Reef. Miller's Ledge had the lowest species diversity of the Tortugas regions (Table 10).

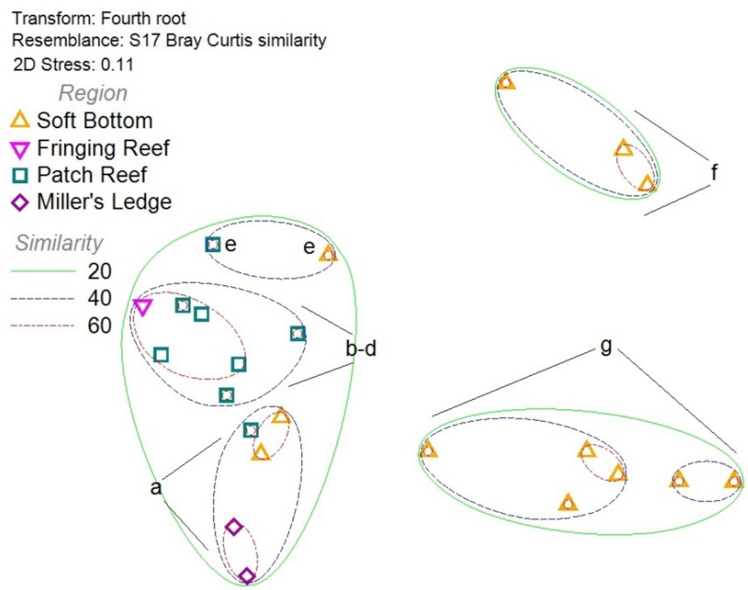

Figure 27. Multi-dimensional scaling (MDS) plot of Blocks surveyed at Tortugas based on Bray-Curtis similarity matrix of fish densities. Assemblage similarities at 20-60% are indicated with the statistically significant groups based on SIMPROF analysis (<0.05) identified by letters.

Table 11. ANOSIM pairwise comparisons of the Tortugas regions.

Groups	**R Statistic**	**Significance Level %**
Soft Bottom, Fringing Reef	0.461	7.7
Soft Bottom, Patch Reef	0.422	0.3
Soft Bottom, Miller's Ledge	0.295	3.3
Fringing Reef, Patch Reef	0.232	44.4
Fringing Reef, Miller's Ledge	1	33.3
Patch Reef, Miller's Ledge	0.875	2.2

Managed Species

A total of 29 managed species were observed; 20 at Pulley Ridge and 17 at Tortugas (Table 12). The most abundant species at Pulley Ridge were almaco jack (*Seriola rivoliana*), vermilion snapper (*Rhomboplites aurorubens*), and red grouper (*Epinephelus morio*). The dominant species at Tortugas were yellowtail snapper (*Ocyurus chrysurus*), dog snapper (*Lutjanus jocu*), and white grunt (*Haemulon plumieri*). Average densities of managed species were significantly different among regions of Pulley Ridge and Tortugas (Fig. 28; One-way ANOVA: $p < 0.0001$). Average densities of managed species at Off Reef sites were significantly higher than the other regions of Pulley Ridge which was driven by a high abundance of almaco jack. Average densities of managed species at Fringing Reef sites were significantly higher than the other regions of the Tortugas. This was driven by high abundances of yellowtail snapper, dog snapper, and unidentified snapper (*Lutjanus* spp.). Species diversity was significantly higher on the Main Ridge compared to all other Pulley Ridge regions (Table 13). Species diversity at all Tortugas regions was generally higher than Pulley Ridge, with the greatest diversity observed on Patch Reef sites.

Table 12. Densities (#/1000 m²) of all managed species for each region of Pulley Ridge and the Tortugas. Species are listed from the highest to lowest overall density.

	PULLEY RIDGE				**TORTUGAS**				
	Main Ridge	**Off Reef**	**Central Basin**	**West Ridge**	**Soft Bottom**	**Fringing Reef**	**Patch Reef**	**Miller's Ledge**	**TOTAL**
Ocyurus chrysurus	0.00	0.00	0.00	0.00	0.00	45.60	0.05	0.00	**45.65**
Lutjanus jocu	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	**20.00**
Unidentified *Lutjanus* sp.	0.09	0.10	0.10	0.10	0.13	10.40	0.10	0.20	**11.22**
Haemulon plumieri	0.00	0.00	0.00	0.00	0.03	4.80	1.55	0.00	**6.38**
Seriola rivoliana	0.07	5.10	0.00	0.00	0.00	0.00	0.00	0.80	**5.97**
Unidentified *Calamus* sp.	0.03	0.10	0.00	0.00	0.03	3.20	1.05	0.00	**4.42**
Cephalopholis cruentatus	0.03	0.00	0.06	0.00	0.00	3.20	0.20	0.20	**3.69**
Lachnolaimus maximus	0.02	0.00	0.02	0.00	0.00	2.80	0.45	0.00	**3.28**
Mycteroperca phenax	0.24	0.00	0.09	0.19	0.00	0.80	0.00	1.20	**2.52**
Epinephelus morio	0.35	0.30	0.24	0.08	0.07	0.00	0.35	0.00	**1.38**
Rhomboplites aurorubens	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.23**
Unidentified *Seriola* sp.	0.16	0.30	0.22	0.19	0.00	0.00	0.15	0.00	**1.02**
Epinephelus adscensionis	0.00	0.00	0.00	0.00	0.00	0.40	0.05	0.00	**0.45**
Seriola dumerili	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.20	**0.34**
Mycteroperca bonaci	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.20	**0.27**
Lutjanus analis	0.17	0.00	0.00	0.00	0.07	0.00	0.00	0.00	**0.24**
Epinephelus drummondhayi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	**0.20**
Balistes vetula	0.08	0.10	0.00	0.00	0.00	0.00	0.00	0.00	**0.18**
Balistes capriscus	0.02	0.00	0.00	0.13	0.00	0.00	0.00	0.00	**0.15**
Pagrus pagrus	0.00	0.10	0.00	0.03	0.00	0.00	0.00	0.00	**0.13**
Centropristis ocyurus	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	**0.10**
Lutjanus campechanus	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	**0.06**
Lutjanus mahogoni	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	**0.05**
Lutjanus griseus	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	**0.05**
Calamus calamus	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	**0.05**
Lutjanus buccanella	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	**0.03**
Unidentified Balistidae	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**
Haemulon album	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**
Epinephelus guttatus	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**
Canthidermis sufflamen	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**
Calamus bajonado	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**
Mycteroperca interstitailis	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
Lutjanus cyanopterus	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
TOTAL	**2.80**	**6.20**	**0.79**	**0.71**	**0.37**	**91.20**	**4.10**	**3.00**	

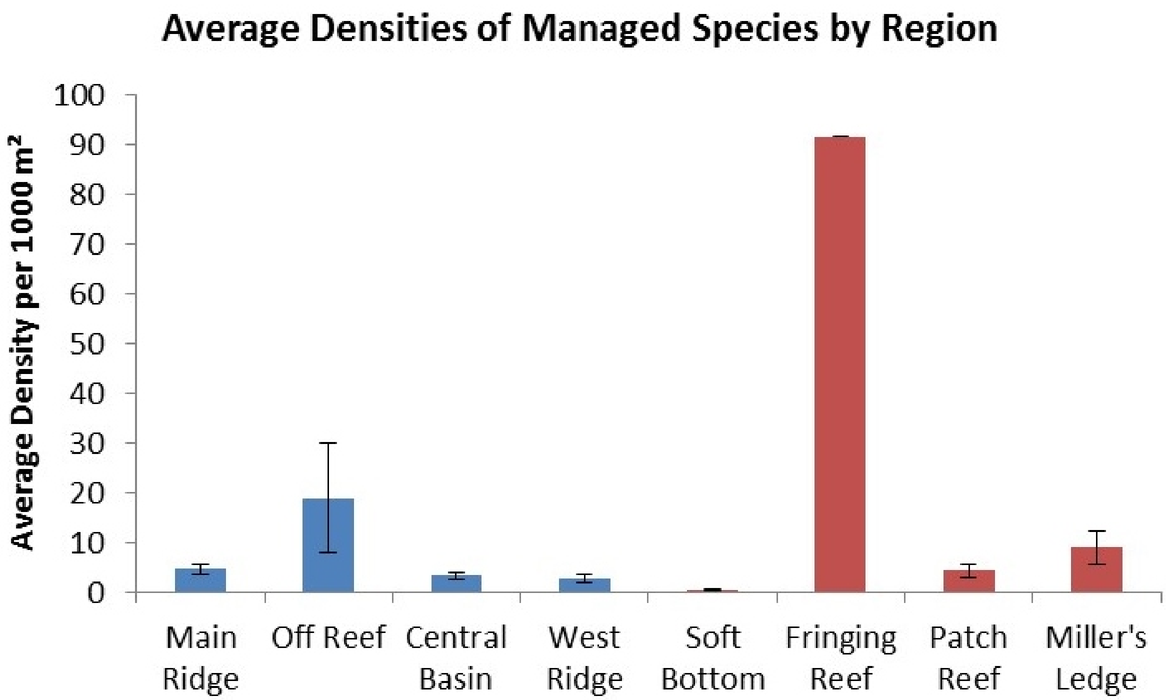

Figure 28. Average densities (#/1000 m²) ± S.E. of managed species by regions. Blue = Pulley Ridge regions. Red = Tortugas regions.

Table 13. Species diversity indices using DIVERSE based on fish densities of managed species. S = total number of species, J' = evenness, and H' = Shannon-Weiner index.

Region	Location	S	J'	H' (log_e)
Main Ridge	Pulley Ridge	22	0.6207	1.919
Off Reef	Pulley Ridge	9	0.4054	0.8908
Central Basin	Pulley Ridge	8	0.4593	0.955
West Ridge	Pulley Ridge	7	0.5122	0.9968
Soft Bottom	Tortugas	7	0.9299	1.81
Fringing Reef	Tortugas	10	0.6562	1.511
Patch Reef	Tortugas	13	0.7413	1.901
Miller's Ledge	Tortugas	8	0.5661	1.177

Lionfish

Lionfish (*Pterois volitans/miles*) were first discovered on Pulley Ridge during submersible dives in 2010 when six fish were observed and their densities have been significantly increasing since then. We observed a total of 1,885 lionfish during the course of this project including on and off transect times; 1,814 of these were observed at Pulley Ridge while only 71 were observed at the Tortugas. Most of these were associated with active red grouper pits in close proximity to the resident large red grouper and numerous small reef fish that assemble in masses in these holes as an oasis. Average densities of lionfish were significantly higher at Off Ridge sites compared to all other regions of Pulley Ridge and were significantly higher on Miller's Ledge compared to all other regions of the Tortugas (Fig. 29; One-way ANOVA: $p < 0.0001$).

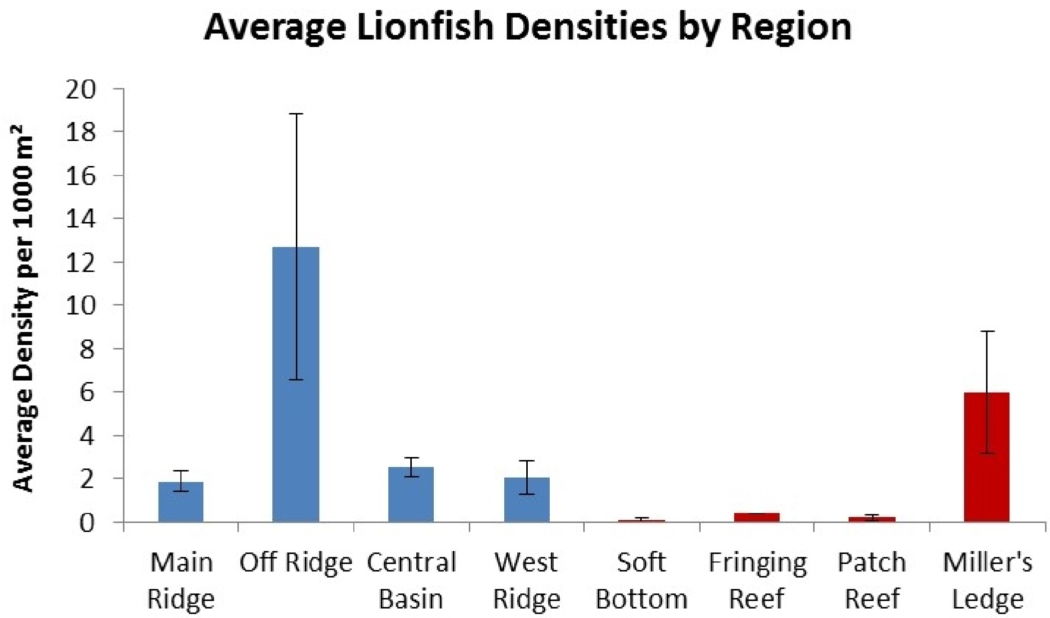

Figure 29. Average densities (#/1000m²) ± S.E. of lionfish by regions. Blue = Pulley Ridge regions. Red = Tortugas regions.

<u>Red Grouper Pits</u>

One of the main contributors to habitat structure at Pulley Ridge is pits (8-15 m in diameter and 1-2 m deep) excavated by red grouper providing habitat not only for them but for numerous other managed species and small reef fish. Using all the ROV data, both on and off transect times, 66 fish taxa were observed in the grouper pits, 16 of which were managed species. Fish species composition of the pits was not significantly different among regions (ANOSIM: Global R = 0.094, sample statistic = 1.1%), but was significantly different depending on what combination of predators was present. Red grouper and lionfish are the two top-level predators that inhabit the grouper pits and exhibit high site fidelity. To test the effect of predator presence on community structure, grouper pits were categorized as having either no predators (no lionfish or red grouper), lionfish only, red grouper only, or both (red grouper and lionfish present). Fish species composition was significantly different depending on the predator species present (Fig. 30; ANOSIM: Global R = 0.402, sample statistic < 0.01). Three significantly different groups resulted from the SIMPROF test ($P < 0.05$), indicated by the letters on the MDS. Grouper pits with lionfish only and both predators formed one group, meaning their fish assemblages were not significantly different from one another. Grouper pits with red grouper only formed their own group as did those with no predators indicating their fish assemblages were significantly different from all other groups. The groups clustered together in this fashion at 80% similarity, meaning the fish species composition of grouper pits with lionfish only and both predators was 80% similar. Pairwise tests using SIMPER demonstrated these differences were primarily due to three damselfish species (sunshinefish (*Chromis insolatus*), purple reeffish (*Chromis scotti*), and yellowtail reeffish (*Chromis enchrysurus*) and cardinalfish (*Apogon* spp.). These species as well as several others including scamp (*Mycteroperca phenax*), striped grunt (*Haemulon striatum*) and school bass (*Schultzea beta*) had higher abundances in grouper pits with either both predators or lionfish only, suggesting there was not a negative lionfish effect as many other studies have found. Red grouper pits are a unique habitat at Pulley Ridge and provide some of the only structural complexity suitable for habitat for both large predators and small reef fish. If the majority of fish are recruiting to these pits, it is conceivable that a lionfish effect may be observed.

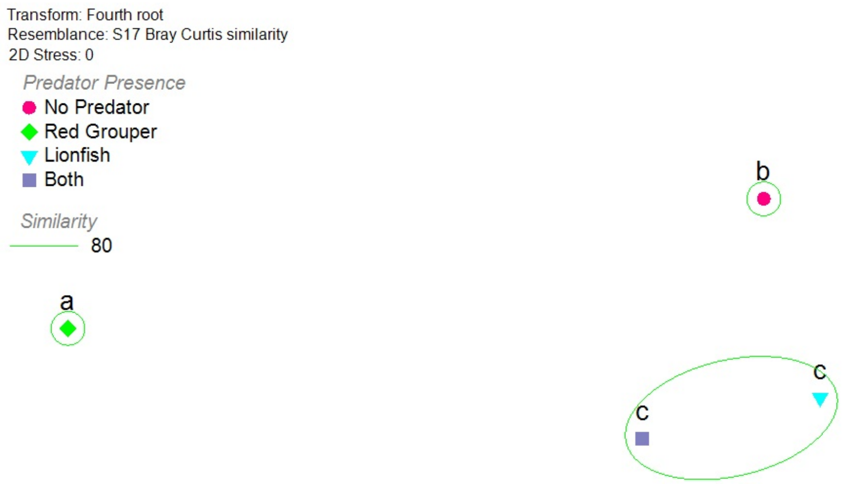

Figure 30. Multi-dimensional scaling (MDS) plot of blocks surveyed at Pulley Ridge based on Bray-Curtis similarity matrix of fish abundances averaged by predator presence category. Assemblage similarities at 80% are indicated with the statistically significant groups based on SIMPROF analysis (< 0.05) identified by letters.

SUMMARY AND CONCLUSIONS

This report summarizes ROV surveys during four cruises with the R/V *F.G. Walton Smith* from 2012 to 2015 which characterizes the mesophotic coral reef ecosystems at Pulley Ridge and Tortugas. This project documents and characterizes the mesophotic benthic habitat, benthic macrobiota, and fish populations within and adjacent to Pulley Ridge Habitat Area of Particular Concern (PR HAPC) and at sites adjacent to, but outside, the North and South Tortugas Ecological Reserves (TERs), and the Florida Keys National Marine Sanctuary (FKNMS).

ROV photographic/video surveys were conducted within 68 1-km^2 random Blocks at southern Pulley Ridge, and 21 Blocks in the region of the Tortugas. A total of 91 ROV dives covered a distance of 150 km at depths from 22.9 to 114.4 m. A total of 237 hours of ROV video were recorded and 17,888 in situ digital images were taken which included quantitative transect images (16,071), and video frame grabs of general habitat images and species documentation images. Individual Cruise Reports (Reed et al. 2012a, 2012b, 2012c, 2014, 2015, 2016a, 2017) for each cruise provided detailed SEADESC (Southeastern United States Deep-Sea Corals) characterization of the benthic habitat and benthic macrobiota for each ROV dive site.

These data may be compared to previous and future research cruises to better understand the long-term health and status of these important mesophotic ecosystems. These data will be of value to the regional Fishery Management Councils, NOAA Fisheries, NOAA Mesophotic Reef Ecosystem Program, NOAA Deep-sea Coral Research and Technology Program (DSCRTP), NOAA Coral Reef Conservation Program (CRCP), and NOAA Marine Sanctuaries for management decisions on these habitats and managed key species. These data will be critical to the various agencies and researchers by documenting deep-water coral/sponge habitat and Essential Fish Habitat (EFH) that are currently unprotected and are under consideration for expansion of the marine protected areas at Pulley Ridge and the Tortugas.

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APPENDIX 1

ROV station summary for all Blocks surveyed at Pulley Ridge and Tortugas during the 2012-2015 R/V *F.G. Walton Smith* cruises.

Area/Region/Block	(Total Blocks) ROV Number	Year	Center Latitude	Center Longitude	Max Depth (m)	Min Depth (m)
Pulley Ridge	**(68)**					
Main Ridge	**(24)**					
Main Ridge- North	(6)					
Block #001	ROV 13-07	2013	24.96677	-83.61687	-73.2	-69.1
Block #002	ROV 13-08 & ROV 13-13	2013	24.95279	-83.63283	-70.5	-61.2
Block #003	ROV 12-12	2012	24.91878	-83.64610	-69.1	-67.4
Block #004	ROV 13-05	2013	24.90178	-83.65272	-69.1	-60.3
Block #005	ROV 13-06	2013	24.89630	-83.66536	-72.2	-63.7
Block #078	ROV 15-02	2015	24.93880	-83.64878	-66.4	-59.3
Main Ridge- Middle	(8)					
Block #006	ROV 13-02	2013	24.85625	-83.65997	-70.8	-61.8
Block #007	ROV 13-04	2013	24.84226	-83.67591	-69.1	-61.0
Block #008	ROV 12-14	2012	24.82224	-83.67322	-66.2	-62.8
Block #009	ROV 12-13	2012	24.81676	-83.68584	-68.9	-62.8
Block #010	ROV 12-11	2012	24.79371	-83.67383	-67.8	-63.3
Block #011	ROV 12-08	2012	24.79125	-83.69577	-72.2	-66.4
Block #080	ROV 15-03	2015	24.86777	-83.66598	-66.5	-62.0
Block #084	ROV 15-02	2015	24.78823	-83.68645	-65.8	-61.3
Main Ridge- South	(10)					
Block #012	ROV 12-10	2012	24.77122	-83.69307	-66.4	-63.9
Block #013	ROV 12-07	2012	24.75724	-83.70900	-68.3	-63.5
Block #014	ROV 12-09	2012	24.74572	-83.70300	-66.6	-64.5
Block #015	ROV 12-03	2012	24.73475	-83.72823	-71.0	-68.7
Block #016	ROV 12-06	2012	24.72569	-83.70030	-67.4	-65.3
Block #017	ROV 12-05	2012	24.72625	-83.73154	-70.5	-68.3
Block #018	ROV 12-01 & ROV 15-01	2012 & 2015	24.72323	-83.72223	-66.8	-64.2
Block #019	ROV 12-02	2012	24.72378	-83.75346	-75.5	-71.2
Block #020	ROV 13-14	2013	24.70018	-83.71022	-68.5	-64.5
Block #033	ROV 13-15	2013	24.71115	-83.68499	-68.7	-66.2
Central Basin	**(25)**					
Central Basin- North	(9)					
Block #022	ROV 13-10	2013	24.83432	-83.71048	-81.4	-77.4
Block #024	ROV 13-10	2013	24.82280	-83.70448	-83.0	-79.7
Block #025	ROV 14-01	2014	24.81183	-83.72972	-80.1	-76.5
Block #026	ROV 13-09	2013	24.80579	-83.71109	-82.6	-76.8
Block #076	ROV 14-11	2014	24.82993	-83.78561	-81.8	-79.0
Block #077	ROV 14-12	2014	24.82745	-83.80755	-81.1	-78.3
Block #086	ROV 15-05 & ROV 15-06	2015	24.84640	-83.74773	-81.5	-80.5
Block #087	ROV 15-04	2015	24.85435	-83.71318	-79.4	-77.5
Block #088	ROV 15-06	2015	24.84940	-83.75705	-81.1	-78.9
Central Basin- South	(16)					
Block #028	ROV 14-05	2014	24.78879	-83.71771	-79.4	-76.7
Block #029	ROV 14-02	2014	24.78330	-83.73033	-80.8	-77.1
Block #030	ROV 14-07	2014	24.75477	-83.73093	-75.7	-72.4
Block #031	ROV 14-14	2014	24.75532	-83.76217	-77.2	-75.8
Block #082	ROV 14-14	2014	24.75837	-83.77155	-78.6	-76.5

Area/Region/Block	(Total Blocks) ROV Number	Year	Center Latitude	Center Longitude	Max Depth (m)	Min Depth (m)
Block #083	ROV 14-15	2014	24.76435	-83.78997	-82.1	-80.2
Block #090	ROV 15-10	2015	24.77837	-83.77417	-81.0	-78.4
Block #091	ROV 15-13	2015	24.74435	-83.78738	-78.8	-77.0
Block #092	ROV 15-07 & ROV 15-08	2015	24.78083	-83.75227	-78.9	-77.0
Block #093	ROV 15-09	2015	24.74682	-83.76547	-76.7	-73.8
Block #094	ROV 15-12	2015	24.76190	-83.81202	-79.9	-77.9
Block #095	ROV 15-11	2015	24.79838	-83.77688	-81.6	-79.1
Block #096	ROV 15-09	2015	24.74380	-83.75617	-76.3	-72.4
Block #117	ROV 15-21	2015	24.77287	-83.78679	-81.1	-79.6
Block #118	ROV 15-21	2015	24.76738	-83.79940	-81.4	-80.2
Block #120	ROV 15-20	2015	24.76136	-83.78078	-80.7	-78.5
West Ridge	**(15)**					
West Ridge- North	(7)					
Block #034	ROV 14-08	2014	24.92702	-83.78986	-84.4	-78.9
Block #035	ROV 14-08	2014	24.92153	-83.80249	-80.6	-77.6
Block #036	ROV 14-09	2014	24.90452	-83.80909	-81.5	-76.8
Block #037	ROV 14-10	2014	24.89053	-83.82502	-81.7	-78.0
Block #106	ROV 15-18	2015	24.86750	-83.81298	-85.7	-82.1
Block #107	ROV 15-17	2015	24.89000	-83.79375	-85.2	-80.4
Block #109	ROV 15-18	2015	24.85898	-83.81628	-84.3	-82.4
West Ridge- South	(8)					
Block #038	ROV 13-11	2013	24.85952	-83.84755	-87.2	-80.1
Block #039	ROV 13-12	2013	24.85402	-83.86017	-93.9	-80.5
Block #040	ROV 13-12	2013	24.84552	-83.86346	-89.9	-86.0
Block #079	ROV 14-13	2014	24.83649	-83.83550	-86.1	-79.8
Block #097	ROV 15-14	2015	24.78983	-83.85299	-82.7	-78.5
Block #099	ROV 15-16	2015	24.83152	-83.87938	-93.6	-88.5
Block #100	ROV 15-15	2015	24.82550	-83.86073	-89.0	-83.8
Block #101	ROV 15-15	2015	24.81700	-83.86403	-86.5	-83.6
Off Reef	**(4)**					
Block #021	ROV 13-03	2013	24.83017	-83.63864	-68.5	-66.2
Block #023	ROV 14-04	2014	24.81015	-83.63596	-68.1	-65.5
Block #027	ROV 14-03	2014	24.77916	-83.65852	-68.9	-64.7
Block #032	ROV 14-06 & ROV 14-16	2014	24.71058	-83.65376	-65.1	-63.1
Tortugas	**(23)**					
Millers Ledge	(2)					
Block #074	ROV 14-18	2014	24.47325	-83.21469	-114.4	-81.0
Block #075	ROV 14-17	2014	24.48231	-83.24429	-111.5	-79.7
Fringing Reef	(1)					
Block #046	ROV 14-23	2014	24.63559	-83.10631	-31.5	-26.0
Patch Reef	(8)					
Block #050	ROV 13-18	2013	24.57235	-83.07663	-27.4	-23.3
Block #051	ROV 13-26	2013	24.53620	-83.05687	-34.1	-31.8
Block #052	ROV 13-27	2013	24.53611	-83.01740	-31.6	-27.6
Block #058	ROV 13-23 & ROV 13-30	2013	24.47279	-82.96807	-40.1	-32.4
Block #059	ROV 13-22	2013	24.46385	-82.99766	-49.1	-41.8

Area/Region/Block	(Total Blocks) ROV Number	Year	Center Latitude	Center Longitude	Max Depth (m)	Min Depth (m)
Block #061	ROV 14-20	2014	24.52706	-83.00753	-32.0	-29.2
Block #066	ROV 14-19	2014	24.54519	-83.03714	-26.8	-22.9
Block #068	ROV 14-19	2014	24.53614	-83.02727	-28.8	-26.0
Soft Bottom	(12)					
Block #042	ROV 13-24	2013	24.75295	-83.11632	-56.0	-54.9
Block #045	ROV 13-16	2013	24.67173	-83.12610	-56.8	-55.5
Block #048	ROV 13-17	2013	24.60856	-83.13590	-54.1	-52.0
Block #053	ROV 13-28	2013	24.50914	-83.06672	-43.1	-41.6
Block #054	ROV 13-20	2013	24.49111	-83.07658	-46.8	-41.8
Block #055	ROV 13-29	2013	24.49098	-83.01739	-39.9	-38.5
Block #057	ROV 13-21	2013	24.47305	-83.07657	-55.3	-50.3
Block #060	ROV 13-23	2013	24.46374	-82.95821	-44.1	-39.9
Block #063	ROV 14-22	2014	24.59947	-83.09640	-33.7	-30.5
Block #067	ROV 14-24	2014	24.51801	-82.99767	-29.3	-27.3
Block #069	ROV 14-21	2014	24.57233	-83.06676	-31.1	-29.4
Block #070	ROV 14-24	2014	24.50898	-82.99766	-31.7	-28.5

APPENDIX 2

Species list and percent cover (from CPCe Point Count analysis of quantitative ROV photographs) of benthic macro-invertebrates and macro-algae for each Block surveyed at Pulley Ridge during the 2012-2015 R/V *F.G. Walton Smith* cruises.

	Main Ridge- North						Main Ridge- Middle	
	Block #001	Block #002	Block #003	Block #004	Block #005	Block #078	Block #006	Block #007
Taxa	31.29%	35.78%	51.57%	59.71%	60.00%	34.13%	62.61%	64.80%
Coral	0.15%	0.08%	0.27%	0.24%	0.17%	0.07%	0.10%	0.03%
Agaricia fragilis Dana, 1848	0.02%	0.00%	0.05%	0.03%	0.00%	0.00%	0.00%	0.00%
Agaricia grahamae Wells, 1973	0.00%	0.00%	0.00%	0.12%	0.13%	0.00%	0.00%	0.00%
Helioseris cucullata (Ellis & Solander, 1786)	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%
Madracis brueggemanni (Ridley, 1881)	0.10%	0.02%	0.00%	0.03%	0.00%	0.05%	0.00%	0.00%
Madracis decactis (Lyman, 1859)	0.00%	0.02%	0.02%	0.02%	0.03%	0.02%	0.02%	0.03%
Madracis formosa Wells, 1973	0.03%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
Montastraea cavernosa (Linnaeus, 1767)	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%
Oculina diffusa Lamarck, 1816	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scleractinia- unid colonial	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Agaricia sp.	0.00%	0.02%	0.00%	0.02%	0.00%	0.00%	0.03%	0.00%
Madracis sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scolymia sp.	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Porifera	1.04%	0.79%	1.60%	1.43%	1.16%	0.72%	1.22%	1.09%
Agelas citrina Gotera & Alcolado, 1987	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Agelas clathrodes (Schmidt, 1870)	0.02%	0.00%	0.00%	0.03%	0.05%	0.00%	0.00%	0.03%
Agelas conifera (Schmidt, 1870)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Aiolochroia crassa (Hyatt, 1875)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Amphimedon compressa Duchassaing & Michelotti, 1864	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Aplysina bathyphila Maldonado & Young, 1998	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Aplysina lacunosa (Lamarck, 1814)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX 3

Species list and percent cover (from CPCe Point Count analysis of quantitative ROV photographs) of benthic macro-invertebrates and macro-algae for each Block surveyed at Tortugas during the 2012-2015 R/V *F.G. Walton Smith* cruises.

Tortugas	Miller's Ledge		Fringing Reef	Patch Reef								Soft Bottom												
	Block #074	Block #075	Block #046	Block #050	Block #051	Block #052	Block #058	Block #059	Block #061	Block #066	Block #068	Block #042	Block #045	Block #048	Block #053	Block #054	Block #055	Block #057	Block #060	Block #063	Block #067	Block #069	Block #070	Total
Taxa	5.34%	4.04%	58.06%	42.48%	19.02%	37.50%	24.47%	12.85%	19.91%	13.50%	40.43%	3.73%	2.71%	0.75%	79.14%	65.01%	59.00%	35.62%	11.32%	28.73%	10.49%	13.34%	20.98%	26.55%
Coral	0.02%	0.00%	3.96%	0.17%	0.12%	0.47%	0.24%	0.02%	0.25%	0.07%	1.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.31%
Agaricia agaricites (Linnaeus, 1758)	0.00%	0.00%	0.10%	0.00%	0.12%	0.03%	0.14%	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%	0.02%
Colpophyllia natans (Houttuyn, 1772)	0.00%	0.00%	0.05%	0.00%	0.00%	0.03%	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%	0.00%	0.00%	0.00%	0.00%
Helioseris cucullata (Ellis & Solander, 1786)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Manicina areolata (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%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Meandrina meandrites (Linnaeus, 1758)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.05%	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%
Millepora alcicornis Linnaeus, 1758	0.00%	0.00%	0.03%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	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%
Montastraea cavernosa (Linnaeus, 1767)	0.00%	0.00%	2.07%	0.02%	0.00%	0.13%	0.02%	0.00%	0.12%	0.00%	1.09%	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%
Mycetophyllia aliciae Wells, 1973	0.00%	0.00%	0.08%	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%	0.00%	0.00%	0.00%	0.00%
Orbicella faveolata (Ellis & Solander, 1786)	0.00%	0.00%	0.22%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	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%	0.01%
Orbicella franksi (Gregory, 1895)	0.00%	0.00%	0.10%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Porites astreoides Lamarck, 1816	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scleractinia- unid colonial	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scleractinia- unid solitary	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Siderastrea radians (Pallas, 1766)	0.00%	0.00%	0.05%	0.07%	0.00%	0.17%	0.09%	0.00%	0.00%	0.02%	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%	0.02%
Siderastrea siderea (Ellis & Solander, 1768)	0.00%	0.00%	0.87%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.10%	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%
Solenastrea bournoni Milne Edwards & Haime, 1849	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Stephanocoenia intersepta (Lamarck, 1836)	0.00%	0.00%	0.25%	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%	0.00%	0.00%	0.01%
Agaricia sp.	0.00%	0.00%	0.05%	0.00%	0.00%	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%	0.00%
Mycetophyllia sp.	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Porifera	3.02%	2.38%	6.22%	0.86%	1.49%	1.87%	3.26%	2.30%	1.17%	0.80%	2.86%	0.18%	0.00%	0.02%	0.00%	0.00%	0.02%	0.39%	0.96%	0.15%	0.32%	0.13%	0.32%	1.25%
Agelas clathrodes (Schmidt, 1870)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Agelas conifera (Schmidt, 1870)	0.00%	0.00%	0.45%	0.00%	0.00%	0.00%	0.10%	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%	0.02%
Agelas wiedenmayeri Alcolado, 1984	0.00%	0.00%	0.10%	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%	0.00%	0.00%	0.00%
Aiolochroia crassa (Hyatt, 1875)	0.02%	0.00%	0.00%	0.03%	0.02%	0.02%	0.00%	0.00%	0.05%	0.00%	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%	0.01%
Amphimedon compressa Duchassaing & Michelotti, 1864	0.00%	0.00%	0.15%	0.02%	0.00%	0.03%	0.02%	0.12%	0.03%	0.00%	0.18%	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%
Aplysina cauliformis Duchassaing & Michelotti, 1864	0.00%	0.00%	0.32%	0.03%	0.00%	0.20%	0.36%	0.00%	0.00%	0.02%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%
Aplysina fulva (Pallas, 1766)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	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%
Axinellidae	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Callyspongia fallax Duchassaing & Michelotti, 1864	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Callyspongia plicifera (Lamarck, 1814)	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.07%	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%	0.01%
Callyspongia vaginalis (Lamarck, 1814)	0.00%	0.00%	0.00%	0.02%	0.02%	0.07%	0.07%	0.03%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.02%	0.00%	0.02%
Chondrilla nucula Schmidt, 1862	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.13%	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%	0.00%	0.01%
Cliona delitrix Pang, 1973	0.00%	0.00%	0.22%	0.00%	0.00%	0.07%	0.03%	0.00%	0.03%	0.00%	0.13%	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%
Cliona varians (Duchassaing & Michelotti, 1864)	0.00%	0.00%	0.05%	0.10%	0.00%	0.35%	0.14%	0.02%	0.02%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.04%
Demospongiae	2.40%	1.37%	0.58%	0.22%	0.18%	0.13%	0.41%	0.74%	0.18%	0.13%	0.30%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.17%	0.52%	0.00%	0.00%	0.00%	0.07%	0.33%
Demospongiae- TER01	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%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Demospongiae- TER02	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%	0.00%	0.00%	0.00%	0.00%	0.00%
Demospongiae- TER03	0.00%	0.00%	0.00%	0.00%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Demospongiae- TER04	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%	0.00%	0.00%	0.00%	0.00%	0.00%
Desmapsamma anchorata (Carter, 1882)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.26%	0.18%	0.18%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%
Dictyoceratida	0.10%	0.02%	0.00%	0.00%	0.02%	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%	0.00%	0.01%
Dysidea etheria de Laubenfels, 1936	0.00%	0.00%	0.00%	0.02%	0.12%	0.00%	0.10%	0.00%	0.00%	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.02%	0.05%	0.00%	0.00%	0.00%	0.00%	0.02%
Geodia neptuni complex	0.00%	0.00%	0.15%	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%	0.00%	0.00%	0.01%
Hadromerida	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Iotrochota birotulata (Higgin, 1877)	0.00%	0.00%	0.38%	0.00%	0.08%	0.34%	0.19%	0.02%	0.15%	0.00%	0.30%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.07%
Ircinia campana (Lamarck, 1814)	0.00%	0.00%	0.00%	0.03%	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%	0.00%	0.00%	0.00%	0.00%	0.00%
Ircinia felix (Duchassaing & Michelotti, 1864)	0.00%	0.00%	0.00%	0.13%	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%	0.00%	0.01%
Ircinia strobilina (Lamarck, 1816)	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.01%
Monanchora arbuscula (Duchassaing & Michelotti, 1864)	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.02%	0.03%	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%
Mycale laxissima (Duchassaing & Michelotti, 1864)	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.02%	0.00%	0.00%	0.00%	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%	0.01%
Niphates digitalis (Lamarck, 1814)	0.00%	0.00%	0.08%	0.02%	0.05%	0.07%	0.00%	0.02%	0.00%	0.02%	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%	0.01%
Niphates erecta Duchassaing & Michelotti, 1864	0.00%	0.00%	0.27%	0.13%	0.23%	0.35%	0.16%	0.22%	0.00%	0.07%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.02%	0.00%	0.07%
Niphatidae	0.00%	0.00%	0.02%	0.05%	0.00%	0.00%	0.00%	0.13%	0.00%	0.03%	0.22%	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%
Poecilosclerida	0.13%	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%	0.00%	0.00%	0.00%	0.00%	0.01%
Poecilosclerida- TER1	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Spheciospongia vesparium (Lamarck, 1815)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.05%	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%
Spirastrellidae	0.10%	0.80%	0.32%	0.05%	0.02%	0.02%	0.07%	0.02%	0.03%	0.02%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.09%	0.00%	0.00%	0.00%	0.00%	0.07%
Svenzea zeai (Alvarez, van Soest & Rützler, 1998)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tectitethya crypta (de Laubenfels, 1949)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Verongula rigida (Esper, 1794)	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.22%	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%	0.01%
Verongula- TER1	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Xestospongia muta (Schmidt, 1870)	0.00%	0.00%	2.09%	0.00%	0.64%	0.00%	0.71%	0.10%	0.12%	0.05%	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%	0.17%
Agelas sp.	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.03%	0.00%	0.02%	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%	0.00%	0.01%
Amphimedon- TER1	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%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%
Aplysina sp.	0.00%	0.00%	0.07%	0.00%	0.03%	0.02%	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%	0.01%
Auletta sp.	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Callyspongia sp.	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Chondrosia sp.	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	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%
Cinachyrella sp.	0.15%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Geodia sp.	0.00%	0.00%	0.10%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Haliclona sp.	0.00%	0.00%	0.00%	0.00%	0.02%	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%	0.00%
Haliclona- TER1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.32%	0.02%	0.25%	0.04%
Ircinia sp.	0.05%	0.07%	0.07%	0.00%	0.00%	0.05%	0.00%	0.03%	0.07%	0.05%	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%	0.02%
Niphates sp.	0.02%	0.00%	0.33%	0.00%	0.00%	0.08%	0.03%	0.18%	0.22%	0.17%	0.30%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.06%
Placospongia sp.	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.13%	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%	0.01%
Polymastia sp.	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Verongula sp.	0.00%	0.00%	0.10%	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%	0.00%	0.00%	0.01%
Alcyonacea- gorgonian	0.03%	0.23%	8.82%	10.24%	0.60%	4.26%	1.65%	1.68%	1.27%	0.92%	8.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.17%	0.00%	0.00%	0.00%	0.02%	0.00%	1.66%
Alcyonacea- gorgonian	0.02%	0.00%	0.00%	0.07%	0.02%	0.00%	0.02%	0.07%	0.03%	0.10%	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%	0.01%
Briareum asbestinum (Pallas, 1766)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Carijoa riisei (Duchassaing & Michelotti, 1860)	0.02%	0.23%	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%	0.00%	0.00%	0.00%	0.01%
Ellisella barbadensis (Duchassaing & Michelotti, 1864)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Erythropodium caribaeorum (Duchassaing & Michelotti, 1860)	0.00%	0.00%	1.85%	0.12%	0.00%	0.00%	0.31%	0.00%	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%	0.10%
Eunicea sp.	0.00%	0.00%	0.22%	0.07%	0.44%	0.15%	0.10%	0.54%	0.32%	0.15%	0.85%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.12%
Iciligorgia schrammi Duchassaing, 1870	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Plexaura kukenthali Moser, 1921	0.00%	0.00%	0.00%	0.00%	0.12%	0.67%	0.09%	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%	0.04%
Primnoidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Pterogorgia anceps (Pallas, 1766)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.15%	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%
Pterogorgia citrina (Esper, 1792)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Ellisella sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	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%	0.01%

Tortugas	Miller's Ledge		Fringing Reef	Patch Reef								Soft Bottom												
Muricea sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.15%	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%	0.01%
Muriceopsis sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.42%	0.07%	1.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%
Pseudoplexaura sp.	0.00%	0.00%	0.03%	0.00%	0.02%	0.77%	0.05%	0.20%	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%	0.05%
Pseudopterogorgia sp.	0.00%	0.00%	6.72%	9.99%	0.02%	2.52%	1.09%	0.47%	0.27%	0.40%	6.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	1.20%
Alcyonacea- Alcyoniina	0.02%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Alcyoniina	0.02%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cnidaria non-coral	0.40%	0.18%	0.02%	0.17%	0.05%	0.00%	0.09%	0.52%	0.07%	0.03%	0.00%	0.02%	2.53%	0.55%	0.00%	0.00%	0.02%	0.40%	0.24%	0.00%	0.00%	0.02%	0.02%	0.22%
Actiniaria	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cerianthidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Hydroidolina	0.38%	0.15%	0.00%	0.17%	0.05%	0.00%	0.05%	0.52%	0.07%	0.03%	0.00%	0.02%	2.16%	0.52%	0.00%	0.00%	0.02%	0.40%	0.24%	0.00%	0.00%	0.02%	0.02%	0.20%
Hydroidolina- TER1	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Hydroidolina- TER2	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Palythoa caribaeorum (Duchassaing & Michelotti, 1860)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Zoanthidae	0.00%	0.02%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Annelida	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.32%	0.00%	0.32%	0.03%
Hermodice carunculata (Pallas, 1766)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sabellidae	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%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%
Filograna sp.	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%	0.00%	0.00%	0.00%	0.00%	0.30%	0.00%	0.32%	0.03%
Mollusca	0.00%	0.00%	0.02%	0.02%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%	0.01%
Bivalvia	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%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Gastropoda	0.00%	0.00%	0.02%	0.02%	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%	0.02%	0.00%
Pectinidae	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Arthropoda	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Brachyura	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bryozoa	0.00%	0.03%	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%	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Bryozoa	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%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Schizoporella sp.	0.00%	0.02%	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%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Echinodermata	0.17%	0.20%	0.02%	0.00%	0.07%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.13%	0.02%	0.13%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%
Clypeasteroida	0.00%	0.00%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Comatulida	0.05%	0.18%	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%	0.00%	0.00%	0.00%	0.01%
Davidaster discoideus (Carpenter, 1888)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Echinoidea	0.00%	0.02%	0.02%	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Eucidaris tribuloides (Lamarck, 1816)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.13%	0.02%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Goniaster tessellatus (Lamarck, 1816)	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%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Luidia alternata (Say, 1825)	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Chordata	0.40%	0.28%	0.02%	0.08%	0.15%	0.12%	1.15%	1.24%	0.03%	0.00%	0.03%	0.03%	0.00%	0.00%	0.00%	0.08%	0.02%	0.67%	0.70%	0.02%	0.12%	0.00%	0.29%	0.24%
Actinopterygii	0.00%	0.00%	0.02%	0.00%	0.02%	0.00%	0.05%	0.00%	0.03%	0.00%	0.03%	0.03%	0.00%	0.00%	0.00%	0.08%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.01%
Ascidiacea	0.37%	0.13%	0.00%	0.07%	0.13%	0.10%	1.05%	1.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.66%	0.02%	0.12%	0.00%	0.27%	0.18%
Didemnidae	0.03%	0.15%	0.00%	0.02%	0.00%	0.02%	0.05%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.59%	0.03%	0.00%	0.00%	0.00%	0.00%	0.04%
Chlorophyta	0.28%	0.13%	21.20%	25.81%	4.21%	21.16%	4.84%	1.46%	3.76%	4.28%	8.42%	0.03%	0.00%	0.00%	3.30%	0.20%	9.60%	0.03%	0.16%	27.17%	7.51%	3.58%	4.82%	6.64%
Anadyomene saldanhae A.B.Joly & E.C.Oliveira, 1969	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.64%	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%	0.03%
Caulerpa brachypus A.B.Joly & Semir	0.00%	0.00%	0.00%	0.00%	0.30%	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%	0.01%
Caulerpa prolifera (Forsskål) J.V.Lamouroux, 1809	0.00%	0.00%	0.00%	0.00%	0.49%	0.00%	0.00%	0.00%	0.42%	0.03%	0.00%	0.00%	0.00%	0.00%	2.95%	0.18%	0.63%	0.00%	0.00%	18.83%	0.49%	0.18%	0.08%	1.07%
Caulerpa racemosa (Forsskål) J.Agardh, 1873	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%	0.00%	0.00%	0.55%	0.00%	0.03%	0.03%
Caulerpa sertularioides (S.G.Gmelin) M.A.Howe, 1905	0.00%	0.00%	0.00%	0.00%	0.57%	0.00%	0.00%	0.00%	1.15%	0.13%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	4.52%	0.00%	0.00%	7.00%	2.17%	0.12%	0.74%	0.73%
Chlorophyta	0.25%	0.10%	0.03%	0.13%	0.00%	0.00%	0.03%	0.03%	0.10%	0.65%	4.86%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.02%	0.33%	0.18%	0.03%	0.15%	0.31%
Chlorophyta- Turf Algae	0.00%	0.00%	21.12%	17.99%	2.65%	20.35%	4.48%	0.12%	1.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.30%	0.00%	0.00%	0.00%	0.00%	0.28%	0.00%	3.16%
Halimeda goreaui W.R.Taylor, 1962	0.00%	0.00%	0.00%	0.08%	0.03%	0.35%	0.16%	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%	0.03%
Halophila decipiens Ostenfeld, 1902	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.35%	1.66%	2.42%	0.20%	0.21%
Penicillus dumetosus (J.V.Lamouroux) Blainville, 1830	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.57%	1.28%	0.53%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.74%	0.15%	0.91%	0.19%
Valonia ventricosa J.Agardh, 1887	0.00%	0.00%	0.00%	0.02%	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%	0.00%	0.00%
Verdigellas peltata D.L.Ballantine & J.N.Norris, 1994	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%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
Caulerpa sp.	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.01%
Cladophora sp.	0.00%	0.00%	0.00%	7.38%	0.00%	0.34%	0.00%	0.00%	0.00%	0.03%	2.42%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.45%
Codium sp.	0.02%	0.03%	0.02%	0.02%	0.00%	0.03%	0.10%	0.07%	0.00%	0.02%	0.02%	0.03%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
Halimeda sp.	0.02%	0.00%	0.03%	0.18%	0.12%	0.07%	0.02%	0.08%	0.20%	0.23%	0.40%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.03%	0.07%	0.20%	0.13%	0.22%	0.09%
Microdictyon sp.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%	0.02%
Udotea sp.	0.00%	0.00%	0.00%	0.00%	0.03%	0.02%	0.00%	0.07%	0.13%	1.82%	0.18%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.50%	1.48%	0.25%	2.45%	0.30%
Phaeophyceae	0.02%	0.00%	14.02%	3.43%	0.35%	0.32%	0.22%	0.05%	4.63%	0.67%	7.12%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.22%	0.00%	1.36%
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	0.00%	0.00%	4.14%	0.00%	0.00%	0.05%	0.02%	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%	0.19%
Phaeophyceae	0.02%	0.00%	0.15%	0.10%	0.00%	0.00%	0.00%	0.00%	0.02%	0.17%	0.63%	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%
Dictyota sp.	0.00%	0.00%	9.72%	0.25%	0.13%	0.24%	0.21%	0.02%	4.60%	0.40%	6.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.22%	0.00%	0.97%
Padina sp.	0.00%	0.00%	0.00%	0.02%	0.00%	0.03%	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%	0.00%
Sargassum sp.	0.00%	0.00%	0.00%	3.06%	0.22%	0.00%	0.00%	0.03%	0.00%	0.10%	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%	0.15%
Rhodophyta	0.65%	0.37%	3.27%	0.20%	0.22%	0.08%	10.93%	3.27%	0.05%	0.43%	0.25%	2.47%	0.04%	0.00%	75.82%	64.71%	0.35%	33.87%	8.38%	0.00%	0.00%	0.00%	0.00%	8.94%
Corallinales (crustose coralline)	0.63%	0.22%	2.82%	0.15%	0.00%	0.08%	0.00%	0.12%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.18%
Martensia pavonia (J.Agardh) J.Agardh, 1863	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	2.43%	0.00%	0.00%	75.68%	64.63%	0.00%	33.64%	0.03%	0.00%	0.00%	0.00%	0.00%	7.70%
Rhodophyta	0.02%	0.13%	0.38%	0.03%	0.15%	0.00%	1.26%	0.05%	0.05%	0.43%	0.20%	0.03%	0.02%	0.00%	0.13%	0.08%	0.15%	0.08%	0.96%	0.00%	0.00%	0.00%	0.00%	0.18%
Rhodophyta- TER1	0.00%	0.00%	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%	0.00%	0.00%	0.00%	0.70%	0.00%	0.00%	0.00%	0.00%	0.03%
Rhodophyta- TER2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.66%	0.00%	0.00%	0.00%	0.00%	0.05%
Gracilaria 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%	0.10%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.01%
Halymenia sp.	0.00%	0.02%	0.07%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Kallymenia sp.	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	9.06%	3.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.96%	0.00%	0.00%	0.00%	0.00%	0.77%
Cyanobacteria	0.00%	0.00%	0.23%	0.71%	9.53%	8.92%	1.91%	1.74%	1.67%	0.83%	3.32%	0.45%	0.00%	0.00%	0.00%	0.00%	49.00%	0.03%	0.80%	0.88%	0.34%	0.23%	2.17%	3.62%
Unidentified Organism	0.05%	0.05%	0.05%	0.13%	0.05%	0.03%	0.03%	0.17%	0.12%	0.07%	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.02%	0.04%
Natural detritus	0.27%	0.15%	0.22%	0.67%	2.18%	0.27%	0.12%	0.39%	6.86%	5.40%	8.67%	0.29%	0.11%	0.02%	0.00%	0.02%	0.00%	0.02%	0.05%	0.52%	1.87%	9.13%	13.02%	2.20%
Non-Fauna	0.07%	0.10%	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%	0.02%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%
Human debris	0.07%	0.10%	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%	0.02%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%
Fishing line/long line	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Human debris- Other	0.03%	0.10%	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%	0.02%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%
Substrate	94.60%	95.86%	41.90%	57.52%	80.98%	62.50%	75.53%	87.15%	80.09%	86.50%	59.57%	96.27%	97.29%	99.25%	20.86%	34.99%	40.98%	64.38%	88.68%	71.25%	89.51%	86.66%	79.02%	73.44%
Bare hard bottom	61.46%	61.47%	38.06%	28.92%	7.99%	14.48%	14.04%	16.21%	4.16%	8.47%	20.33%	2.43%	0.23%	0.17%	0.00%	0.37%	0.02%	3.58%	2.63%	0.15%	0.64%	1.34%	1.19%	12.59%
Bare dead coral plate	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%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bare rock	20.38%	11.22%	29.16%	0.35%	3.17%	8.89%	8.98%	3.25%	2.71%	1.95%	12.36%	0.00%	0.02%	0.00%	0.00%	0.28%	0.00%	0.59%	0.30%	0.03%	0.15%	0.02%	0.54%	4.56%
Bare rubble/cobble	41.09%	50.24%	8.84%	28.56%	4.83%	5.59%	5.07%	12.95%	1.45%	6.52%	7.97%	2.43%	0.22%	0.17%	0.00%	0.08%	0.02%	2.99%	2.33%	0.12%	0.49%	1.32%	0.66%	8.03%
Bare soft bottom	33.13%	34.39%	3.84%	28.60%	72.99%	48.02%	61.49%	70.94%	75.92%	78.03%	39.24%	93.84%	97.05%	99.08%	20.86%	34.62%	40.97%	60.80%	86.05%	71.10%	88.88%	85.32%	77.83%	60.85%
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%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

APPENDIX 4

Species list and densities (number/km) of each fish species for each Block observed in ROV video transects at Pulley Ridge during the 2012-2015 R/V *F.G. Walton Smith* cruises.

Pulley Ridge Class/Family/Taxa - common name	Main Ridge- North Block #001	Block #002	West Ridge- South Block #039	Block #040	Block #079	Block #099	Block #100	Block #101	Grand Total
Actinopteri									
-									
Actinopteri - Fish unid.	0.4	0.4	0.4	0.4	111.2	1.6	1.6	31.2	1893.2
Acanthuridae									
Acanthurus tractus Poey, 1860- Ocean Surgeonfish						0.8			0.8
Apogonidae									
Apogon affinis (Poey, 1875)- Bigtooth Cardinalfish									140.0
Apogon pseudomaculatus Longley, 1932 - Twospot Cardinalfish					0.4				3.6
Apogon spp. - Cardinalfish unid.									207.8
Balistidae									
Balistes capriscus Gmelin, 1789- Grey Triggerfish									0.4
Balistes vetula Linnaeus, 1758- Queen Triggerfish									2.3
Balistidae - Filefish unid.						0.4			0.8
Canthidermis sufflamen (Mitchill, 1815)- Ocean Triggerfish									0.4
Bothidae									
Bothidae - Flounder unid.						0.4			0.4
Carangidae									
Carangidae - Unidentified Jack									2.8
Caranx spp. - Jack							2.0		2.4
Decapterus macarellus (Cuvier, 1833)- Mackerel Scad									61.6
Decapterus spp. - Scad									48.0
Seriola dumerili (Risso, 1810)- Greater Amberjack									3.2
Seriola rivoliana Valenciennes, 1833- Almaco Jack									22.0
Seriola spp. - Amberjack		0.4				0.8		0.8	13.2
Chaetodontidae									
Chaetodon ocellatus Bloch, 1787- Spotfin Butterflyfish		0.4							7.1
Chaetodon sedentarius Poey, 1860- Reef Butterflyfish	2.0	2.8			2.0		3.2	1.6	215.5
Prognathodes aculeatus (Poey, 1860)- Longsnout Butterflyfish					0.4				15.5
Prognathodes aya (Jordan, 1886)- Bank Butterflyfish				0.4	1.2	0.4			14.4
Diodontidae									
Chilomycterus sp. - Unidentified Burrfish									0.4
Diodon holocanthus Linnaeus, 1758- Balloonfish									1.2
Echeneidae									
Remora remora (Linnaeus, 1758)- Remora									0.4
Gobiidae									
Gobiidae - Gobies									0.4
Haemulidae									
Haemulidae/*Schultzea beta* - Bonnetmouths/School Bass									3412.0
Haemulon album Cuvier, 1830- Margate									0.4
Haemulon spp. - Unidentified Grunt									12.0
Haemulon striatum (Linnaeus, 1758)- Striped Grunt									660.3
Haemulon vittata (Poey, 1860)- Boga									80.4
Holocentridae									
Holocentrus rufus (Walbaum, 1792)- Longspine Squirrelfish									0.4
Holocentrus spp. - Squirrelfish unid.		1.2	0.8		0.4			0.4	140.2
Myripristis jacobus Cuvier, 1829- Blackbar Soldierfish									2.8
Labridae									
Bodianus pulchellus (Poey, 1860)- Spotfin Hogfish					2.0			0.8	50.9
Decodon puellaris (Poey, 1860)- Red Hogfish							0.4		0.8
Halichoeres bathyphilus (Beebe & Tee-Van, 1932)- Greenband Wrasse									3.6
Halichoeres spp. - Wrasse unid.			2.0	2.8			1.6		40.0
Lachnolaimus maximus (Walbaum, 1792)- Hogfish									0.8
Lutjanidae									
Lutjanus analis (Cuvier, 1828)- Mutton Snapper									4.0
Lutjanus campechanus (Poey, 1860)- Red Snapper									1.6
Lutjanus cyanopterus (Cuvier, 1828)- Cubera Snapper									0.3
Lutjanus spp. - Snapper unid.									5.6
Rhomboplites aurorubens (Cuvier, 1829)- Vermilion Snapper									28.4
Malacanthidae									
Malacanthus plumieri (Bloch, 1786)- Sand Tilefish									3.4
Microdesmidae									
Ptereleotris calliura (Jordan & Gilbert, 1882)- Blue Goby	0.4								0.8
Monacanthidae									
Monacanthus spp. - Unidentified Filefish			0.8	0.4					4.4
Monacanthus tuckeri Bean, 1906- Slender Filefish	0.4			0.8	0.4	0.8		0.8	16.0
Mullidae									
Pseudupeneus maculatus (Bloch, 1793)- Spotted Goatfish									5.6
Muraenidae									
Gymnothorax moringa (Cuvier, 1829)- Spotted Moray									2.7
Muraenidae - Moray Eel									0.8
Ophichthidae									
Ophichthidae - Worm Eels And Snake Eels									0.4
Ophidiidae									
Ophidiidae - Cusk Eels									1.2
Ostraciidae									
Acanthostracion polygonius Poey, 1876- Honeycomb Cowfish									1.6
Acanthostracion quadricornis (Linnaeus, 1758)- Scrawled Cowfish									0.4
Acanthostracion spp. - Unidentified Cowfish									1.2
Pomacanthidae									
Centropyge argi Woods & Kanazawa, 1951- Cherubfish	0.4	12.0			1.2		1.6	0.4	155.7
Holacanthus bermudensis Goode, 1876- Blue Angelfish									6.8
Holacanthus tricolor (Bloch, 1795)- Rock Beauty					2.0				55.0
Pomacanthus arcuatus (Linnaeus, 1758)- Gray Angelfish									0.4
Pomacanthus paru (Bloch, 1787)- French Angelfish									0.8
Pomacanthus sp. - Angelfish									0.4
Pomacentridae									
Chromis cyanea (Poey, 1860)- Blue Chromis									23.9
Chromis enchrysura Jordan & Gilbert, 1882- Yellowtail Reeffish	0.4	13.6	1.6		17.2	31.6		0.8	986.4
Chromis insolata (Cuvier, 1830)- Sunshine Chromis/Sunshinefish		2.8			3.6				272.8
Chromis scotti Emery, 1968- Purple Reeffish		17.2					0.8		643.7
Chromis spp. - Chromis unid.	0.4				2.0			4.8	184.4
Microspathodon chrysurus (Cuvier, 1830)- Yellowtail dameslfish									0.4
Stegastes partitus (Poey, 1868)- Bicolor Damselfish		3.6						0.4	98.6
Priacanthidae									
Priacanthus arenatus Cuvier, 1829- Bigeye									4.3
Pristigenys alta (Gill, 1862)- Short Bigeye					0.4				1.6
Scaridae									
Sparisoma atomarium (Poey, 1861)- Greenblotch Parrotfish	4.4	7.2	9.6	1.6	4.4		1.6	3.2	222.3
Sciaenidae									
Equetus lanceolatus (Linnaeus, 1758)- Jack-Knife Fish		2.0							7.6
Scombridae									
Acanthocybium solandri (Cuvier, 1832)- Wahoo									0.4
Scorpaenidae									
Pterois volitans (Linnaeus, 1758)- Lionfish	1.2	2.0	2.8		0.4			4.4	177.0
Scorpaenidae - Scorpionfish									0.4
Serranidae									
Anthias tenuis Nichols, 1920- Threadnose Bass									1.6
Anthiinae - Anthiinae									192.8
Centropristis ocyurus (Jordan & Evermann, 1887)- Bank Sea Bass									0.4
Cephalopholis cruentata (Lacepède, 1802)- Graysby									2.3
Epinephelus guttatus (Linnaeus, 1758)- Red Hind									0.4
Epinephelus morio (Valenciennes, 1828)- Red Grouper		0.4							16.3
Hemanthias vivanus (Jordan & Swain, 1885)- Red Barbier									1.2
Liopropoma eukrines (Starck & Courtenay, 1962)- Wrasse Bass			0.8	2.8	2.0			0.8	76.7
Mycteroperca bonaci (Poey, 1860)- Black Grouper									1.6
Mycteroperca interstitialis (Poey, 1860)- Yellowmouth Grouper									0.3
Mycteroperca phenax Jordan & Swain, 1884- Scamp Grouper			0.4						10.6
Plectranthias garrupellus Robins & Starck, 1961- Apricot Bass			0.4	0.4					0.8
Pronotogrammus martinicensis (Guichenot, 1868)- Roughtongue Bass									5.6
Schultzea beta (Hildebrand, 1940)- School Bass					0.4				1594.5
Serranus annularis (Günther, 1880)- Orangeback Bass	8.0	2.8	4.0	4.8	2.4		2.8	2.4	148.5
Serranus chionaraia Robins & Starck, 1961- Snow Bass		0.4	3.6	1.6				0.4	6.8
Serranus notospilus Longley, 1935- Saddle Bass				0.4					1.2
Serranus phoebe Poey, 1851- Tattler			1.6	0.4	0.8	1.2	0.4		20.8
Serranus tigrinus (Bloch, 1790)- Harlequin Bass									0.4
Serranus tortugarum Longley, 1935- Chalk Bass	24.8	76.8	9.6	1.2		6.0	0.8	0.8	616.7
Sparidae									
Calamus bajonado (Bloch & Schneider, 1801)- Jolthead Porgy									0.4
Calamus spp. - Calamus Porgy Gen.									1.2
Pagrus pagrus (Linnaeus, 1758)- Red Porgy									0.8
Sphyraenidae									
Sphyraena barracuda (Edwards, 1771)- Great Barracuda									1.5
Syngnathidae									
Hippocampus zosterae Jordan & Gilbert, 1882- Longsnout Seahorse									0.4
Synodontidae									
Saurida sp. - Lizardfish unid.									0.4
Synodus spp. - Lizardfish unid.	0.8					0.4			2.0
Synodus synodus (Linnaeus, 1758)- Diamond Lizardfish					0.8				1.6
Tetraodontidae									
Canthigaster rostrata (Bloch, 1786)- Sharpnose Puffer	2.8	3.2	8.8	6.4	0.8		0.4	0.4	90.7
Elasmobranchii									
Myliobatidae									

APPENDIX 5

Species list and densities (number/km) of each fish species for each Block observed in ROV video transects at Tortugas during the 2012-2015 R/V *F.G. Walton Smith* cruises.

Tortugas	Miller's Ledge		Fringing Reef	Patch Reef								Soft Bottom												Grand Total
Class/Family/Taxa - common name	Block #074	Block #075	Block #046	Block #050	Block #051	Block #052	Block #058	Block #059	Block #061	Block #066	Block #068	Block #042	Block #045	Block #048	Block #053	Block #054	Block #055	Block #057	Block #060	Block #063	Block #067	Block #069	Block #070	
Actinopteri																								
-																								
Actinopteri - Fish unid.	312.8	0.4	1517.2	1.6		88.4	40.8	0.8	120.0	0.8	162.4	2.0	2.0		1.6	1.6	0.8	0.8	1.2	23.3		1.2	1.2	2280.9
Acanthuridae																								
Acanthurus coeruleus Bloch & Schneider, 1801- Blue Tang			2.0	0.8	2.0	1.2					2.4													8.4
Acanthurus spp. - Unidentified Doctorfish			37.2	5.6	2.0	7.6	6.0	1.2	2.8	7.2	11.6											3.2		84.4
Apogonidae																								
Apogon maculatus (Poey, 1860)- Flamefish																		0.4						0.4
Apogon pseudomaculatus Longley, 1932 - Twospot Cardinalfish	0.4	0.8														0.8			1.2					3.2
Apogon sp. - Cardinalfish unid.							0.4																	0.4
Aulostomidae																								
Aulostomus maculatus Valenciennes, 1841- Trumpetfish			0.8																					0.8
Balistidae																								
Balistidae - Filefish unid.			0.4								0.4													0.8
Bothidae																								
Bothidae - Flounder unid.					0.4							2.4	1.2	0.8	0.8	0.4				2.7	0.4			9.1
Carangidae																								
Carangidae - Unidentified Jack			17.6		10.8	1.6														6.0			3.6	39.6
Caranx ruber (Bloch, 1793)- Bar Jack			5.2																					5.2
Decapterus spp. - Scad																				168.0	146.4		34.8	349.2
Seriola dumerili (Risso, 1810)- Greater Amberjack		0.4																						0.4
Seriola rivoliana Valenciennes, 1833- Almaco Jack	1.6																							1.6
Seriola spp. - Amberjack											1.2													1.2
Trachinotus blochii (Lacepède, 1801)- Permit			0.4																					0.4
Chaetodontidae																								
Chaetodon capistratus Linnaeus, 1758- Foureye Butterflyfish			7.2			0.8					1.6													9.6
Chaetodon ocellatus Bloch, 1787- Spotfin Butterflyfish			3.6	1.6		1.2	2.0	1.2	0.8	1.6	1.2								1.6					14.8
Chaetodon sedentarius Poey, 1860- Reef Butterflyfish	2.4	4.0	5.6	8.8	2.0	8.4	5.2	4.4	0.8		4.0					1.6		2.8	4.0			0.4		54.4
Chaetodon striatus Linnaeus, 1758- Banded Butterflyfish				0.8																				0.8
Prognathodes aya (Jordan, 1886)- Bank Butterflyfish	3.6	4.0																						7.6
Diodontidae																								
Diodon sp. - Unidentified Spiny Puffer																	0.4							0.4
Gobiidae																								
Gobiidae - Gobies						0.4			1.2	0.4													0.4	2.4
Haemulidae																								
Anisotremus virginicus (Linnaeus, 1758)- Porkfish			1.2																					1.2
Haemulon plumierii (Lacepède, 1801)- White Grunt			4.8	6.8		1.2	0.4			0.4	3.6											0.4		17.6
Haemulon sciurus (Shaw, 1803)- Bluestriped Grunt			1.2																					1.2
Haemulon spp. - Unidentified Grunt			8.4			8.8			0.8		80.0							14.0						112.0
Haemulon striatum (Linnaeus, 1758)- Striped Grunt	148.0										82.8		0.4											231.2
Holocentridae																								
Holocentrus adscensionis (Osbeck, 1765)- Squirrelfish								1.6										1.6						3.2
Holocentrus spp. - Squirrelfish unid.	6.0	1.6	10.4	2.0		0.8	2.8		0.8		1.2								0.4					26.0
Myripristis jacobus Cuvier, 1829- Blackbar Soldierfish			0.4																					0.4
Kyphosidae																								
Kyphosus spp. - Chub			4.4																					4.4
Labridae																								
Bodianus pulchellus (Poey, 1860)- Spotfin Hogfish	1.2	1.6	3.2		0.4			0.8																7.2
Bodianus rufus (Linnaeus, 1758)- Spanish Hogfish			3.2			0.4	0.4																	4.0
Decodon puellaris (Poey, 1860)- Red Hogfish	0.4	4.0																						4.4
Halichoeres bathyphilus (Beebe & Tee-Van, 1932)- Greenband Wrasse		0.8					0.4												1.6					2.8
Halichoeres garnoti (Valenciennes, 1839)- Yellowhead Wrasse			17.6	33.6	16.0	10.0	1.2		0.4	0.8	13.2							0.4				3.2		96.4
Halichoeres spp. - Wrasse unid.	1.6	0.4	246.8	56.8	23.2	56.8	4.4	2.8	24.0	44.8	173.6					4.8	2.8	13.2	0.4		0.4	23.2	3.6	683.6
Lachnolaimus maximus (Walbaum, 1792)- Hogfish			2.8	0.8		0.4		0.8	0.4	0.8	0.4													6.4
Thalassoma bifasciatum (Bloch, 1791)- Blueheaded Wrasse			11.2	6.8	2.8	1.6	0.4		1.2	0.8	6.8													31.6
Xyrichtys martinicensis Valenciennes, 1840- Rosy Razorfish																						12.4	0.4	12.8
Xyrichtys novacula (Linnaeus, 1758)- Pearly Razorfish																						2.8	0.8	3.6
Xyrichtys spp. - Unidentified Razorfish					3.2										4.4	4.4						1.6		13.6
Lutjanidae																								
Lutjanus analis (Cuvier, 1828)- Mutton Snapper																						0.8		0.8
Lutjanus buccanella (Cuvier, 1828)- Blackfin Snapper																						0.4		0.4
Lutjanus griseus (Linnaeus, 1758)- Gray Snapper				0.4																				0.4
Lutjanus jocu (Bloch & Schneider, 1801)- Dog Snapper			20.0																					20.0
Lutjanus mahogoni (Cuvier, 1828)- Mahogany Snapper							0.4																	0.4
Lutjanus spp. - Snapper unid.		0.4	10.4				0.4		0.4					0.4				0.4	0.4			0.4		13.2
Ocyurus chrysurus (Bloch, 1791)- Yellowtail Snapper			45.6						0.4															46.0
Malacanthidae																								
Malacanthus plumieri (Bloch, 1786)- Sand Tilefish										0.4														0.4
Microdesmidae																								
Ptereleotris calliura (Jordan & Gilbert, 1882)- Blue Goby						0.4	0.8	0.4				7.2		0.8	0.4		2.0							12.0
Monacanthidae																								
Aluterus schoepfii (Walbaum, 1792)- Scrawled Filefish											0.4													0.4
Monacanthus spp. - Unidentified Filefish												1.6			7.6	1.2	10.0							20.4
Mullidae																								
Pseudupeneus maculatus (Bloch, 1793)- Spotted Goatfish			31.2	6.4		13.6	2.4		0.8		3.6											1.2		59.2
Muraenidae																								
Gymnothorax moringa (Cuvier, 1829)- Spotted Moray	0.4																							0.4
Muraenidae - Moray Eel												0.8												0.8
Ophichthidae																								
Ophichthidae - Worm Eels And Snake Eels												0.4												0.4
Ostraciidae																								
Acanthostracion spp. - Unidentified Cowfish			1.2	0.8		0.4	0.8				0.4					0.4			0.4					4.4
Pomacanthidae																								
Centropyge argi Woods & Kanazawa, 1951- Cherubfish	0.4							2.0																2.4
Holacanthus bermudensis Goode, 1876- Blue Angelfish		0.4	6.4		0.4	1.6		0.4		0.4	1.6													11.2
Holacanthus tricolor (Bloch, 1795)- Rock Beauty		1.2	9.2			0.4	1.2		0.4		1.2													13.6
Pomacanthus arcuatus (Linnaeus, 1758)- Gray Angelfish			1.6	0.8	0.8	0.4				0.8														4.4

Tortugas	Miller's Ledge		Fringing Reef	Patch Reef								Soft Bottom												Grand Total
Class/Family/Taxa - common name	Block #074	Block #075	Block #046	Block #050	Block #051	Block #052	Block #058	Block #059	Block #061	Block #066	Block #068	Block #042	Block #045	Block #048	Block #053	Block #054	Block #055	Block #057	Block #060	Block #063	Block #067	Block #069	Block #070	
Pomacanthus paru (Bloch, 1787)- French Angelfish								1.6	1.2															2.8
Pomacanthus sp. - Angelfish						0.4																		0.4
Pomacentridae																								
Chromis cyanea (Poey, 1860)- Blue Chromis			1090.8		0.8	33.6	2.0		57.6		105.2													1290.0
Chromis enchrysura Jordan & Gilbert, 1882- Yellowtail Reeffish	44.4	16.8	1.6	1.6	110.4	24.4	26.8	152.0	1.6	2.0	2.4	0.4				7.6		35.6	61.2			0.4		489.2
Chromis insolata (Cuvier, 1830)- Sunshine Chromis/Sunshinefish		7.2	8.0	0.4	0.4	0.8	6.8	1.2	0.4		2.0													27.2
Chromis scotti Emery, 1968- Purple Reeffish	0.8	0.4	24.8			48.8	6.0	1.6	6.0	0.8	35.6													124.8
Chromis spp. - Chromis unid.			80.0			3.2		0.8	2.8	0.8	60.4							4.8						152.8
Pomacentrus spp. - Unidentified Damselfish				2.8	0.4	5.2	0.4																	8.8
Stegastes leucostictus (Müller & Troschel, 1848)- Beaugregory			2.0						0.4		1.2													3.6
Stegastes partitus (Poey, 1868)- Bicolor Damselfish			147.2	100.8	25.6	46.4	42.8	20.0	19.6	6.0	96.0							5.2	0.8			4.4		514.8
Stegastes variabilis (Castelnau, 1855)- Cocoa Damselfish			0.4																					0.4
Priacanthidae																								
Priacanthus arenatus Cuvier, 1829- Bigeye	0.4	1.2									0.8	0.4							0.4					3.2
Pristigenys alta (Gill, 1862)- Short Bigeye								0.4								0.8								1.2
Scaridae																								
Scaridae - Parrotfish unid.			34.4	14.8		0.4	0.8		1.2		3.2				3.6	0.4								58.8
Scarus coeruleus (Edwards, 1771)- Blue Parrotfish			4.8																					4.8
Scarus iseri (Bloch, 1789)- Striped Parrotfish			10.0						1.2		0.8													12.0
Scarus spp. - Unidentified Parrotfish			24.0						2.4															26.4
Scarus taeniopterus Lesson, 1829- Princess Parrotfish						0.4																		0.4
Sparisoma atomarium (Poey, 1861)- Greenblotch Parrotfish		0.4				5.2	3.6									15.2		1.6	0.8					26.8
Sciaenidae																								
Equetus lanceolatus (Linnaeus, 1758)- Jack-Knife Fish		0.4						0.4																0.8
Scorpaenidae																								
Pterois volitans (Linnaeus, 1758)- Lionfish	3.2	8.8	0.4			1.2	0.4											1.2						15.2
Serranidae																								
Anthiinae - Anthiinae	41.2																							41.2
Cephalopholis cruentata (Lacepède, 1802)- Graysby	0.4		3.2			0.4					1.2													5.2
Diplectrum bivittatum - Dwarf Sand Perch																						7.6	0.8	8.4
Diplectrum formosum (Linnaeus, 1766)- Sand Perch												0.4			2.0	1.2	1.2			0.7				5.5
Epinephelus adscensionis (Osbeck, 1765)- Rock Hind			0.4				0.4																	0.8
Epinephelus drummondhayi Goode & Bean, 1878- Speckled Hind		0.4																						0.4
Epinephelus morio (Valenciennes, 1828)- Red Grouper				0.8							2.0								0.8					3.6
Hypoplectrus spp. - Unidentified Hamlet			15.2						0.4		2.8													18.4
Liopropoma eukrines (Starck & Courtenay, 1962)- Wrasse Bass	2.4	2.4																						4.8
Mycteroperca bonaci (Poey, 1860)- Black Grouper		0.4																						0.4
Mycteroperca phenax Jordan & Swain, 1884- Scamp Grouper	0.4	2.0	0.8																					3.2
Plectranthias garrupellus Robins & Starck, 1961- Apricot Bass	1.2																							1.2
Pronotogrammus martinicensis (Guichenot, 1868)- Roughtongue Bass	232.0	167.2																						399.2
Rypticus bistrispinus (Mitchill, 1818)- Freckled Soapfish												1.2												1.2
Rypticus saponaceus (Bloch & Schneider, 1801)- Greater Soapfish			0.4																					0.4
Serranus annularis (Günther, 1880)- Orangeback Bass	1.6	1.2				0.8		2.0			0.4							1.2						7.2
Serranus baldwini (Evermann & Marsh, 1899)- Lantern Bass										0.4														0.4
Serranus chionaraia Robins & Starck, 1961- Snow Bass								0.8										0.4						1.2
Serranus notospilus Longley, 1935- Saddle Bass	0.4	3.2					0.4	2.4																6.4
Serranus phoebe Poey, 1851- Tattler	4.8	3.6					2.0	2.0								0.8		1.2	2.8					17.2
Serranus tortugarum Longley, 1935- Chalk Bass		0.8			1.2	9.6	5.6	8.0			0.4							5.2	6.4	0.7				37.9
Sparidae																								
Calamus calamus (Valenciennes, 1830)- Saucereye Porgy				0.4																				0.4
Calamus spp. - Calamus Porgy Gen.			3.2	2.4		2.4	2.0	0.4	0.4		0.8				0.4									12.0
Diplodus holbrookii (Bean, 1878)- Spottail Pinfish						0.8	0.4																	1.2
Diplodus sp. - Unidentified Porgy							0.4																	0.4
Syngnathidae																								
Hippocampus spp. - Unidentified Seahorse																	1.2							1.2
Synodontidae																								
Synodus intermedius (Spix & Agassiz, 1829)- Sand Diver	0.4	0.4																						0.8
Synodus spp. - Lizardfish unid.						0.4		0.4				1.6	3.2	0.8	0.4	0.4	1.2					0.4		8.8
Tetraodontidae																								
Canthigaster rostrata (Bloch, 1786)- Sharpnose Puffer	3.2	2.4	1.6	0.4	1.6	1.2	3.2	0.8			1.2				0.8				1.6					18.0
Sphoeroides spengleri (Bloch, 1785)- Bandtail Puffer					0.4	1.2						1.2			1.2	4.8	2.4	0.8						12.0
Tetraodontidae - Unidentified Puffer													0.8											0.8
Tetraodontiformes																								
Lactophrys trigonus (Linnaeus, 1758)- Trunkfish				0.4																				0.4
Triglidae																								
Triglidae - Sea Robin												0.8												0.8
Elasmobranchii																								
Ginglymostomatidae																								