Coral Reef Conservation Program (CRCP) Local Action Strategy (LAS) Project 3B "Southeast Florida Coral Reef Fishery-Independent Baseline Assessment" - 2012-2013 Interim Report

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Coral Reef Conservation Program (CRCP) Local Action Strategy (LAS) Project 3B "Southeast Florida Coral Reef Fishery-Independent Baseline Assessment"

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2012-2013 Interim Report

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Project 3B

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Executive Summary

Reef fishes are important biologic, ecologic, and economic resources of the marine ecosystem which must be managed for sustainability. Until recently there was no long-term monitoring program in place to assess the condition of fish resources of the northern Florida Reef Tract (FRT) (northern Miami-Dade, Broward, Palm Beach, and Martin counties). An assessment/monitoring plan for the northern Florida reef tract was designed through a joint cooperative effort by scientists at the University of Miami Rosenstiel School of Marine and Atmospheric Science, NOAA-Southeast Fisheries Science Center and Nova Southeastern University Oceanographic Center (NSUOC). This report is a synoptic compilation of the two-year data collection from all partner agencies, and includes data from the 234 and 354 sites or Primary Sampling Units (PSUs) sampled in 2012 and 2013, respectively. The majority of the field work was accomplished through funding granted to NSUOC. Significant amounts of data were also collected by multiple partner agencies that were able to dedicate their time and resources to the project. In 2012 funding for the first year of data collection was awarded by Florida Department of Environmental Protection (FDEP) to NSUOC on July 1st, 2012. Funding for a second year of sampling was awarded by National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) to NSUOC through the National Coral Reef Institute Cooperative Agreement on June 18, 2013. Field sampling for each year began in May and ran through October. Funding for a third year of data collection (2014) and a final report was awarded by NOAA CRCP to NSUOC.

Over the course of the two-year study period for this interim report, >170,000 individual fish of 266 species were recorded. Total mean density for all sites and strata combined for both years was 162 fishes/SSU. For 2012, mean density was 151 fishes/SSU; in 2013 it was 168 fishes/SSU. However, in general, 2012 counts were higher at most sites. When low vs. high slope strata were compared, the high slope strata showed higher fish density. Likewise, species richness was higher at most sites in 2012 than 2013 and was also significantly higher for both years on sites with high slope. Multivariate analyses showed patterns in the reef fish communities associated with benthic habitats. Water depth was a primary determinant of fish distribution with differences in assemblages between shallow and deep sites. Also most of the surveys in the southern regions (Broward-Miami, Deerfield, and South Palm Beach) clustered tightly together indicating high similarity between communities in the deep habitats within these regions. Conversely, fish communities in North Palm Beach and Martin were much more variable and mostly separated in disparate areas of the plot. This suggests that the Martin and North Palm Beach fish communities are distinctly different from the southern regions.

The dataset, in its entirety, provides the opportunity for further mining to examine individual species and reef fish assemblage correlations with a host of abiotic and biotic variables. Thus, from both management and ecological-sciences perspectives, it is a valuable resource. It is already clear there are significant differences in the geographic distribution of reef fishes at local and regional scales. There are interacting strata and latitudinal differences in total reef fish abundance, species distribution, sizes, and assemblage structure. The combination of data from all three years will provide a complete regional baseline fishery-independent assessment.

Acknowledgements

The success of this project can be attributed to the cooperative partnerships forged between multiple key agencies, universities, and individuals who have a vested interest in maintaining the health and sustainability of the coral reef ecosystems of southeastern Florida. We thank James Bohnsack, Jeremiah Blondeau, and Natalia Zurcher for their essential support and guidance throughout this process. By sharing the expertise they have gained through many years of involvement with the parent RVC project during its evolution in the Florida Keys and Dry Tortugas, they have strengthened our preliminary monitoring efforts here along the northern reaches of the Florida Reef Tract. In addition, we thank Kurtis Gregg for his valuable assistance in helping to facilitate the fundamental partnerships vital to this project and acting as a sounding board for questions and new ideas and for assistance in the field.

A large number of well qualified scientific divers from our partner agencies (many of whom had much larger additional roles in this project) lent their time and resources to help make this project a successful and productive endeavor. They are listed as follows: From FDEP-CRCP – Jennifer Jordan Báez, Meghan Balling, Karen Bohnsack, Christopher Boykin, Gina Chiello, William Fisher, Melissa Gil, Julio Jimenez, Jamie Monty, Jenna Sansgaard, Melissa Sathe, Kristina Trotta, Katherine and Ori Tzadik, and Joanna Walczak; from the FWC Tequesta laboratory - Erick Ault, Jeff Beal, and Grant Stoecklin; from St. Lucie Inlet Preserve State Park - Ernest Cowen and Charles Jabaly; from Miami-Dade County (DERM) - Damaso Rosales, Rebecca Ross, Jon Sidner, and Sara Thanner; from Broward County (NRPMD) - Kenneth Banks, Courtney Kiel, and Pat Quinn; from FDEP-West Palm - Irene Arpayaglou; and from Coastal Eco-Group, Inc. – Jenny Stein.

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List of Acronyms

ANOSIM	Analysis of Similarity
ANOVA	Analysis of Variance
CREIOS	Coral Reef Ecosystem Integrated Observing System
CRCP	Coral Reef Conservation Program
DERM	Department of Environmental Resource Management
FDEP	Florida Department of Environmental Protection
FDOU	Fishing Diving and Other Uses
FRRP	Florida Reef Resilience Program
FRT	Florida Coral Reef Tract
FWC	Florida Fish and Wildlife Conservation Commission
GIS	Geographic Information Systems
LAS	Local Action Strategy
LIDAR	Light Detection and Ranging
MDS	Multi-Dimensional Scaling
NFWF	National Fish and Wildlife Federation
NMFS	National Marine Fisheries Service
NRPMD	Natural Resources Planning and Management Division
NOAA	National Oceanic and Atmospheric Administration
NSUOC	Nova Southeastern University Oceanographic Center
PSU	Primary Sampling Unit
QA/QC	Quality assurance and quality control
RSMAS	University of Miami Rosenstiel School of Marine and Atmospheric Science
RVC	Reef Visual Census
SEFSC	Southeast Fisheries Science Center
SEFCRI	Southeast Florida Coral Reef Initiative
SE FL	Southeast Florida
SSU	Second-stage Sample unit
USCRTF	U.S. Coral Reef Task Force

1. INTRODUCTION

The ecosystem services of the Florida Reef Tract (FRT), including the diverse reef fish assemblage that it supports, have direct links to the health of both the state and local economies (Johns et al., 2001; Johns et al., 2004). Yet, it is widely believed and increasingly supported by multiple studies that many commercially and recreationally important fishes have been over-harvested and stocks are currently being exploited at an unsustainable rate throughout the region (Ferro et al., 2003; Johnson et al., 2007; Ault and Franklin, 2011; Gregg, 2013a). Further, a wide array of other acute and chronic anthropogenic impacts are applying increasing levels of additional stress to the entire reef system, e.g., coastal construction projects, sedimentation, ship groundings and anchor damage, water pollution and other water quality issues (Banks et al. 2008; Jordan et al., 2009; Behringer et al., 2011; Walker et al., 2012; Gregg, 2013b). These impacts are largely attributed to the growing human population that resides in the highly developed coastal area of southeast Florida. Because reef fishes are an important biologic, ecologic, and economic resource of the marine ecosystem, reef fish population trends and associated driving forces need to be examined closely in order to understand and effectively manage the resource sustainably. Since 1979, fishery-independent monitoring of reef fish populations has been ongoing in the Florida Keys (the southern portion of the FRT from Dry Tortugas to Biscayne National Park). However, until recently there was no comparable long-term monitoring program in place to assess the state of the fish resources of the northern FRT (northern Miami-Dade, Broward, Palm Beach, and Martin counties).

Under the guidance of the U.S. Coral Reef Task Force (USCRTF), the Florida Department of Environmental Protection (FDEP) and the Florida Fish and Wildlife Conservation Commission (FWC) coordinated the formation of a team of marine resource professionals (local, state, regional, and federal), scientists, non-governmental organization representatives, and other coral reef stakeholders. This group, known as the Southeast Florida Coral Reef Initiative (SEFCRI) Team, gathers to develop local action strategies targeting coral ecosystems in Miami-Dade, Broward, Palm Beach and Martin counties.

The SEFCRI Team identified the need for the development of a fishery-independent monitoring program for southeast Florida's coral reefs. This management need was again identified by stakeholders, managers, and scientists in 2008 during the Florida Reef Resilience Program (FRRP) Workshop and most recently by managers and scientists at the National Oceanic and Atmospheric Administration (NOAA) Atlantic/Caribbean Coral Reef Ecosystem Integrated Observing System (CREIOS) Workshop, and at Florida's Strategic Management Priorities Workshop. The need for fishery-independent information was confirmed in 2008 as contractors began gathering fishery-dependent and independent data for SEFCRI Local Action Strategy (LAS) Fishing, Diving, and Other Uses (FDOU) Project 18 & 20A: *Fisheries Resource Status and Management Alternatives for the Southeast Florida Region*. The contractors found several "snapshot" fishery-independent data sets in two of the four counties within the four-county region, which mainly focused on artificial reef fish populations, and were only collected for one to two years. Preliminary results from Project 18 & 20A indicated that spatially and temporally explicit fishery-independent assessment on southeast Florida coral reefs was lacking and existing "snapshot" data could not be used to determine southeast Florida coral reef fisheries status and trends. Thus, the development of a fishery-independent assessment program for the region was recommended (Ault et al., 2012).

In 2011, Nova Southeastern University Oceanographic Center (NSUOC) received funding through the National Fish and Wildlife Federation (NFWF) to develop a training program aimed at building the capacity to conduct a large-scale assessment of reef fish populations in southeast Florida. The assessment project was designed through a joint cooperative effort by scientists at the University of Miami Rosenstiel School of Marine and Atmospheric Science (RSMAS) and NOAA-Southeast Fisheries Science Center (NOAA-SEFSC) with the goal to effectively build on the success of the fishery-independent monitoring program implemented in the Florida Keys and apply it to the southeast Florida (SE FL) reef tract. A robust statistical design and sampling plan for an initial region-wide survey was developed with additional assistance from, and archival data being provided by scientists at NSUOC (CRCP Project 3A) (http://www.dep.state.fl.us/coastal/programs/coral/reports/DEP_CRCP_3a_Report.pdf) (Ault et al., 2012). The data acquired in the assessment will, for the first time, enable resource managers to examine the Florida Coral Reef Tract on a holistic scale and more accurately assess the status and trends of the fish resources and conduct system-wide stock assessments.

While the majority of the field work for this project was accomplished through funding granted to NSUOC, a significant portion of the data were collected by multiple partner agencies that were able to dedicate their time and resources to the project: NOAA-SEFSC, FDEP-CRCP, FDEP-Southeast District, Miami-Dade County (DERM), Broward County (NRPMD), and the FWC Tequesta laboratory. Funding to collect data at 200 sites throughout the southeast Florida region was awarded by FDEP-CRCP to NSUOC on July 1st, 2012. Field sampling began that same month and continued through October of 2012. Funding for the second year of sampling was awarded by NOAA Coral Reef Conservation Program (CRCP) to NSUOC through the National Coral Reef Institute Cooperative Agreement on June 18, 2013, and a supplemental grant from FDEP-CRCP was awarded to NSUOC on July 15, 2013. Field sampling began in May and ran through October of 2013. This report is a compilation of the two-year data collection from all partner agencies, and includes data from all 234 and 354 sites sampled in 2012 and 2013, respectively. Field sampling for the third year of the assessment began in May 2014. The combination of data from all three years will provide a complete regional baseline fishery-independent assessment.

2. PROJECT GOALS AND OBJECTIVES

The main goal of this project is implementation of a cooperative and statistically robust, habitat-based, tiered fishery-independent monitoring protocol designed to meet two main objectives: 1) to determine changes in southeast Florida reef fish populations over time and in response to future management strategies, and 2) to provide a seamless integration with the existing Reef Visual Census (RVC) program data, which will allow for the entire Florida Reef Tract to be evaluated in a holistic manner. In addition, this project is intended to continue fostering beneficial partnerships among NSUOC, FDEP CRCP, NOAA National Marine Fisheries Service (NMFS), and Keys RVC and local SE FL partner agencies and organizations.

Implementation included: project planning, in water field work/data collection, data entry, data quality assurance and quality control (QA/QC), data analysis, report writing, coordination with Keys Reef Visual Census (RVC) partners and local SE FL partners, Geographic Information Systems (GIS) support/modeling to visually display the data, and determination of sites for the 2013 and 2014 sampling seasons.

3. METHODOLOGY

3.1. Study Area and Design

The study area included all previously mapped marine benthic hardbottom habitats shallower than 33 m from Government Cut in Miami-Dade County to the northern border of Martin County (Figure 1). The survey area for the annual FL Keys RVC survey spans south from Government Cut through Biscayne Bay National Park and the remainder of the Florida Keys. The sampling design for the northern FRT was created with local stakeholder input in a separate FDEP-CRCP project by Ault et al. (2012). The plan adapted the stratified, random statistical sampling design developed and implemented for the Florida Keys reef fish monitoring plan (Smith et al., 2011).

***Figure 1**. Study area included all reef habitats between the northern boundary of Martin County to Government Cut in Miami-Dade County.*

The reef-scape was gridded into 100-m cells referred to herein as primary sampling units (PSUs). Each PSU was divided into 4 50-m grid cells to acquire second-stage randomized data collection locations with the PSU (Figure 2). A PSU is synonymous with a "site" throughout the remainder of this document. At each second-stage data collection site multiple data collections (fish counts) occurred. During the analysis, an arithmetic mean for adjacent counts from each buddy team was calculated to determine the fish density per data collection area (177 m^2). This area is referred to herein as a second-stage unit (SSU). Each PSU and SSU was characterized by three main strata types, which combined are termed herein as map strata: coral reef ecosystem biogeographic subregion, benthic habitat type, and topographic slope (Table 1). The coral reef ecosystem biogeographic subregions as defined in Walker (2012) and Walker and Gilliam (2013) were used to divide the study area into ecologically relevant regions. The grid cells were characterized according to which region the majority of the unit resided. Benthic habitat maps from previous efforts were used to determine the majority habitat type in each PSU and SSU (Riegl et al., 2005; Walker et al., 2008; Walker, 2009; Walker, 2013). The benthic habitat maps contained more detail than possible for the stratification, therefore *a priori* decisions were made to combine more specific habitats into broader strata (Table 2). And, since topographic complexity also affects local fish distributions (Walker et al., 2009), topographic slope was included in the stratification as a surrogate for larger scale (10s of meters) topographic complexity. The slope was calculated in ArcGIS using high resolution LIDAR (Light Detection and Ranging) data. The LIDAR data were analyzed for slope where all areas greater than 5° were considered “high slope”. A single polygon layer of these areas was created and used to determine if the PSU and SSU majority were high or low slope.

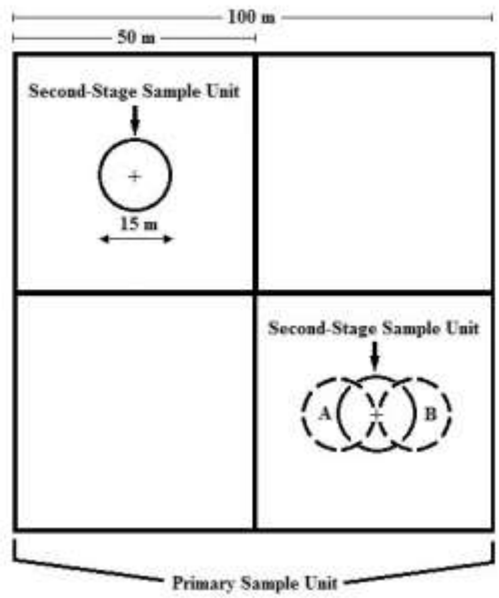

Figure 2*. Illustration of Primary Sample Unit (PSU) and Second-Stage Sample Units (SSUs). Selection of 2 individual target SSUs is accomplished by a randomization of the 4 cells within the PSU. The dashed circles represent a buddy pair (A and B). [Modified from Smith et al., 2011].*

The map strata were used to parse the region into finer categories to optimize the survey locations for the eight targeted fishery species. A pure randomized design would take many more surveys to acquire the necessary data on the desired species, whereas a strategically targeted design is much more efficient (Smith et al., 2011). In the Florida Keys, this strategy has been used effectively to optimize data collection by capturing the variability of species by habitat strata and allocating more sample sites to those areas of higher variation. In the case of southeast Florida, initially there was not much regional information available about the fisheries species to inform the survey design, thus the proportion of benthic habitats were used (Ault et al., 2012). Subsequent years used the previously collected data to aid in the site allocations (see Figure 41). When including the biogeographic subregions, slope, and benthic habitat types, there were too many individual categories to be practical in the stratified random design and many were not thought to pertain to the targeted fish species. For example, the subtle differences between Colonized Pavement-Shallow and Ridge-Shallow benthic communities and geomorphology were not thought to be major factors affecting species distribution. Therefore certain benthic habitats were combined into what was thought to be more relevant strata, the nearshore habitats (NEAR). Combining the benthic habitats into habitat strata resulted in thirty-one map strata that were used in the sampling allocations (Table 1).

It was estimated that 360 PSUs could be visited each year. Site allocations for each stratum were guided by the proportional distribution of strata in the sampling frame (Appendix 1). Each stratum was given a minimum of 5 sites. Then the remaining sites were distributed proportionally by the strata area. Extremely large strata were limited to 50 sites. Unlike the FL Keys and Dry Tortugas annual surveys, which have been conducted largely within the boundaries of protected areas or special use zones, there were no special strata that needed to be accommodated within the SE FL area survey frame. Once the total number of target sites was determined for each stratum, the corresponding number of PSUs for each was randomly chosen based on equal probability of selection from the survey frame using NOAA's sampling design tool for ArcGIS (http://coastalscience.noaa.gov/projects/detail?key=185). Then two of the four SSUs in each chosen PSU were randomly selected. The center location of the two chosen SSUs were the sample sites for that PSU.

Table 1. *Map strata for the site randomization to optimize survey outcomes. The biogeographic subregions, habitat strata, and slope were used to define these areas. See Table 2 for habitat strata details.*

Region	**Habitat Strata**	**Slope**
Broward-Miami	INNR	High
Broward-Miami	INNR	Low
Broward-Miami	MIDR	High
Broward-Miami	MIDR	Low
Broward-Miami	NEAR	High
Broward-Miami	NEAR	Low
Broward-Miami	OFFR	High
Broward-Miami	OFFR	Low
Broward-Miami	PTDP	High
Broward-Miami	PTDP	Low
Broward-Miami	PTSH	N/D
Deerfield	MIDR	High
Deerfield	MIDR	Low
Deerfield	NEAR	Low
Deerfield	OFFR	High
Deerfield	OFFR	Low
Deerfield	PTDP	High
Deerfield	PTDP	Low
South Palm Beach	NEAR	Low
South Palm Beach	OFFR	High
South Palm Beach	OFFR	Low
South Palm Beach	PTDP	High
South Palm Beach	PTDP	Low

Region	Habitat Strata	Slope
South Palm Beach	PTSH	N/D
North Palm Beach	DPRC	High
North Palm Beach	DPRC	Low
North Palm Beach	NEAR	Low
Martin	NEAR	High
Martin	NEAR	Low
Martin	RGDP	High
Martin	RGDP	Low

Table 2. *Mapped benthic habitat classes and stratification habitat codes for this study, and major categories for the benthic habitat map in the southeast Florida region.*

Map Habitat Class	Habitat Strata
Deep Ridge Complex	DPRC
Linear Reef-Inner	INNR
Linear Reef-Middle	MIDR
Linear Reef-Outer	OFFR
Ridge-Deep	OFFR (RGDP in Martin only)
Ridge-Shallow	NEAR
Other Delineations (Artificial, dredged inlets, sand borrow areas)	OTHR
Aggregated Patch Reef-Deep	PTDP
Aggregated Patch Reef-Shallow	PTSH
Patch Reef	PTSH <20m; PTDP >20m
Colonized Pavement-Deep	OFFR
Colonized Pavement-Shallow	NEAR
Unconsolidated Sediment	SAND
Scattered Coral/Rock in Sand	PTSH <20m; PTDP >20m
Seagrass	SGRS
Spur and Groove	OFFR
No Map Data	UNKW

Throughout the four-county region, a total of 360 primary and 216 alternate sites were selected in 2012. For 2013, a slightly different strategy was employed, using 360 primary/core, 105 secondary/tier 2, and 216 alternate sites. Core target sites were prioritized and completed before the tier 2 sites to ensure a minimum number of sites in each stratum were targeted in case all the sites were not surveyed. Over the course of the 2013 field season almost every site on both the core and tier 2 lists were sampled. Due to the success of the 2013 sampling season, the secondary site strategy was abandoned in 2014, and 350 primary and 176 alternate sites were selected.

Prior to the beginning of field sampling, the target locations were visually inspected with the high-resolution bathymetry and benthic habitat maps in GIS to determine if the location was within the intended strata. If not, the points were moved (within the SSU where possible) to the designated target habitat. In cases where no suitable habitat was nearby, the point was discarded and a suitable alternate was chosen. Appendix 2 contains four maps that illustrate the target locations and the actual survey locations for 2012. Survey targets without a corresponding "actual" location were not surveyed. This was more of a problem in the North Palm Beach and Martin County regions which were challenging to survey due to logistical constraints. Appendix 3 contains four maps that illustrate the target and actual survey locations for 2013. These maps show "Core" and "Tier 2" target locations. Appendix 4 displays the intended locations for 2014.

3.2. Data Collection

Assessing population size and community level or species-specific trends of coral reef fishes is inherently difficult because of many factors. Reef fishes are speciose, exhibit various behavioral traits, have patchy distributions, and occur in heterogeneous and diverse habitats. These factors can make it difficult to determine optimal or standardized survey methods, and as a result many different visual survey methods have been developed to give researchers more options. In recent years much progress has been made in regards to standardizing survey methodology between and among the multiple scientific and regulatory entities that routinely monitor and conduct research on the coral reefs found within the territorial waters of United States (Brandt et al., 2009). The most widely agreed-upon method for assessing populations of coral reef fishes is the stationary point-count (Bohnsack and Bannerot, 1986). During a point-count, a survey diver establishes a location at the center of an imaginary cylinder 15m in diameter (177 m^2) that stretches all the way from the sea floor to the sea surface. During a Reef Visual Census (RVC) point-count, for the first five minutes only species names are recorded, with the exception of any highly migratory or target species which are enumerated as soon as they are seen. It is the species encountered during the first five minutes that are most critical for establishing a "snapshot" of the area as it existed when the divers entered the water. For the second five minutes, the numbers and size ranges (mean, min, max) (fork length) of each species are filled in, with new species being added to the list as they are encountered. Additional members of species that were observed during the first five minutes that enter the survey area after their initial observation are not recorded a second time. Advantages of this method include: 1) a non-destructive nature, 2) ability to be easily randomized, 3) fishery-independence, 4) ability to observe community as a whole, and 5) ability to be quickly and cheaply employed. Disadvantages of the RVC method can be the tendency to underestimate numbers of fish, especially in terms of density and diversity of small, cryptic fishes (and sometimes exceptionally abundant fishes), especially in highly complex habitats. However, one of the goals of a well-designed fisheries monitoring program is to establish and maintain a consistent sampling method which will track and quantify relative changes in abundance/density/diversity over space and time. The RVC method meets this goal. In addition, the stratified sampling design implemented in this project is specifically designed to generate sample sizes adequate enough to allow for meaningful statistical comparisons within the observed range of abundance levels.

Task methodology followed established methods from the CRCP Project 3A report: Development of a Coral Reef Fishery-Independent Assessment Protocol for the Southeast Florida Region (Ault et al., 2012), and RVC report: A Cooperative Multi-agency Reef Fish Monitoring Protocol for the Florida Keys Coral Reef Ecosystem (Brandt et al., 2009). Fishery-independent assessment protocol on all habitats included a rapid characterization of multiple benthic habitat features with the RVC stationary point-count. Divers were equipped with a standardized 1-meter "All Purpose Tool" (APT) that was used to aid in size estimation of fishes and assessment of the benthos. Benthic habitat features surveyed after each point-count included: substrate slope, max vertical hard and soft relief, surface relief coverage of hard and soft features, abiotic footprint, biotic cover by major organismal category, habitat type, underwater visibility, water temperature, cylinder radius, and current strength (Brandt et al., 2009).

Abundance and distribution of reef fishes has been shown to fluctuate on a seasonal basis within the SEFCRI area, with greater abundances for many species being the norm for the summer months (Walker et al., 2002). Therefore, data collection took place only within the months of May through October in both years. The percentage of sites sampled during each month of the sampling season is broken down as follows:
2012 – May (0%), June (0%), July (12%), August (32%), September (30%), October (26%)
2013 – May (3%), June (16%), July (20%), August (26%), September (22%), October (13%)

In 2012, 41 divers from 7 partner agencies conducted 881 individual dives, completing 234 sites. In 2013, 34 divers from 6 partner agencies conducted 1,227 individual dives, completing 354 sites. During the combined 2012-2013 sampling seasons, a grand total of 588 sites were surveyed. A 44% increase in sampling effort was seen in 2013 as compared to 2012. For a detailed breakdown of number of SSUs sampled from each ecological subregion and habitat strata see Appendix 1. Table 3 lists the total number and percentage of sites contributed by each agency for each year. However, this does not account for the contribution that many divers made while working from other partner agency vessels in order to increase sampling efficiency.

Table 3. *Sampling effort, broken down by partner agency contribution.*

Agency	**2012 # of sites (percentage)**	**2013 # of sites (percentage)**
NSUOC	163 (70%)	198 (56%)
NOAA-SEFSC	19 (8%)	113 (32%)
FDEP-CRCP	18 (8%)	16 (4%)
Miami-Dade County	15 (6%)	7 (2%)
FWC Tequesta	7 (3%)	14 (4%)
Broward County	10 (4%)	6 (2%)
FDEP-West Palm	2 (1%)	0 (0%)

3.3. Data Entry and Proofing

Efforts to ensure maximum quality of the data were maintained throughout all levels of the data collection, entry, and verification process in order to avoid introducing error into the database. This began with a review of the data sheet immediately following each dive, during which the diver consulted with his/her dive buddy and the other dive team about each entered variable to detect unreasonable entries, discrepancies, or missing data. Divers were encouraged to enter their data as soon as possible upon returning from the field, ideally the same or next day, but no longer than one week in order to give the diver the ability to best recall the specifics of each dive, detect any potential errors, and most accurately enter the data. Upon reaching the end of the sampling season, the lead data management representative from each partner agency was responsible for generating proofing sheets which served as an aid to finding and correcting errors to the dataset during the quality assurance/quality control process. Once all errors were identified and corrected, the final version of the data (i.e., sample, species, and substrate files, boat log, diver log, and environmental data) for each agency was submitted to NSUOC for the final data merge and verification procedures. Once final data from each agency was compiled, the RVC Annual Master Spreadsheet file was created. This file consisted of merged (via Merge2.0.exe program) ASCII sample, substrate and species data outputs from the RVC data entry program, along with a combined version of the Boat/Field and Water Quality/Environmental logs, each of which became one of four individual worksheets within the completed RVC Annual Master Spreadsheet file. The next step involved performing an in-depth cross check of each of the four worksheets to locate any missing samples or incorrectly entered data, outliers, unlikely lengths or numbers of particular species, or any other questionable entries. Questionable elements discovered during this process were resolved by contacting the individual diver(s) responsible for the data. A final rigorous verification followed which scrutinized the habitat and substrate data, comparing the observed results to the GIS database.

3.4. Data Analysis

A descriptive ecological analysis that includes species inventory, density, and frequency of occurrence of all fish species observed was performed on the 2012 and 2013 datasets. This analysis follows established methods from a previous RVC report (Brandt et al., 2009). Each of the aforementioned metrics was partitioned by individual strata (subregion, habitat type, slope, and depth). Density is reported in terms of mean "SSU Density", which is the average of the data collections conducted in each secondary survey location (usually 2, rarely 1 or 3). This standardized each data collection to a single area of 177 m^2, referred to herein as an SSU. For some analyses, species that were recorded past the 10 minute mark during a survey were omitted, as it is those recorded within the first 5-10 minutes that are generally considered most relevant to the purposes of the study and make up the best "snapshot" of the fish community as it existed when the divers began recording their observations. In addition, an initial exploration into the trends of distribution and abundance throughout the greater Florida Reef Tract (combining data from the southeast FL region with that from the FL Keys and Dry Tortugas) of select species was undertaken.

Of particular concern in the southeast Florida region, and one of the primary motivating factors for this program, is the population status of commercially and recreationally important species. In particular, a selection of eight target species (based on their estimated level of exploitation and relative abundance in southeast Florida) were examined for an in-depth evaluation of average density and percent occurrence at different life-stages (pre-exploited and exploited) and average length of the exploited phase individuals. The minimum legal size limit was used as a measure for pre-exploited versus exploited and varied by species (Table 4). Fish with a fork length (FL) less than the specified length were considered as “pre-exploited” (not targeted in recreational or commercial fishing) and larger fish as “exploited”. The species were: Gray Triggerfish (*Balistes capriscus*), Red Grouper (*Epinephelus morio*), White Grunt (*Haemulon plumieri*), Bluestriped Grunt (*Haemulon sciurus*), Hogfish (*Lachnolaimus maximus*), Mutton Snapper (*Lutjanus analis*), Gray Snapper (*Lutjanus griseus*), and Yellowtail Snapper (*Ocyurus chrysurus*).

Table 4. *List of commercially and recreationally important species’ exploited lengths.*

Species	**Length (cm)**
Gray triggerfish, *Balistes capriscus*	30
Red grouper, *Epinephelus morio*	50
White grunt, *Haemulon plumieri*	20
Bluestriped grunt, *Haemulon sciurus*	20
Hogfish, *Lachnolaimus maximus*	30
Mutton snapper, *Lutjanus analis*	40
Gray snapper, *Lutjanus griseus*	25
Yellowtail snapper, *Ocyurus chrysurus*	25

4. RESULTS AND DISCUSSION

4.1. Fish Assemblage

Over the course of the two-year study period, >170,000 individual fish of 266 species were observed (214 in 2012 and 257 in 2013). There were 16 species observed in 2012 that were not encountered in 2013, and 56 species that were observed in 2013 that had not been encountered in 2012. Comparatively, 214 species have been recorded from 13 years of annual monitoring (2001-2013) at repeated monitoring sites within Broward County (Gilliam et al., 2014) and a compiled total of 354 species (not all reef associated) have been recorded in Broward County from multiple projects over the course of the past 10+ years (Spieler et al., unpublished data).

4.1.1. Fish Density

Total mean density for all sites and strata combined for both years was 162 ± 7.9 SEM fishes/SSU. For 2012 mean density was 155 ±7.3 fishes/SSU and in 2013 it was 167 ±12.3 fishes/SSU. However, when SSUs were compared by habitat strata on a yearly basis, in general

2012 was higher with the exception of the NEAR-low, PTSH, OFFR-low, and RGDP-low+high (Figure 3). However, since the RGDP stratum was under-sampled in 2012, yearly comparisons for that particular stratum are unjustified. When both years are combined, the RGDP-high stratum was significantly higher than the others, with DPRC-low and RGDP-low being lower, while the remaining strata were similar to one another (ANOVA (analysis of variance), $p<0.05$) (Figure 4). If low and high slope strata are compared within each individual habitat, mean density was higher in both years for the high slope strata in every instance. Not surprisingly, if all habitats are combined from both years and only low vs. high strata are compared, the high slope strata have significantly higher density (Low: 127 ±8.9 fishes/SSU; High: 270 ±17.2 fishes/SSU; ANOVA, $p<0.05$). It is also worth noting that the spike in density for the RGDP–high stratum is largely attributable to the presence of high numbers of mackerel and rough scad (*Decapterus macarellus* and *D. punctatus*, respectively) in 2013.

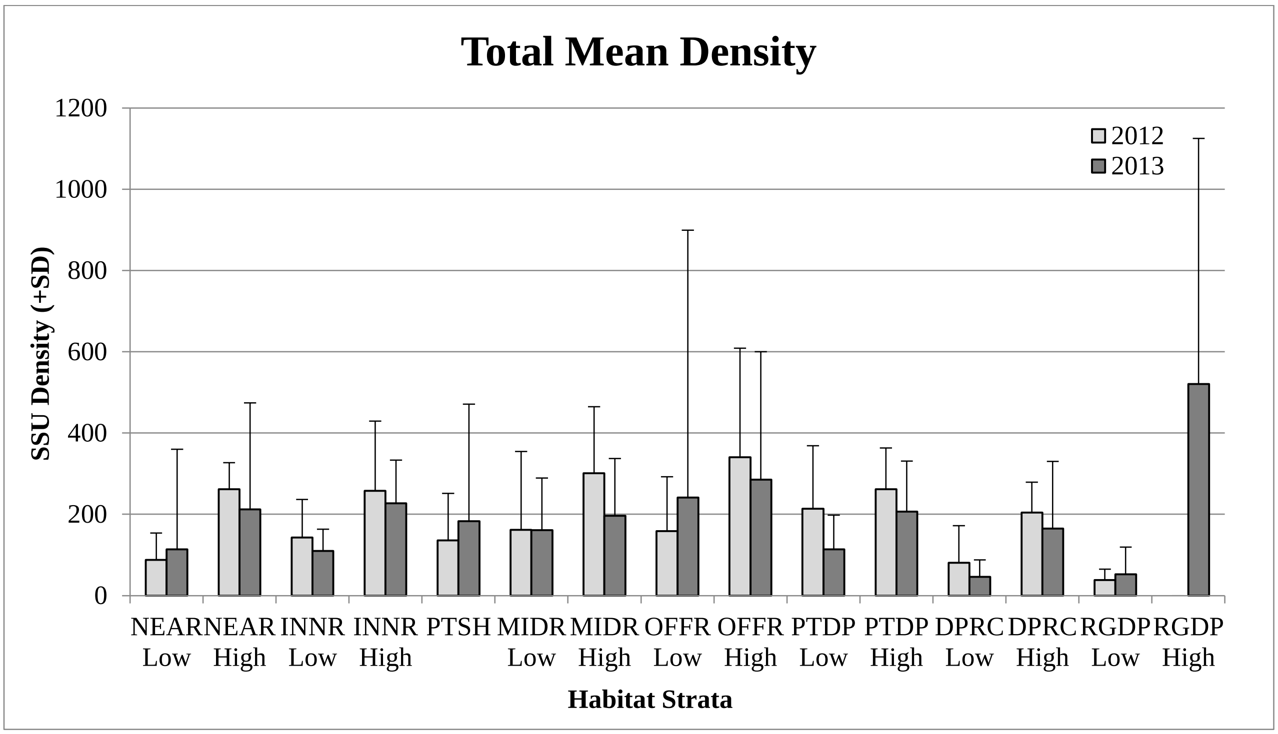

***Figure 3**. Mean SSU density by habitat strata, unfiltered data (including species observed after 10 minutes). NEAR-low (N=129,146), NEAR-high (N=8,16), INNR-low (N=41,33), INNR-high (N=4,12), PTSH (N=20,8), MIDR-low (N=68,50), MIDR-high (N=7,20), OFFR-low (N=66,71), OFFR-high (N=28,86), PTDP-low (24,33), PTDP-high (N=13,41), DPRC-low (N=19,82), DPRC-high (N=3,12), RGDP-low (N=2,18), RGDP-high (N=0,11).*

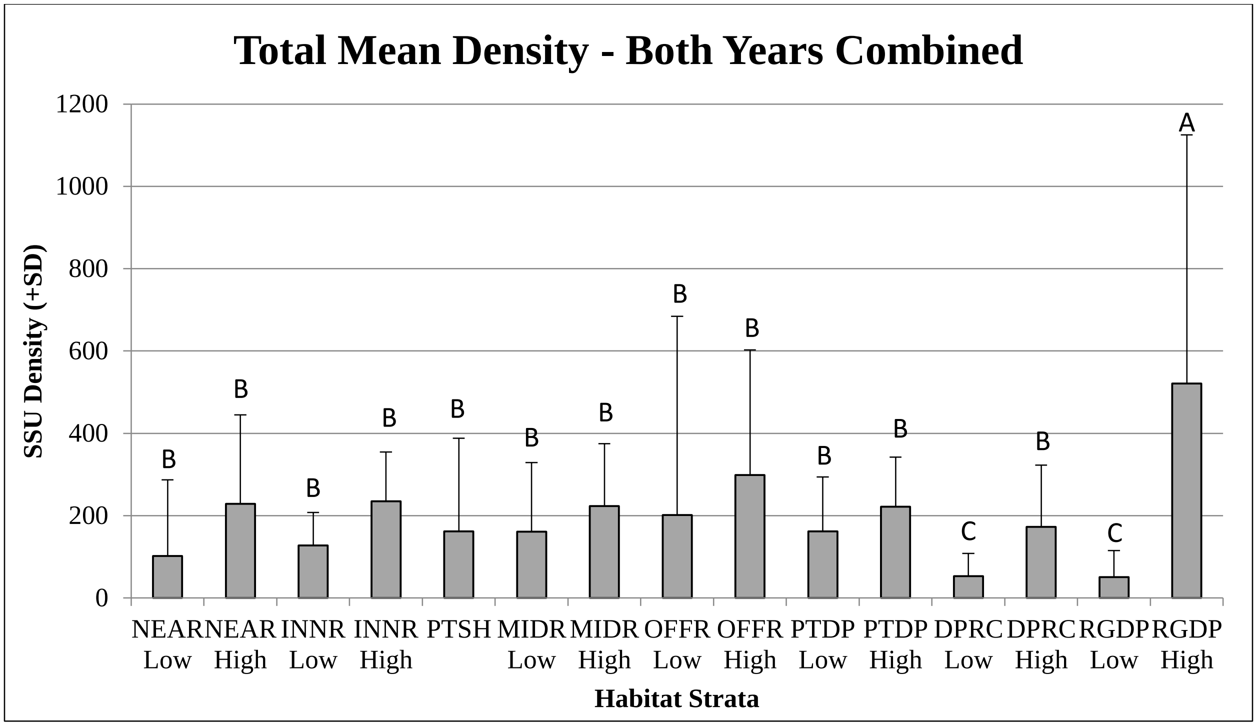

Figure 4. *Mean SSU density by habitat strata, both years combined. Letters above the bars indicate homogenous groupings (SNK, p<0.05). NEAR-low (N=275), NEAR-high (N=24), INNR-low (N=74), INNR-high (N=16), PTSH (N=53), MIDR-low (N=118), MIDR-high (N=27), OFFR-low (N=137), OFFR-high (N=112), PTDP-low (N=52), PTDP-high (N=46), DPRC-low (N=101), DPRC-high (N=15), RGDP-low (N=20), RGDP-high (N=13).*

4.1.2. Fish Species Richness

Mean species richness for all sites and strata combined for both years was 25.6 ±0.32 species/SSU. For 2012 mean species richness was 27 ±0.45 species/SSU and in 2013 it was 24.5 ±0.39 species/SSU. Similar to mean density, when all strata were compared on a yearly basis, 2012 was higher in every instance except for RGDP (Figure 5). Species richness was also significantly higher for both years on sites with high slope (Low: 22.6 ±0.32 species/SSU; High: 31.53 ±0.51 species/SSU; ANOVA, $p<0.05$). The reasons for the uniformly higher species richness observed across the board in 2012 are unclear. It is unlikely the difference is based on differences among individual counters. The same divers counted many of the same strata both years. Also it is unlikely the difference is an artifact of differences in diver identification skills as poorly trained divers are less likely to recognize and differentiate between species so it would be anticipated 2012 would have lower species counts than 2013. Year-to-year differences in richness are not uncommon (Kilfoyle et al., 2013). Interestingly, Gilliam et al. (2014) documented overall higher abundance and species richness of reef fishes in 2013 as compared to 2012 and every year prior. However, that study used transect surveys in addition to point-counts, and therefore inherently includes higher numbers of cryptic species and juveniles than the current study. Surveys for the Gilliam study took place on a limited number of habitats as well, and therefore it was not able to make the same kind of community level assessments on the number of habitats that are targeted in this study and as such may not be fully comparable.

The top 10 most abundant species averaged over both years were, in order of decreasing abundance: Bicolor damselfish, *Stegastes partitus*; Bluehead wrasse, *Thalassoma bifasciatum*; White grunt, *Haemulon aurolineatum;* Bridled goby, *Coryphopterus glaucofraenum*; unidentified/juvenile grunts, *Haemulon* spp.; Yellowhead wrasse, *Halichoeres garnoti*; Ocean surgeonfish, *Acanthurus bahianus*; Slippery dick wrasse, *Halichoeres bivitattus*; French grunt, *Haemulon flavolineatum*; and Redband parrotfish, *Sparisoma aurofrenatum.*

In terms of frequency of occurrence, the list is quite similar to the top 10 most abundant species, with 6 out of 10 species being present on both lists. In decreasing order: Sharpnose pufferfish, *Canthigaster rostrata*; Bluehead wrasse, *Thalassoma bifasciatum*; Ocean surgeonfish, *Acanthurus bahianus*; Bicolor damselfish, *Stegastes partitus*; Slippery dick wrasse, *Halichoeres bivitattus*; Doctorfish, *Acanthurus chirurgus*; Redband parrotfish, *Sparisoma aurofrenatum*; Yellowhead wrasse, *Halichoeres garnoti*; Spotted goatfish, *Pseudupeneus maculatus*; and Blue tang, *Acanthurus coeruleus*.

Following the 2013 survey, seven species not previously recorded in the FL Keys or Dry Tortugas were added to the species list used in the RVC data entry program. Those species are: Whitebone porgy, *Calamus leucosteus*; Black seabass, *Centropristis striata*; Mottled mojarra, *Eucinostomus lefroyi;* Oyster toadfish, *Opsanus tau;* Blackwing searobin, *Prionotus rubio;* Banded rudderfish, *Seriola zonata;* and Rough scad, *Trachurus lathami*. The porgy, seabass, toadfish, and searobin are considered as more temperate species that, logically, were found in the northern portion of the survey area. The northern regions (Martin and North Palm Beach) also had significantly lower species richness than those further south (ANOVA, $p<0.05$) (Figure 6).

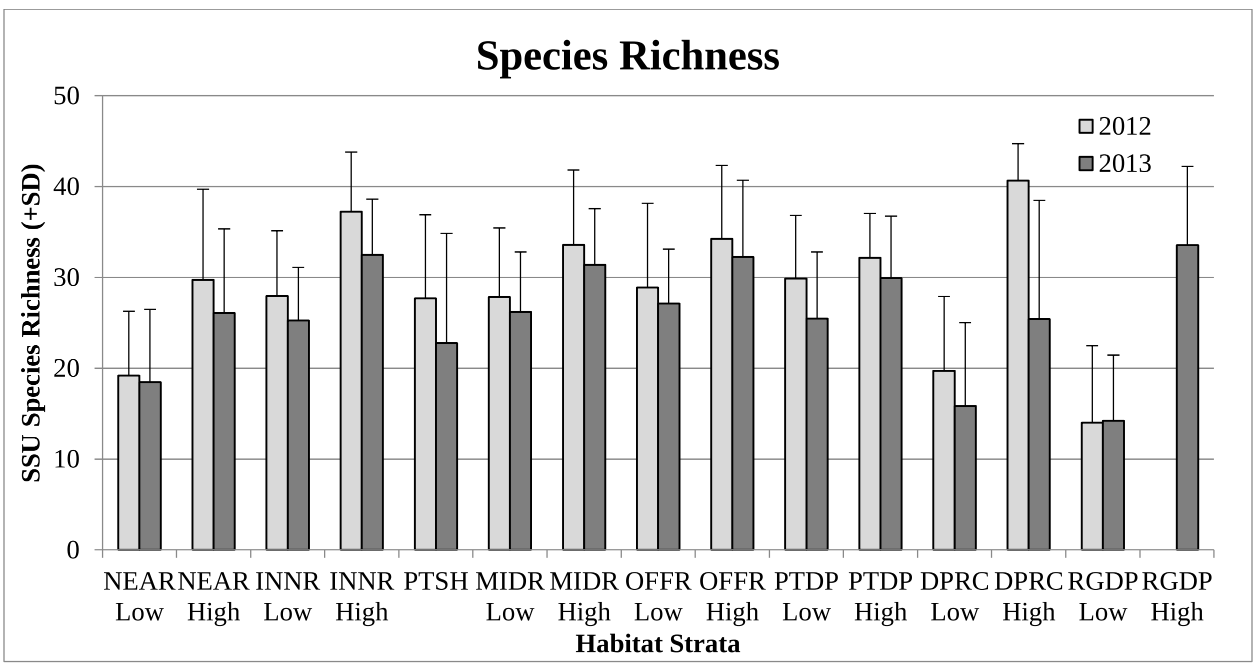

Figure 5*. Species richness by habitat strata; all species/unfiltered data. NEAR-low (N=129,146), NEAR-high (N=8,16), INNR-low (N=41,33), INNR-high (N=4,12), PTSH (N=20,8), MIDR-low (N=68,50), MIDR-high (N=7,20), OFFR-low (N=66,71), OFFR-high (N=28,86), PTDP-low (24,33), PTDP-high (N=13,41), DPRC-low (N=19,82), DPRC-high (N=3,12), RGDP-low (N=2,18), RGDP-high (N=0,11).*

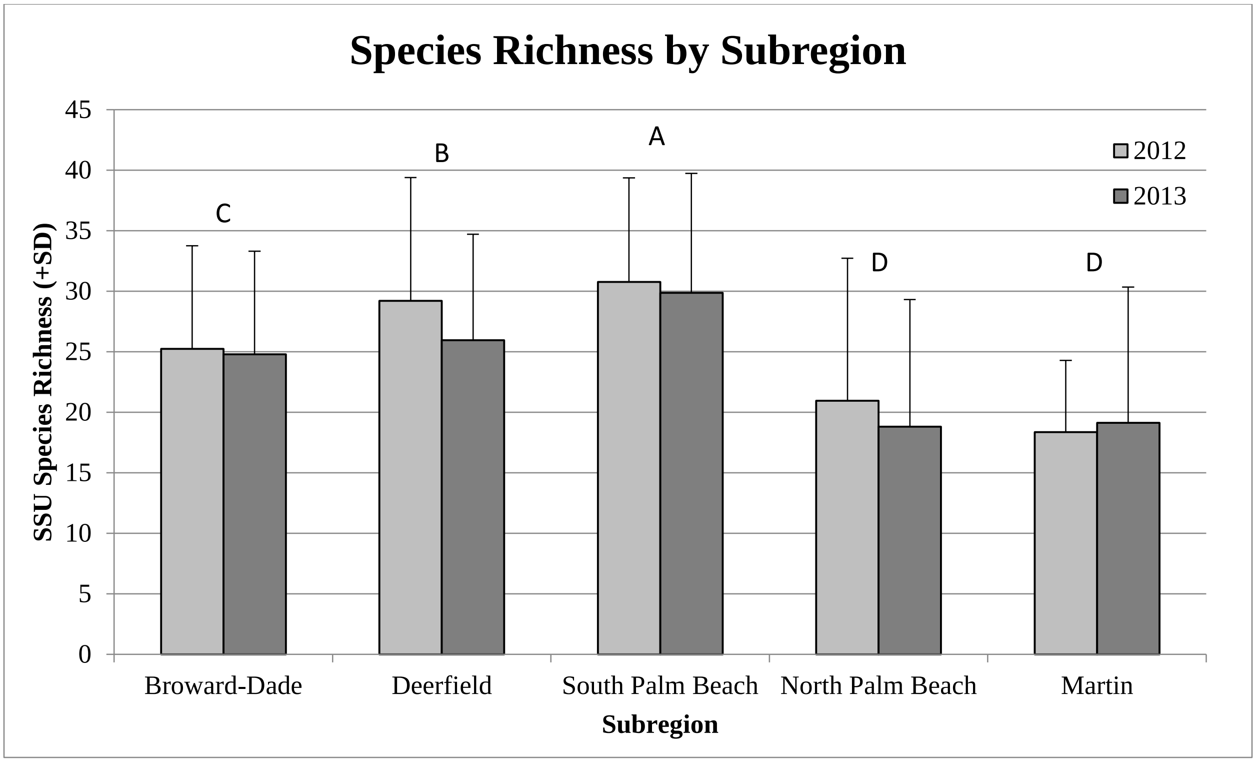

Figure 6. *Species richness broken down by biogeographic subregion. Letters above the bars indicate homogenous groupings (SNK, p<0.05). Broward-Dade (N=277,320), Deerfield (N=75, 90), South Palm Beach (N=40, 78), North Palm Beach (N=26,106), Martin (14, 45).*

4.1.3. Fish Community Regional Habitat Associations

Multivariate analyses showed patterns in the reef fish communities associated with benthic habitats (Figure 8). Surveys in many of the habitats clustered tightly indicating that the communities at these sites were most similar to each other. These included Linear Outer Reef (LIRO), Spur and Groove (SPGR), Colonized Pavement Deep (CPDP), Aggregated Patch Reef Deep (APRD), and Linear Reef Middle (LIRM). As indicated by their spread away from each other and the main cluster of points, other habitats contained more variable but relatively distinct communities. For example the Ridge Deep (RGDP) and Deep Ridge Complex (DPRC) were spread out and mostly separated from surveys in other habitats. The Ridge Shallow (RGSH) and Colonized Pavement Shallow (CPSH) were also spread out, however they were comingled indicating that the communities in these habitats, although variable, are more similar to each other than other habitats. These results agree with previously reported analyses on a large dataset for northern Broward County (Walker et al., 2009). Walker et al. (2009) found that fish communities were more tightly clustered in the deeper communities and more variable in the shallow. They also found that the communities on the shallow Ridge and Colonized Pavement were not statistically different and therefore considered a habitat classification higher up the hierarchy that combines those two habitats, the Nearshore Ridge Complex. Based on both Walker et al. (2009) and this study, it appears that combining the communities on the deeper habitats CPDP, LIRO, SPGR, APRD, and perhaps LIRM could be warranted.

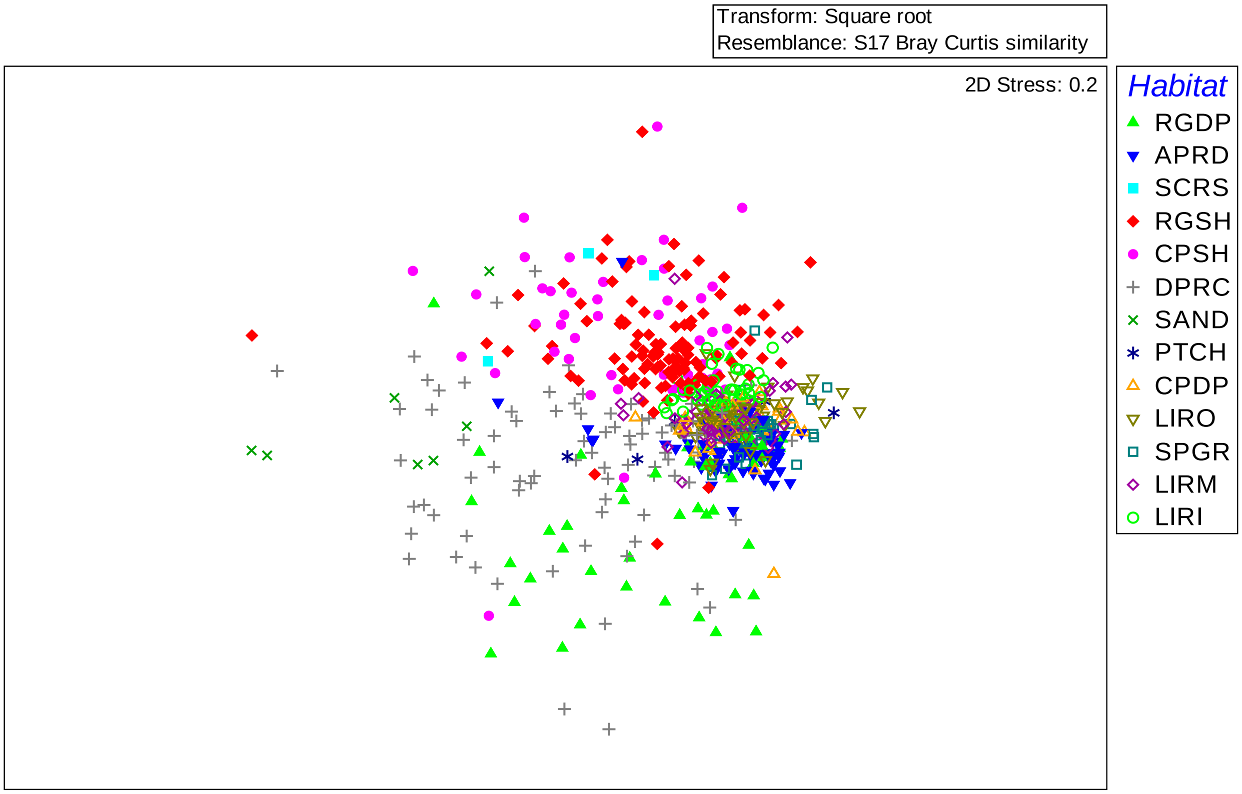

Figure 7*. MDS plot of all 2013 RVC SSUs categorized by Habitat.*

Since Ferro et al. (2003), Walker et al. (2009), and this study's results indicate depth is one of the primary determinants of fish community structure, the data were analyzed separately for surveys that occurred in deep habitats (APRD, CPDP, DPRC, LIRM, LIRO, PTCH, RGDP, SCRS, and SPGR) and shallow ones (CPSH, LIRI, and RGSH). Among the deep habitat surveys, a similar pattern emerged in the MDS (multi-dimensional scaling) with a tightly clustered area of sites and many others spread throughout much of the graph (Figure 8). The potential causes of this pattern were explained when categorizing the surveys by the coral reef ecosystem regions of Walker (2012) and Walker and Gilliam (2013). Most of the surveys in the southern regions (Broward-Miami, Deerfield, and South Palm Beach) all clustered tightly together indicating a high similarity between the communities in the deep habitats within these regions. Conversely, the deep habitat fish communities in North Palm Beach and Martin were much more variable and mostly separated in disparate areas of the plot. This suggests that the Martin and North Palm Beach fish communities are distinctly different from the southern regions, South Palm Beach, Deerfield, and Broward-Miami, which are more similar to each other. An analysis of similarity (ANOSIM) by region showed significant differences between Martin and North Palm Beach (R=0.37), South Palm Beach (R=0.76), Deerfield (R=0.79), and Broward-Miami (R=0.92) (Table 5).

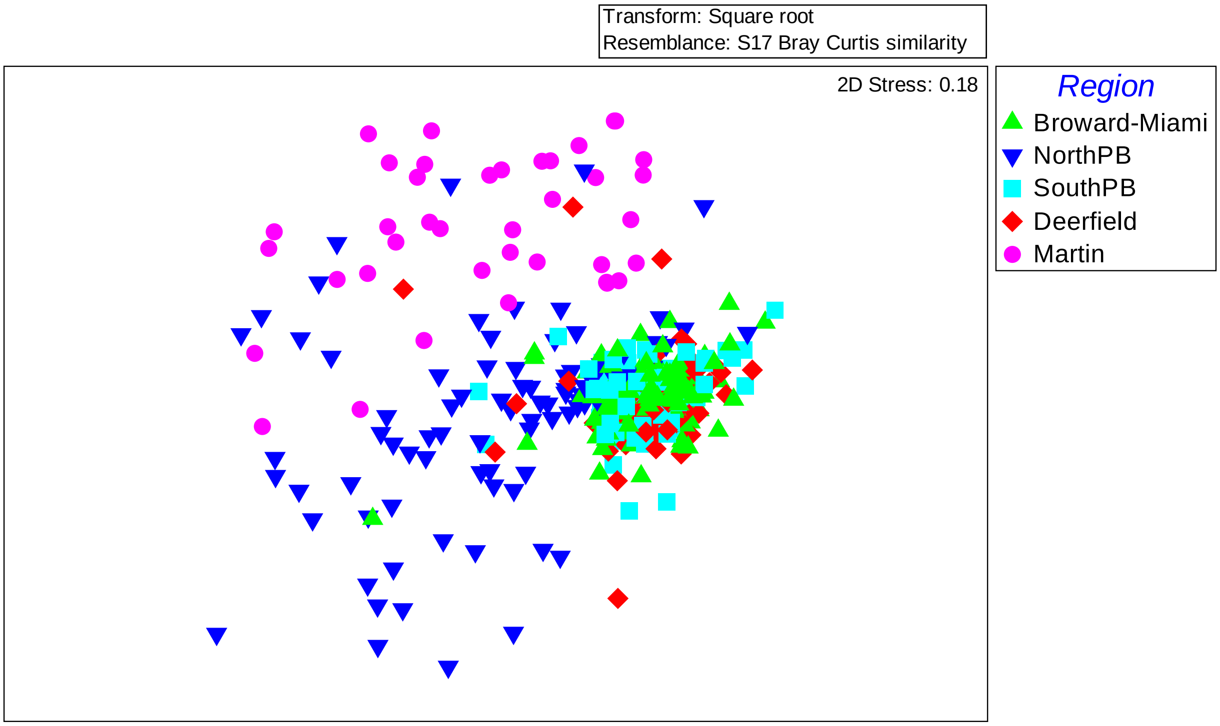

***Figure 8**. MDS plot of 2013 deep habitat (APRD, CPDP, DPRC, LIRM, LIRO, PTCH, RGDP, SCRS, and SPGR) fish surveys categorized by benthic habitat Coral Reef Ecosystem Regions of Walker et al. (2012) and Walker and Gilliam (2013).*

***Table 5.** A summary of the ANOSIM pairwise tests of the RVC data on Deep and Shallow Habitats between the five biogeographic regions. A significance level less than 5% indicates significance. The R statistic indicates the strength of the difference where 1 is the strongest and 0 is weakest.*

ANOSIM Pairwise Tests	**Deep Habitats**		**Shallow Habitats**	
	R Statistic	**Significance Level %**	**R Statistic**	**Significance Level %**
Broward-Miami, NorthPB	0.47	0.1	0.402	0.2
Broward-Miami, SouthPB	0.208	0.1	0.455	0.1
Broward-Miami, Deerfield	0.089	0.1	0.545	0.1
Broward-Miami, Martin	0.922	0.1	0.523	0.2
NorthPB, SouthPB	0.135	0.1	0.087	13.5
NorthPB, Deerfield	0.207	0.1	-0.042	63.6
NorthPB, Martin	0.372	0.1	0.615	0.2
SouthPB, Deerfield	0.069	0.1	0.028	21.8
SouthPB, Martin	0.759	0.1	0.56	0.1
Deerfield, Martin	0.79	0.1	0.138	10.7

Although not as compelling, the fish communities in shallow habitats also showed statistically significant patterns in the MDS (Figure 10). The shallow sites generally all had a wider spread within regions, but separation by region was evident. The Broward-Miami sites were mostly clustered together, but a few sites from other regions comingled in the cluster. ANOSIM showed significant differences between Martin and North Palm Beach (R=0.62) and Broward-Miami (R=0.52) (Table 5).

Although the individual counters differed to some degree between the north and south regions it is unlikely that this significantly impacted the results. All counters received the same RVC training and the significant differences between fish communities in the north regions (Martin and North Palm Beach) versus those further south coincide with differences in benthic communities of Walker and Gilliam (2013). They found that benthic communities were explained by differences in temperature regimes along the southeast Florida coast. The northern communities were dominated by cold-tolerant coral species and the number of tropical species was substantially diminished. Analyses of bottom temperature differences along the reef tract showed significant cold-water upwelling occurs more frequently and intensely in the northern regions north of an area refered to as the Bahamas Fracture Zone (Walker et al., *in prep*), a geological feature that coincides with the end of historical outer reef growth and where the Florida Current diverges from the coast. The upwelling is strongest in the deep habitats and less intense and frequent in the shallow ones. This could explain why the shallow fish communities are more similar between regions than the deep communities. Interestingly the region of highest species richness was South Palm Beach (Figure 6) which is just south of the Bahamas Fracture Zone.

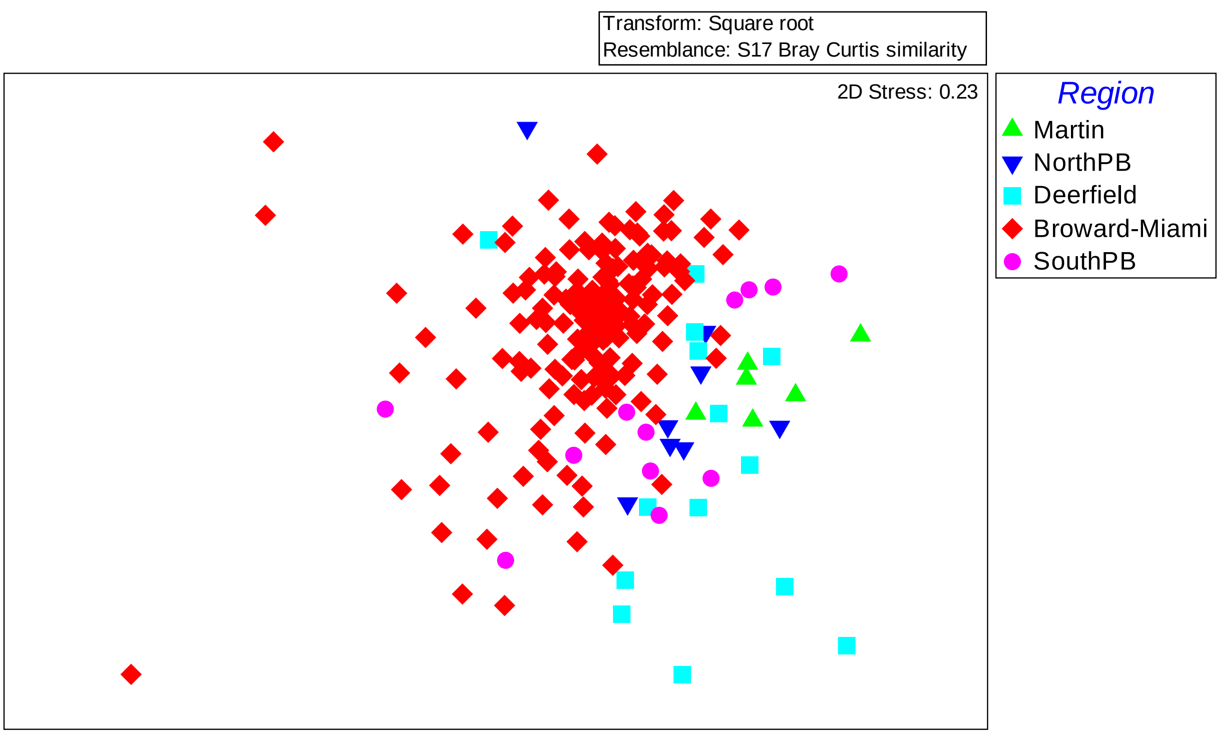

Figure 9*. MDS plot of 2013 shallow habitat (CPSH, LIRI, and RGSH) fish surveys categorized by benthic habitat Coral Reef Ecosystem Regions of Walker et al. (2012) and Walker and Gilliam (2013).*

Similarity percentage comparisons between regions indicated that the four top species contributing to the community differences in 2013 were Bicolor damselfish, *Stegastes partitus*; Bluehead wrasse, *Thalassoma bifasciatum*; Yellowhead wrasse, *Halichoeres garnoti*; *and* Tomtate, *Haemulon aurolineatum*. The MDS plot of deep habitat surveys (Figure 9) illustrated as bubble plots show the relative density of the individual species at each survey site (Figure 10). These are the exact same plots; however, each site is represented by the density of the particular species. Sites with large circles had high densities, small indicated very low density, and missing sites indicate none present. *Stegastes partitus*, *Thalassoma bifasciatum*, and *Halichoeres garnoti* are all tropical reef-associated species. The bubble plots show their highest densities in the cluster of south region sites and very low densities in the northern region sites indicating a loss of tropical species in the north. *Haemulon aurolineatum*, a species more tolerant of cold temperatures, was denser in the north. This may suggest that latitudinal differences in bottom temperature and upwelling are affecting the fish community compositions on the northern Florida Reef Tract.

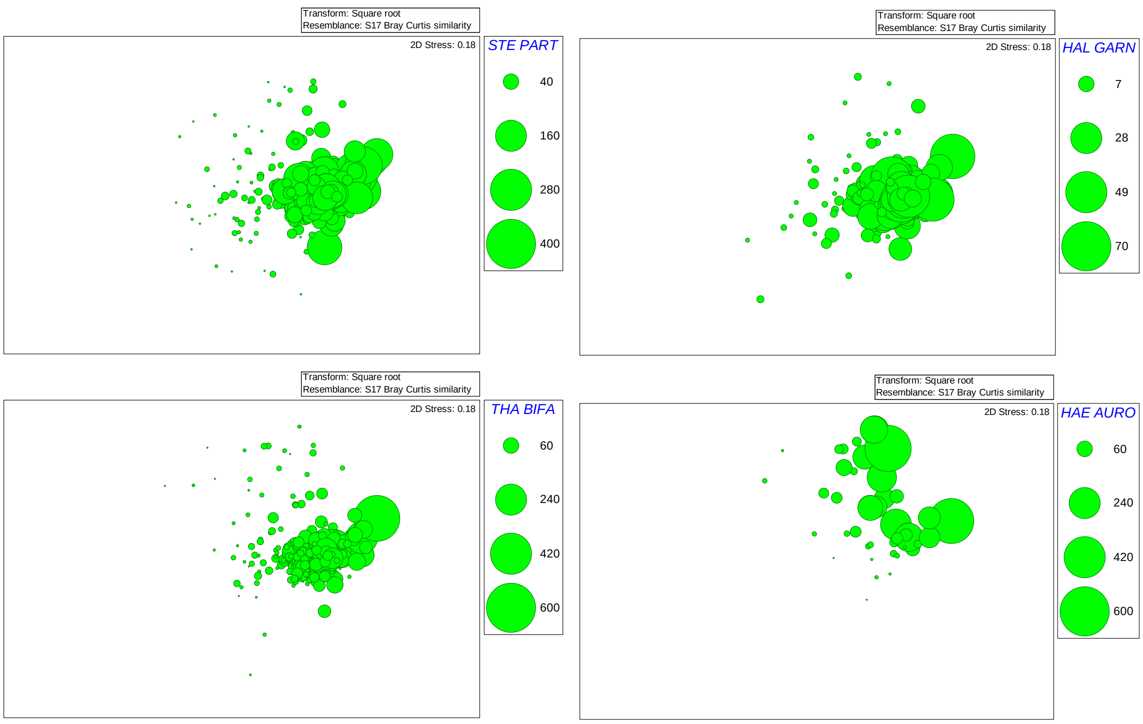

Figure 10*. Bubble MDS plots illustrating the density of each individual species contributing to the differences between north and south regions. Upper Left = Stegastes partitus; Upper Right = Halichoeres garnoti; Lower Left = Thalassoma bifasciatum; and Lower Right = Haemulon aurolineatum.*

4.1.4. Exploited Species

With a few notable exceptions, discussed below under the individual species, most of the exploited species showed a cosmopolitan but unequal distribution across all the strata, although not necessarily for both years. Of the eight species, the two species of grunts (*Haemulon* spp.) and the yellowtail snapper (*Ocyurus chrysurus*) exhibited dramatically higher density than the other species (Figure 11). When the data from both years are combined and split out by pre-exploited and exploited phase sized individuals, it is clear that for most of the exploited species the pre-exploited phase is largely responsible for driving the observed trends in total mean density (Figures 13, 16, 25, 28, 34). This is further confirmed by partitioning of the data into discrete size classes (by 5 cm increments) and plotting the total number of observations from each size class (Figures 14, 17, 26, 29, 35). In contrast, with white grunts (*Haemulon plumieri*), it appears that both pre-exploited and exploited phase life-stages are responsible for driving the observed trends (Figures 19, 20). With bluestriped grunt (*Haemulon sciurus*) the data suggest that pre-exploited phase individuals are largely responsible for driving the observed trends in the low relief strata, whereas the larger exploited individuals are more prevalent on high relief (Figures 22, 23) and with gray snapper (*Lutjanus griseus*) the data suggest that the pre-exploited phase is largely responsible for driving the observed trends within the shallower habitats while the exploited phase dominates the deeper areas (Figures 31, 32). It is noteworthy that the pre-exploited size ranges for all the exploited species have low numbers in newly settled and early juvenile size ranges. This likely indicates that either nursery areas were not targeted or the count methodology was not effective for fishes in this size range, or both.

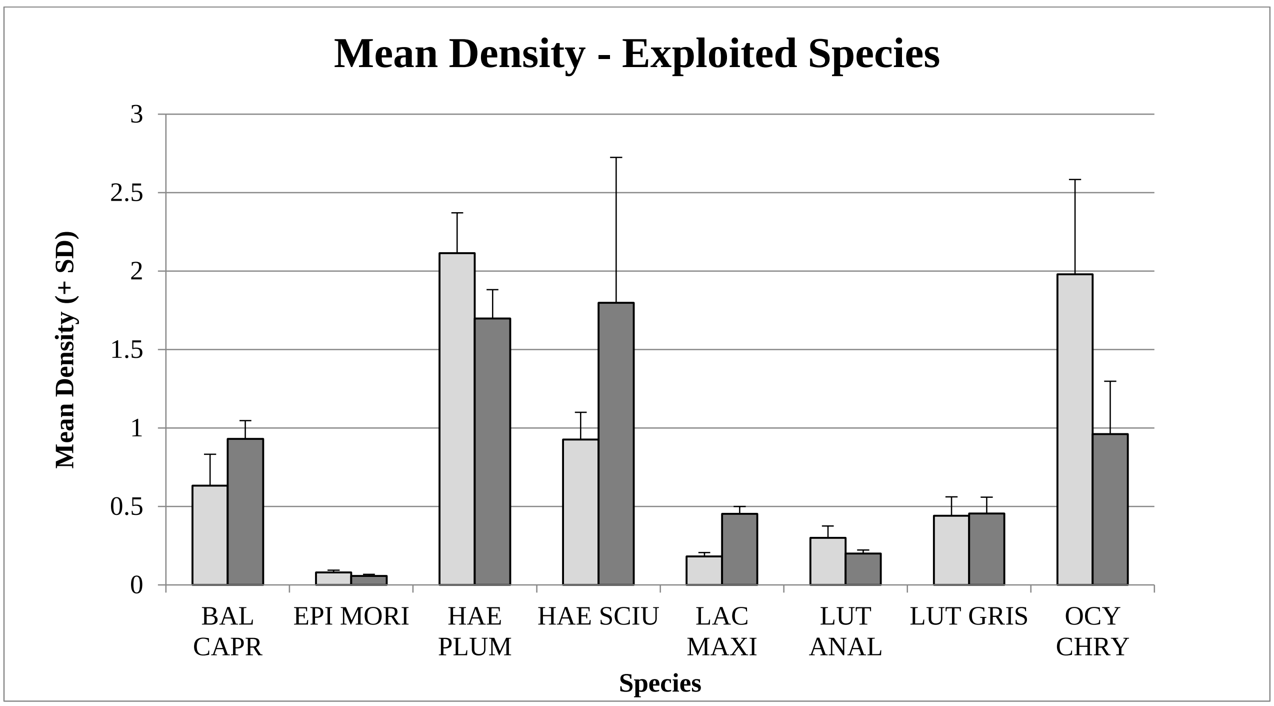

***Figure 11**. Mean Density for exploited species. Light bars = 2012, dark bars = 2013.*

4.1.5. Exploited Species: Gray Triggerfish

Gray triggerfish (*Balistes capriscus*) was the 19th most frequently observed species, with an average percent occurrence of 35.4 and average density of 0.78 fishes/SSU (Appendix 5). Percent occurrence of this species in the FL Keys and Dry Tortugas was below 10%. Comparison of *B. capriscus* densities by habitat strata (Figure 12) reveals shared peaks in the following strata for both years: shallow patch-reef (PTSH), middle reef (MIDR), and deep ridge complex (DPRC). The ridge-deep (RGDP) stratum from Martin County also exhibits a peak in 2013, but that stratum was under-sampled in 2012 and therefore stands alone. In addition, it is noted that for each low-high slope pairing within a given strata the low relief sites had higher *B. capriscus* densities in almost every instance. Comparison of the different lifestages to low and high relief habitats shows a clear association of pre-exploited phase triggerfish for low-relief, suggesting that juveniles may prefer low-relief habitats. The average size of exploited-phase individuals was 32 cm, and 8.8% of the total number of *B. capriscus* observed qualified as exploited-phase (≥30cm). In addition, a gradual trend of increasing size with increasing depth was also noted, with the largest individuals occurring in the RGDP and DPRC strata and in the North Palm Beach and Martin subregions. Greatest density was observed in the South Palm Beach subregion, and from the 10-15m and 15-20m depth ranges.

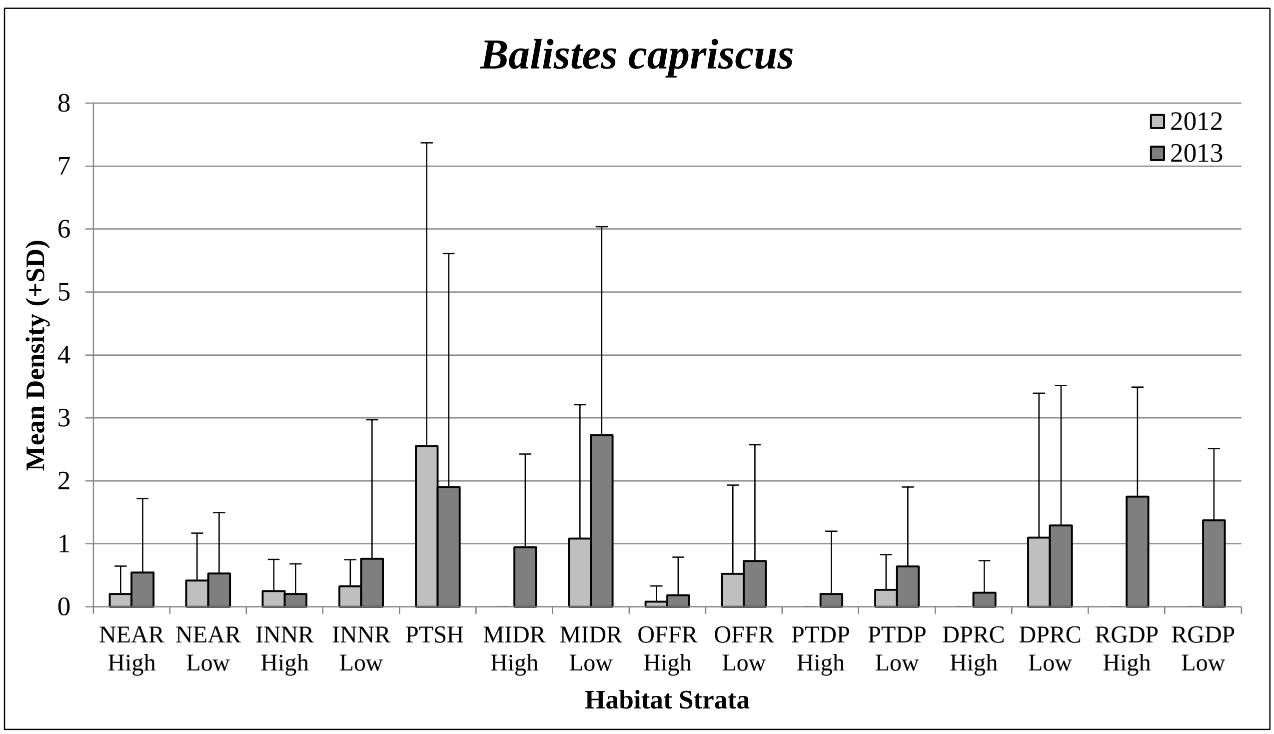

***Figure 12**. Gray triggerfish (*Balistes capriscus*) total mean density per habitat strata; yearly comparison.*

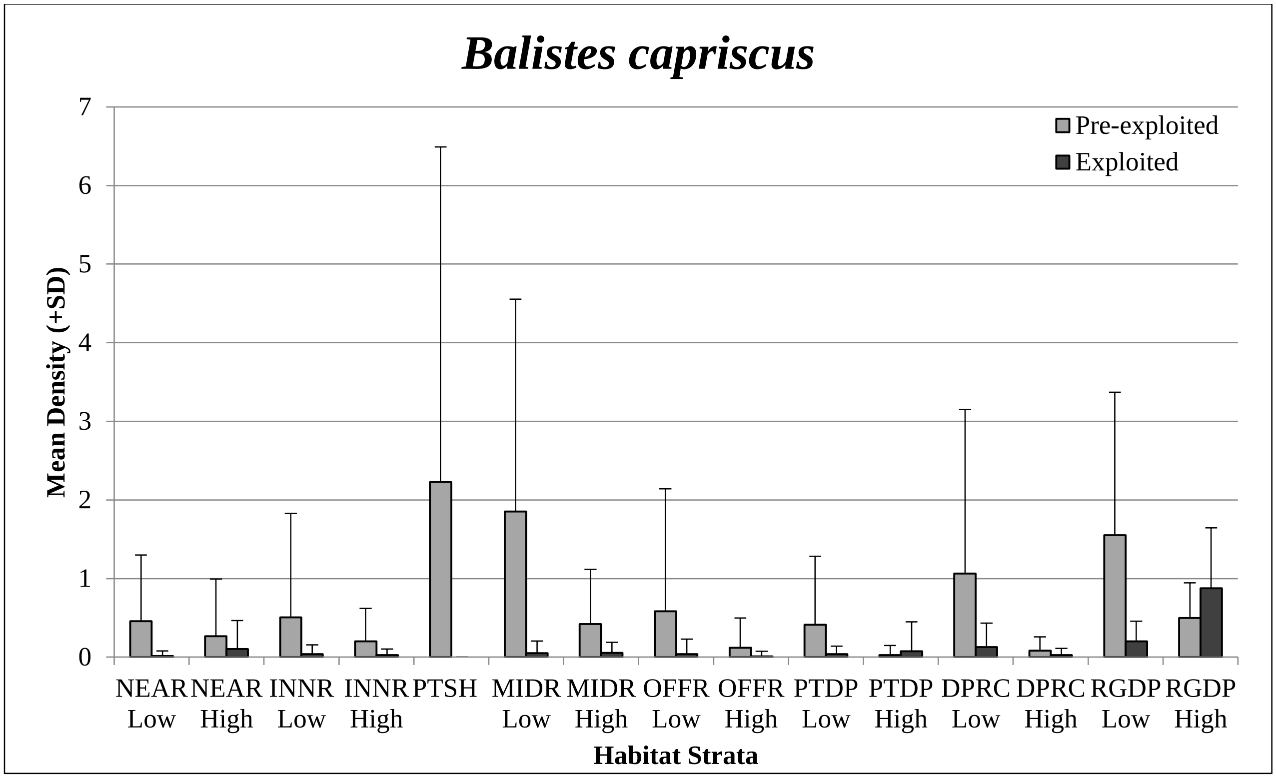

Figure 13. *Gray triggerfish (*Balistes capriscus*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2012 and 2013 combined.*

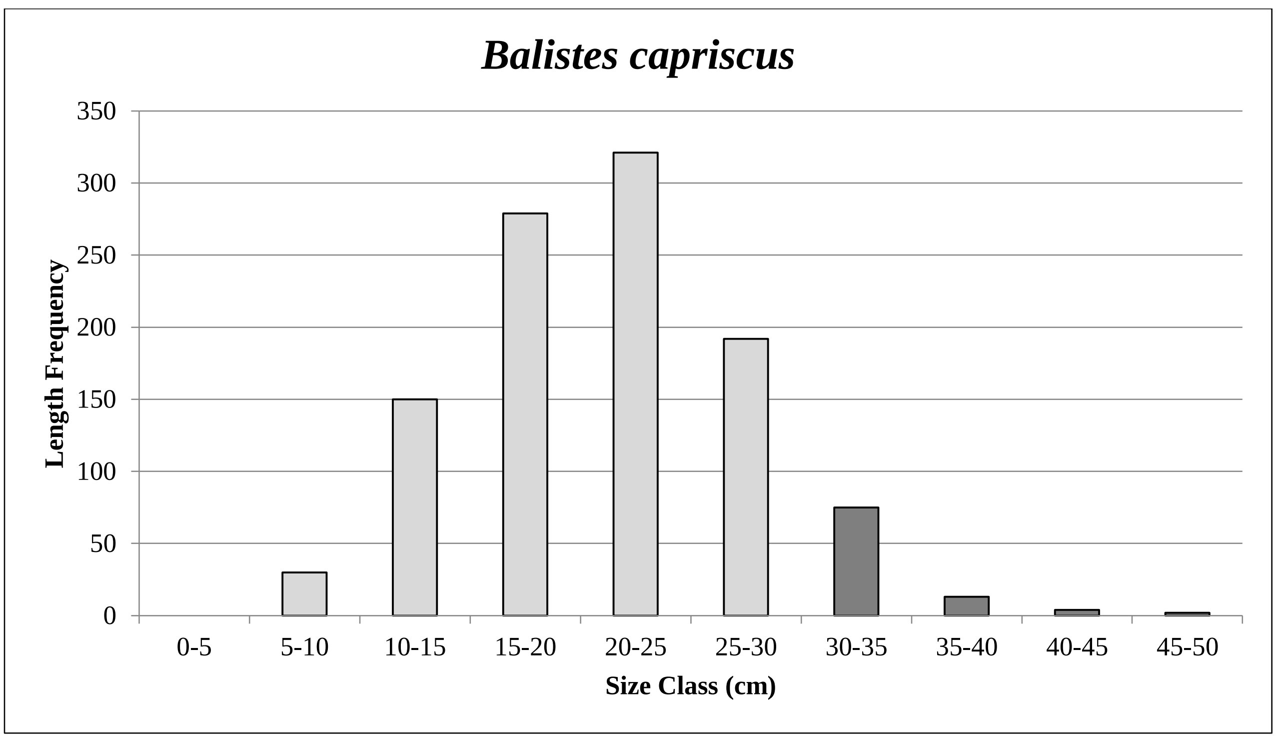

Figure 14. *Length frequency of Gray triggerfish (*Balistes capriscus*) by size class. Darker grey indicates exploited size classes.*

4.1.6. Exploited Species: Red Grouper

Red grouper (*Epinephelus morio*) was the 66th most frequently observed species, with an average percent occurrence (*P*) of 10.5 and average density (*D*) of 0.07 fishes/SSU (Appendix 7). Comparatively, the data suggest that southeast FL has far fewer red groupers than the FL Keys (*P*=20.4, *D*=0.16) and Dry Tortugas (*P*=62.2, *D*=0.62). Examination of *E. morio* densities by habitat strata (Figure 15) reveals a considerable amount of inter-annual variation. Greater numbers of grouper were observed in 2012 than in 2013 for all habitats, with the exception of the ridge-deep (OFFR) and patch deep (PTDP) strata. Greatest densities were observed in the linear reef-inner (INNR), patch reef-shallow (PTSH), linear reef-middle (MIDR), ridge-deep (OFFR), aggregated patch reef-deep (PTDP), and deep ridge complex (DPRC) strata. Additionally, the greatest number of observations was made in the 15-20m depth range. When low-high slope pairings within strata are compared, the data suggests that there may be a preference for low relief habitats for all strata except PTDP and DPRC. Occurrences of *E. morio* were shown to decrease from south to north. The average size of exploited-phase individuals was 56 cm, and 6.0% of the total number observed qualified as exploited-phase (≥50cm). Groupers of legal size were only encountered on the ridge-shallow (NEAR-low), linear reef-middle (MIDR-low), and ridge-deep (OFFR-low) habitats (Figure 16).

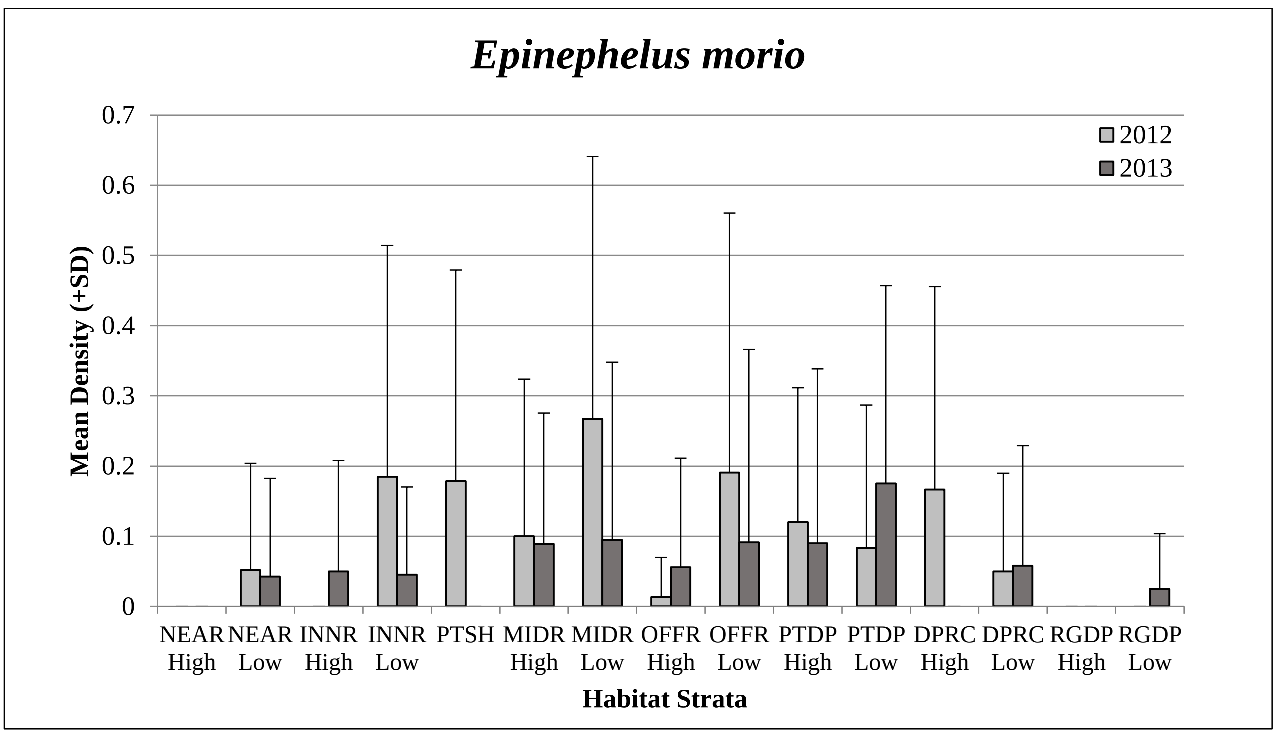

Figure 15. *Red grouper (*Epinephelus morio*) total mean density per habitat strata; yearly comparison.*

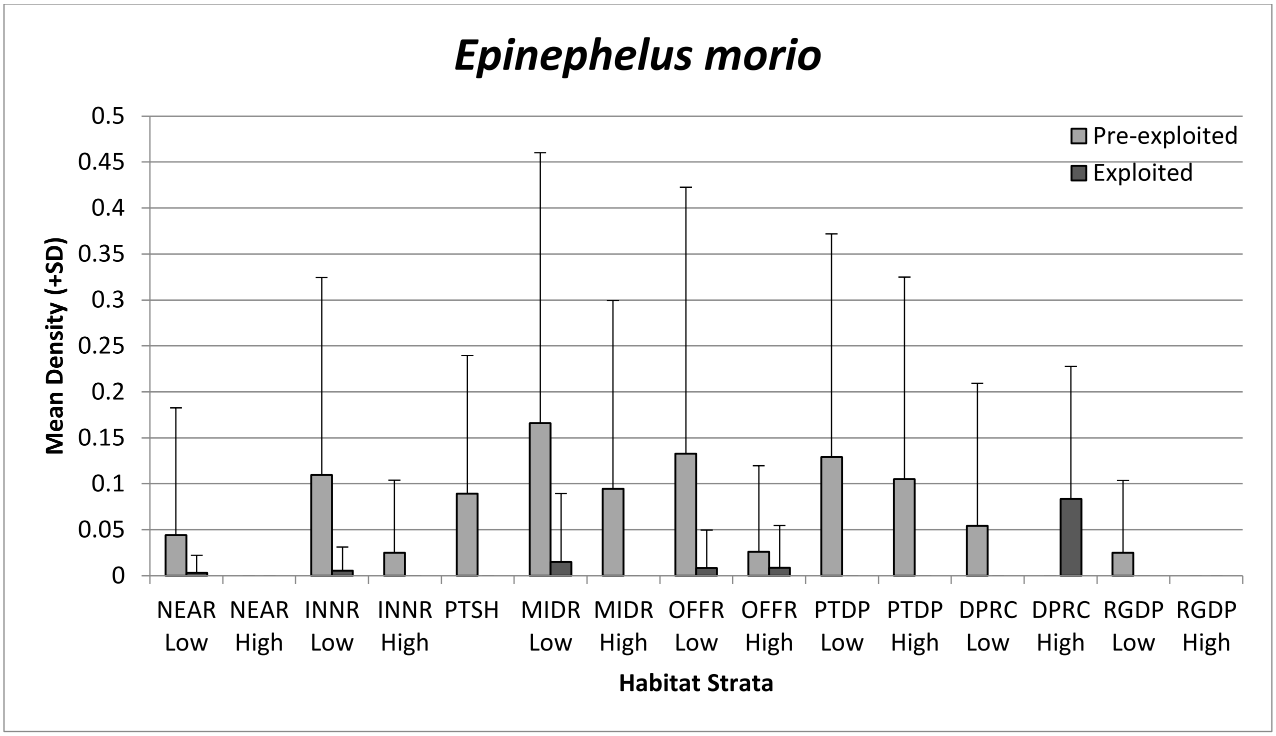

Figure 16. *Red grouper (*Epinephelus morio*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2012 and 2013 combined.*

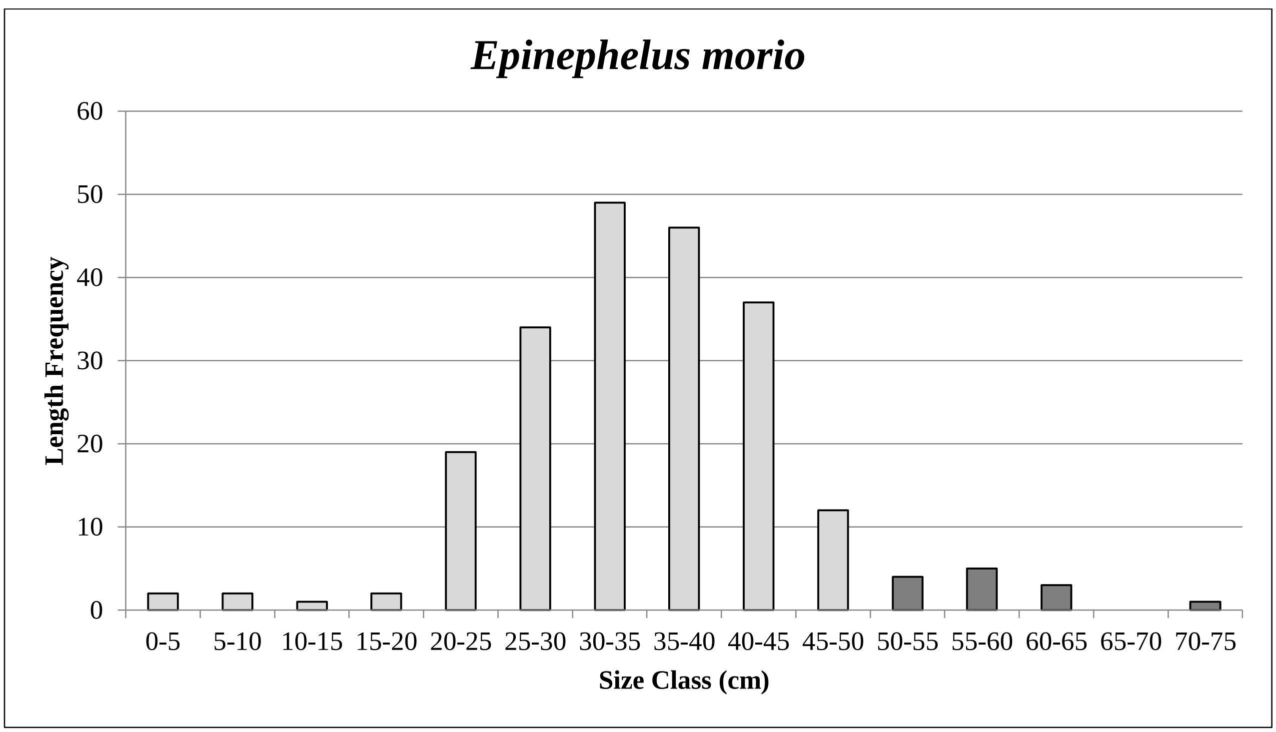

Figure 17*. Length frequency of Red grouper (*Epinephelus morio*) by size class. Darker grey indicates exploited size classes.*

4.1.7. Discussion of White Grunt

White grunt (*Haemulon plumieri*) was the 11th most frequently observed species, with an average percent occurrence (*P*) of 45.2 and average density (*D*) of 1.91 fishes/SSU (Appendix 7). Comparatively, the data suggest that southeast FL has fewer white grunts than the FL Keys (*P*=73.5, *D*=8.96) and Dry Tortugas (*P*=79.6, *D*=6.58). Examination of *H. plumieri* densities by habitat strata (Figure 18) reveals, for the most part, a high degree of consistency between 2012 and 2013 and across strata. Greatest densities were recorded on linear reef-inner (INNR) and deep ridge complex (DPRC) habitats, both coinciding with high slope strata. Otherwise, there does not appear to be an association with low versus high slope habitats. Additionally, the greatest number of observations comes from the 5-10m depth range. The average size of exploited-phase individuals was 23 cm, and 34.3% of the total number observed qualified as exploited-phase (≥20cm). White grunts of legal size were encountered in every habitat strata. The average size of *H. plumieri* increases marginally but steadily across a longitudinal gradient, with the smallest individuals occurring in the 0-5m depth range and the largest in 25-30m.

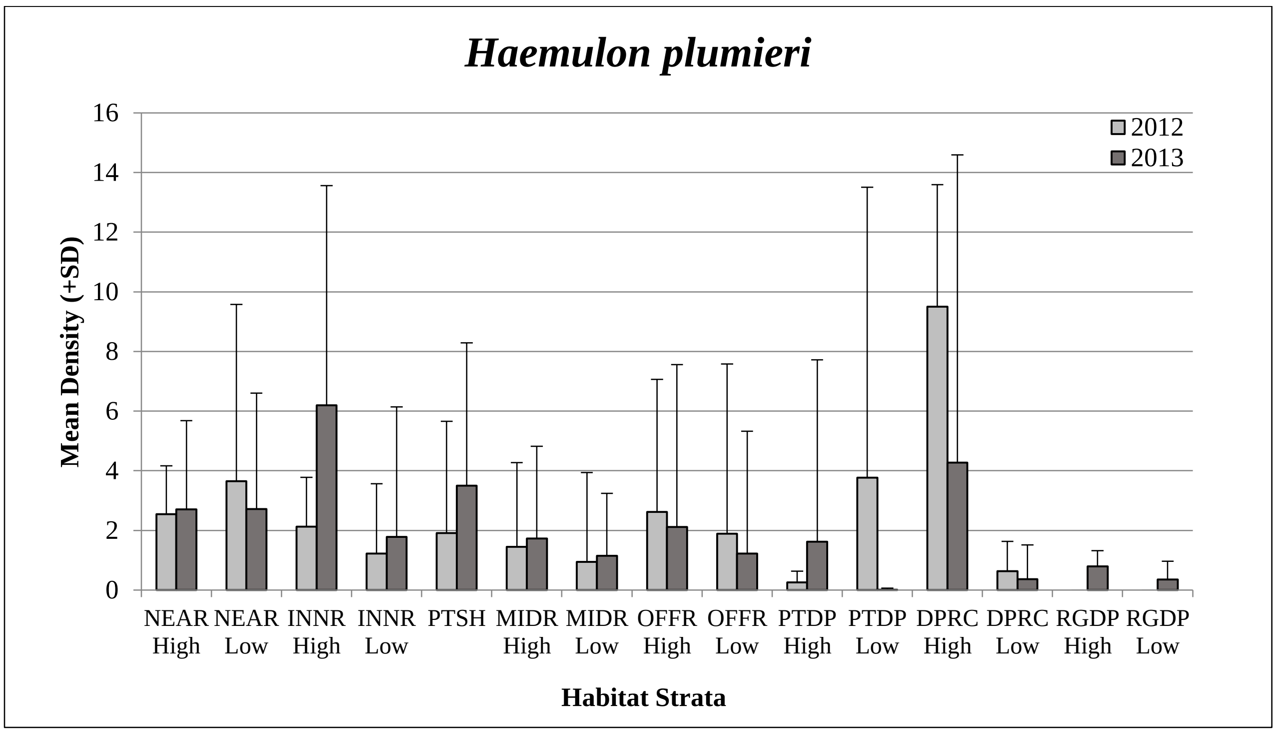

***Figure 18**. White grunt (*Haemulon plumieri*) total mean density per habitat strata; yearly comparison.*

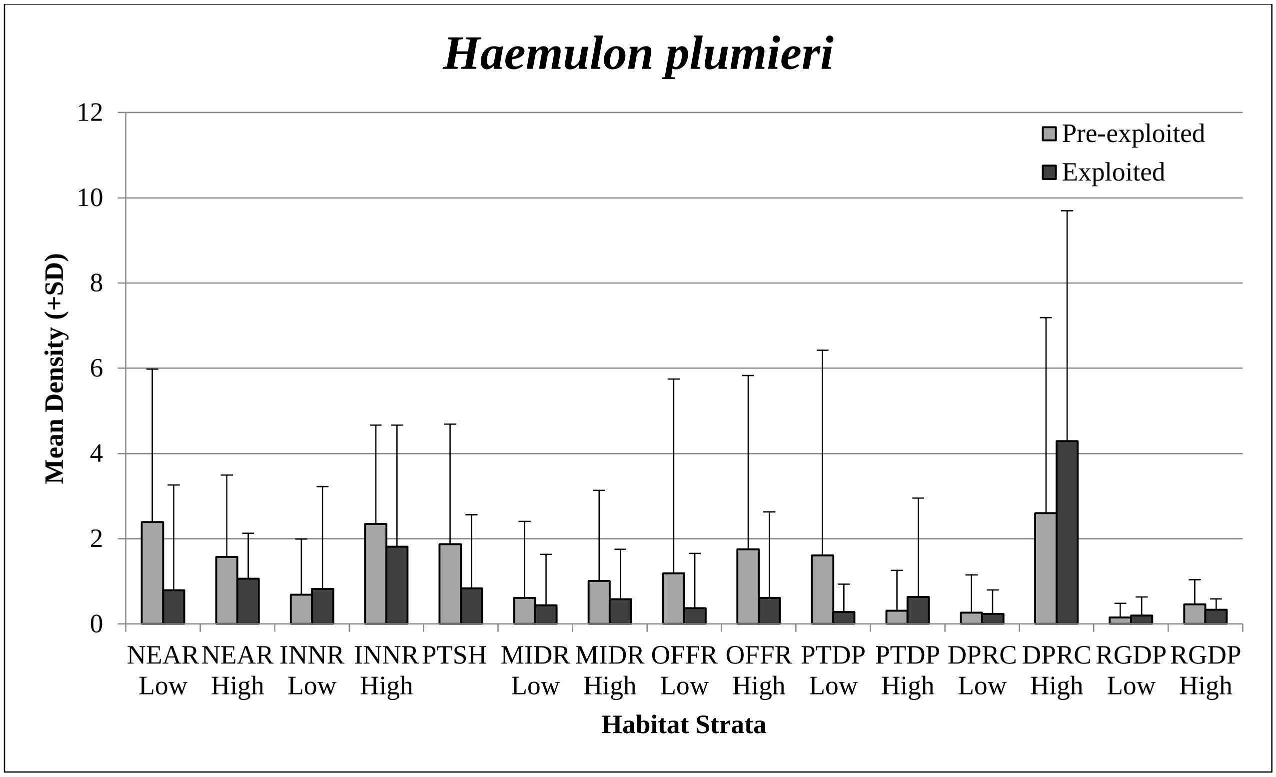

***Figure 19**. White grunt (*Haemulon plumieri*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2012 and 2013 combined.*

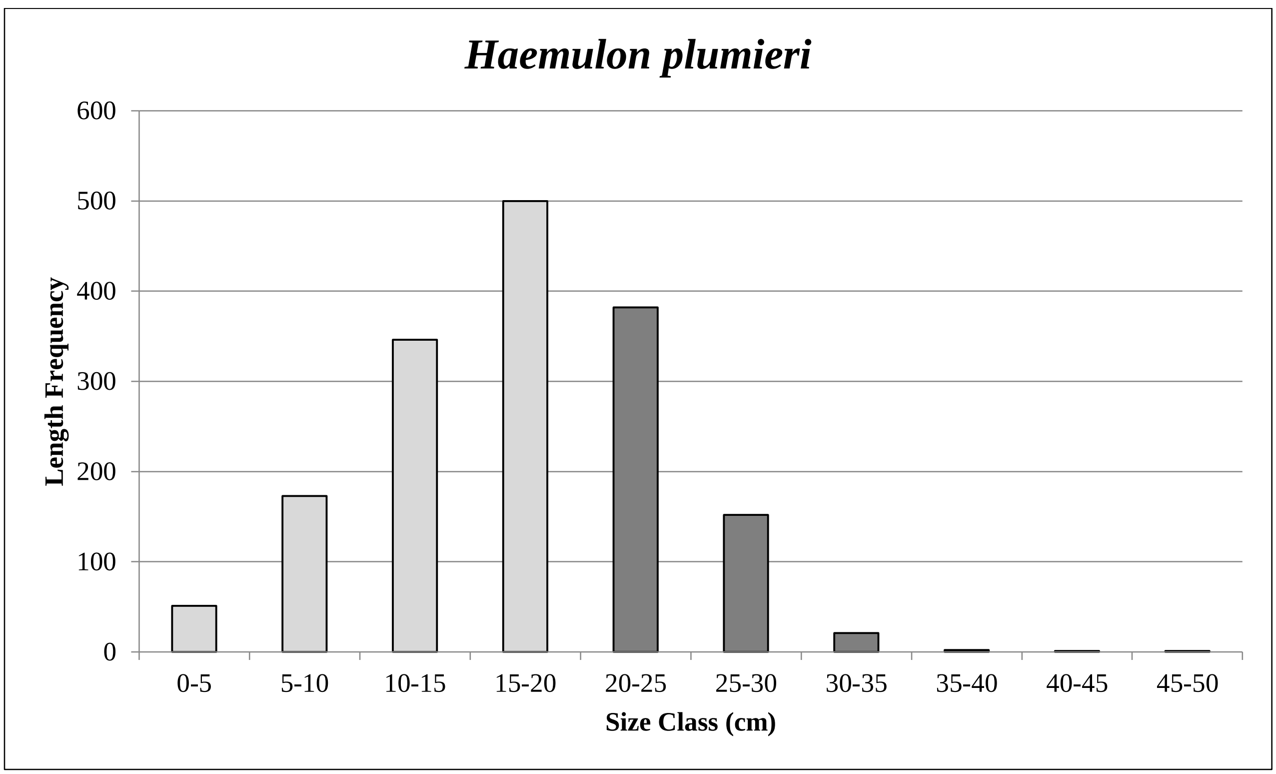

***Figure 20**. Length frequency of White grunt (*Haemulon plumieri*) by size class. Darker grey indicates exploited size classes.*

4.1.8. Discussion of Bluestriped Grunt

Bluestriped grunts (*Haemulon sciurus*) were not as commonly encountered as *H. plumieri*, ranking 41st among the most frequently observed species and with an average percent occurrence (*P*) of 17.5 and average density (*D*) of 1.36 fishes/SSU (Appendix 7). Percent occurrence of this species in the FL Keys and Dry Tortugas was below 10%. Comparison of *H. sciurus* densities by habitat strata (Figure 21) reveals a moderate amount of inter-annual variation, with more fish observed in 2012 than in 2013. Greater numbers of grunts were observed on ridge shallow (NEAR- high and low), linear reef-inner (INNR- high and low), and linear reef-middle (MIDR) in 2013 for all habitats, although they were largely absent from many of the remaining strata that year. There was a peak in density for the South Palm Beach subregion. Additionally, the greatest number of observations was made in the 5-10m depth range. This coincides with the relatively greater recorded densities for the NEAR and INNR habitats in 2013. When low-high slope pairings within strata were compared, there seemed to be no preference for either. The average size of exploited-phase individuals was 23.5 cm, and 40.6% of the total number observed qualified as exploited-phase (≥20cm).

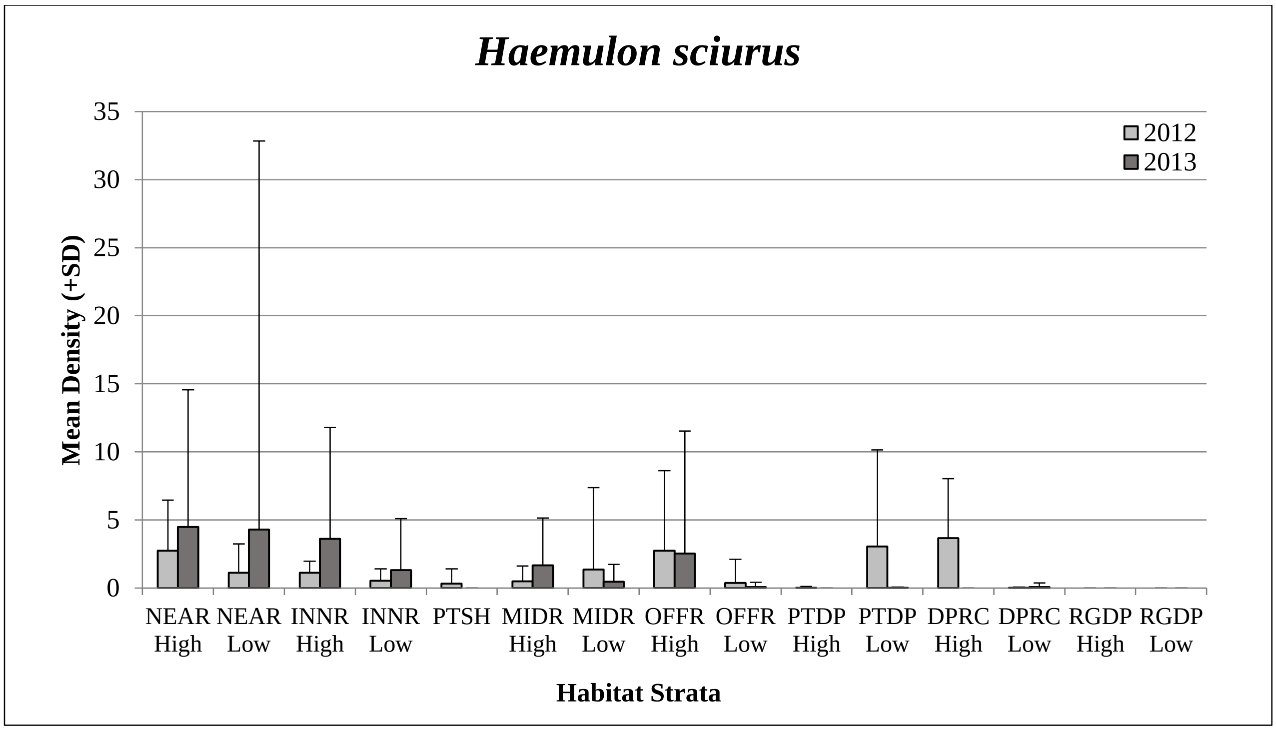

Figure 21. *Bluestriped grunt (*Haemulon sciurus*) total mean density per habitat strata; yearly comparison.*

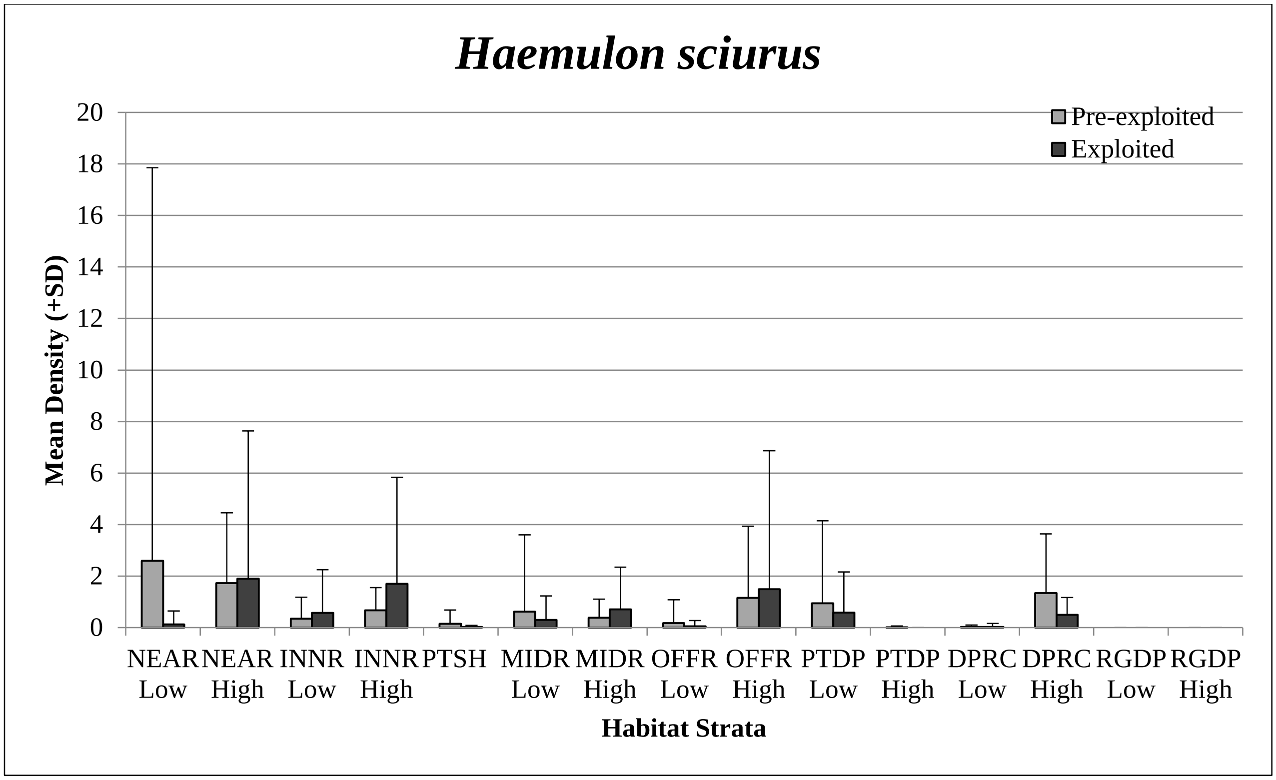

Figure 22. *Bluestriped grunt (*Haemulon sciurus*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2012 and 2013 combined.*

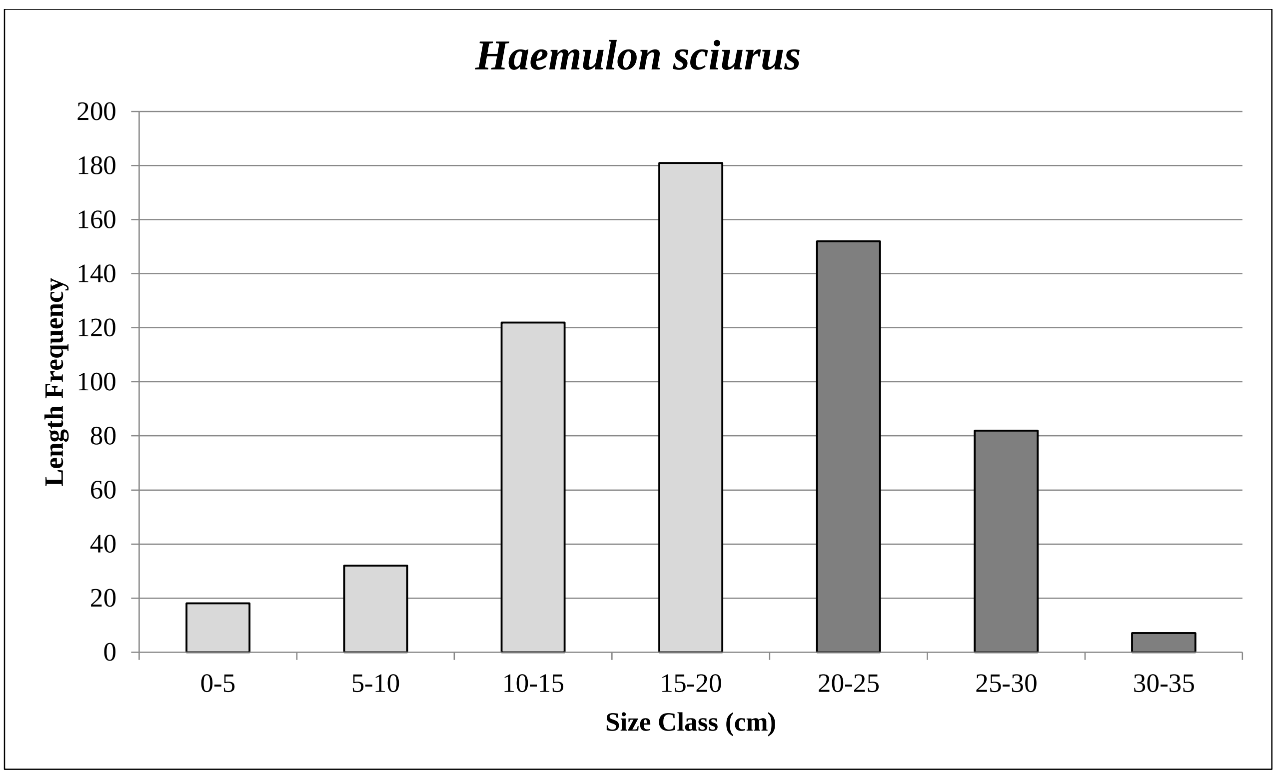

Figure 23. *Length frequency of Bluestriped grunt (*Haemulon sciurus*) by size class. Darker grey indicates exploited size classes.*

4.1.9. Discussion of Hogfish

Hogfish (*Lachnolaimus maximus*) was the 30th most frequently observed species, with an average percent occurrence of 22.5 and average density of 0.32 fishes/SSU (Appendix 7). Comparatively, the data suggest that southeast FL has fewer hogfish than the FL Keys (*P*=62.5, *D*=1.15) and Dry Tortugas (*P*=48.1, *D*=0.55). Examination of *L. maximus* densities by habitat strata (Figure 24) reveals a considerable amount of inter-annual variation, with 2013 exhibiting the greatest densities in all strata. When low-high slope pairings within strata are compared, there does not seem to be any preference for low versus high slope habitats in any strata. The average size of exploited-phase individuals was 33.9 cm, and 22.7% of the total number observed qualified as exploited-phase (≥30cm). Hogfish of legal size were encountered in every habitat strata except deep ridge complex (DPRC-low) and ridge-deep (RGDP-low/Martin County), with the greatest concentration of large individuals occurring in the aggregated patch reef-shallow (PTSH) and linear reef-middle (MIDR). Mean fork length *of L. maximus* increased from south to north. Also, it is interesting to note that the largest individuals occurred in both the 0-5m and 25-30m depth ranges.

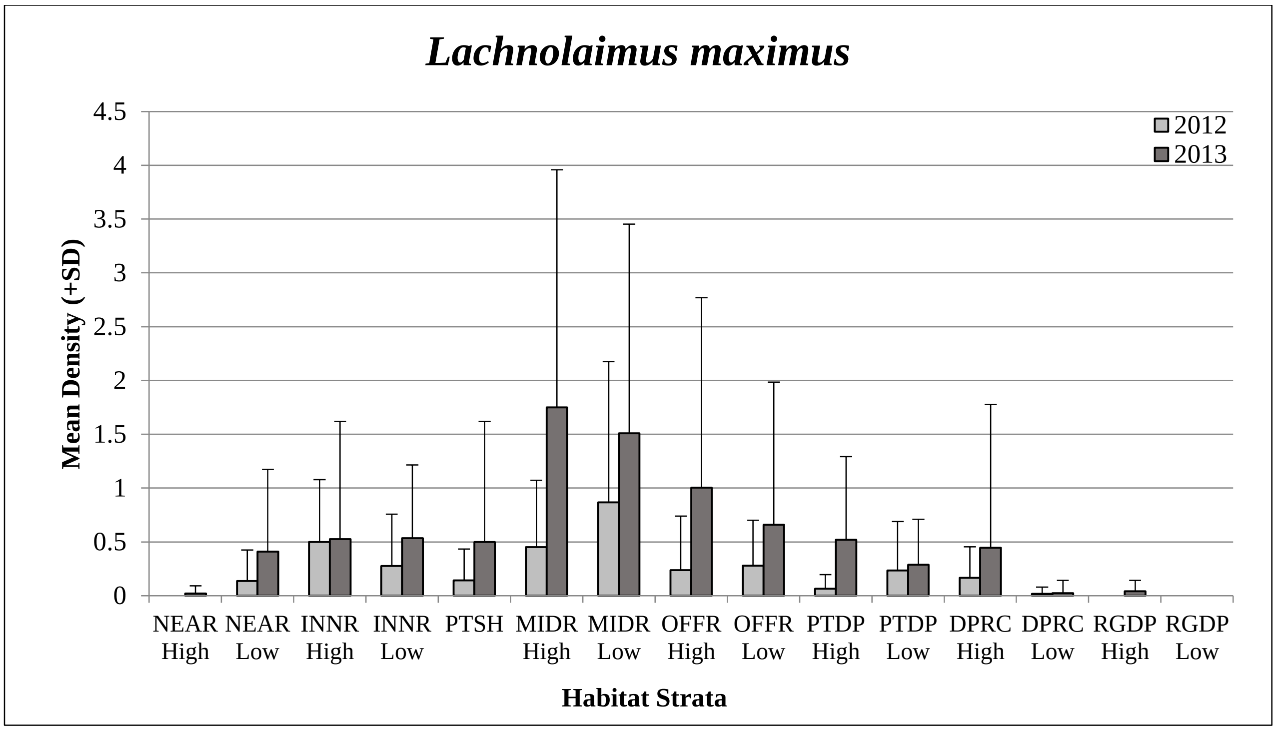

Figure 24. *Hogfish (*Lachnolaimus maximus*) total mean density per habitat strata; yearly comparison.*

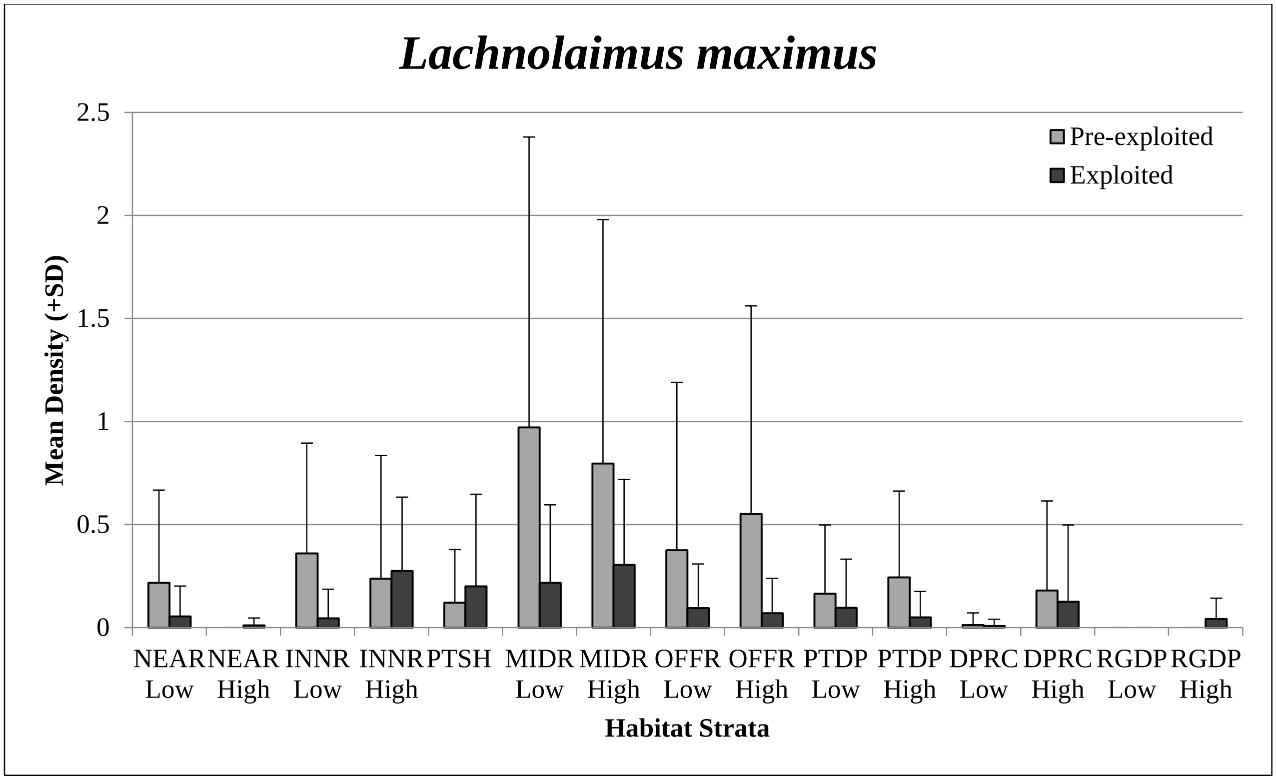

***Figure 25.** Hogfish (*Lachnolaimus maximus*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2012 and 2013 combined.*

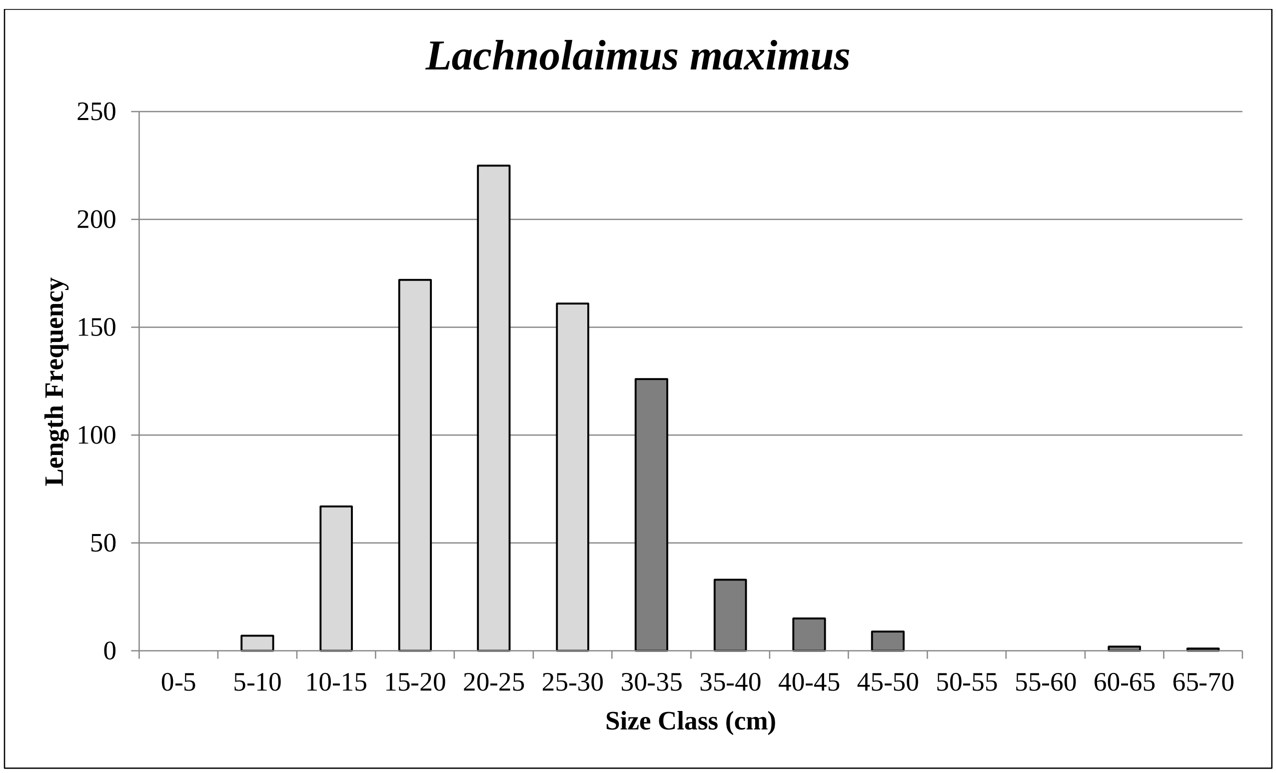

***Figure 26.** Length frequency of Hogfish (*Lachnolaimus maximus*) by size class. Darker grey indicates exploited size classes.*

4.1.10. Discussion of Mutton Snapper

Mutton snapper (*Lutjanus analis*) was the 29th most frequently observed species, with an average percent occurrence (*P*) of 23.8 and average density (*D*) of 0.25 fishes/SSU (Appendix 7). Comparatively, the data suggest that southeast FL has more mutton snappers than the FL Keys (*P*=17.8, *D*=0.18) and Dry Tortugas (*P*=22.8, *D*=0.19). Examination of *L. analis* densities by habitat strata (Figure 27) reveals a considerable amount of inter-annual variation, with 2013 exhibiting the greatest densities in all strata except for the deep ridge complex (DPRC-low). In 2012 the DPRC-low strata was responsible for 45% of all *L. analis* observations that year. In 2013, mutton snappers favored PTSH, MIDR, PTDP, OFFR, and INNR habitat strata. When low-high slope pairings within strata are compared, there does not seem to be any preference for low versus high-slope habitats. The average size of exploited-phase individuals was 44.4 cm, and 19.3% of the total number observed qualified as legal size (≥40cm). Mutton snappers of legal size were encountered in every habitat strata except colonized pavement-shallow (NEAR-high) and deep ridge complex (DPRC-high), with the greatest concentration of both pre-exploited and exploited sized individuals occurring in the aggregated patch reef-shallow (PTSH), linear reef-middle (MIDR), and aggregated patch reef-deep (PTDP) habitats. In addition, the data suggest that there may be a gradient of increasing size with depth, with NEAR habitat holding the smallest individuals and DPRC the largest.

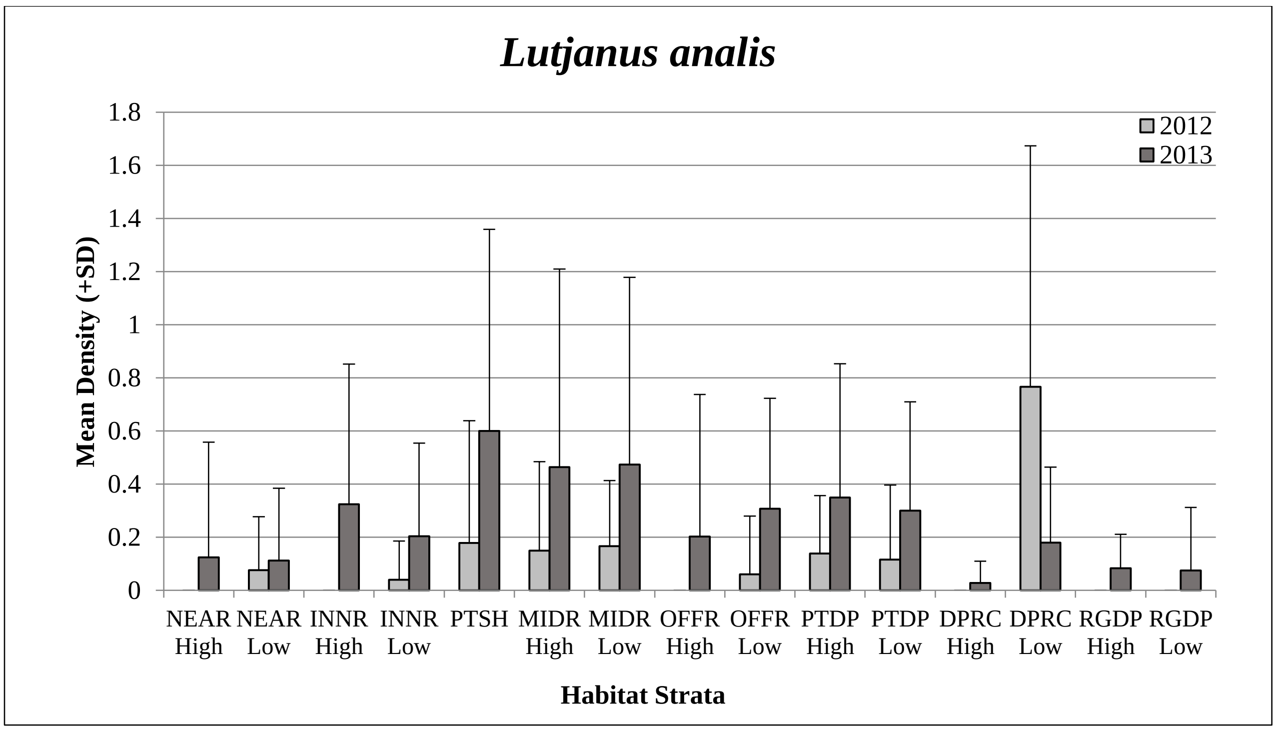

Figure 27. *Mutton snapper (*Lutjanus analis*) total mean density per habitat strata; yearly comparison.*

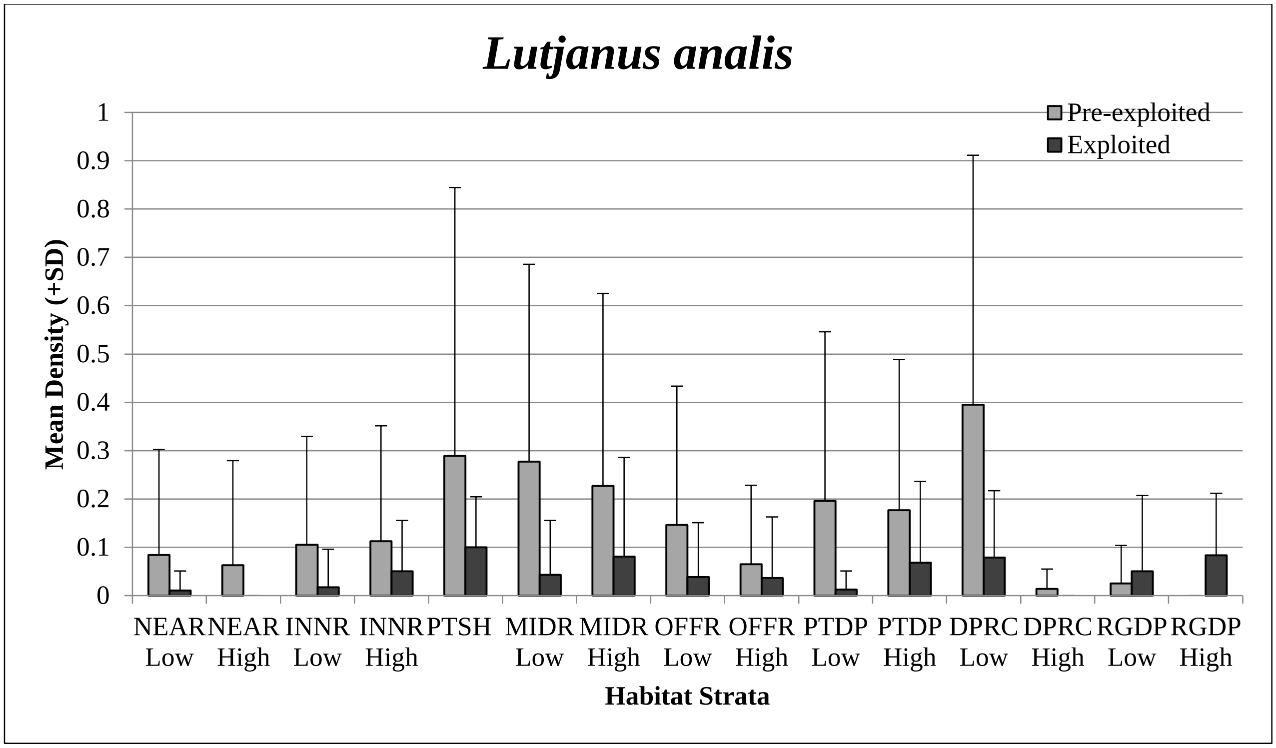

***Figure 28**. Mutton snapper (*Lutjanus analis*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2013 only.*

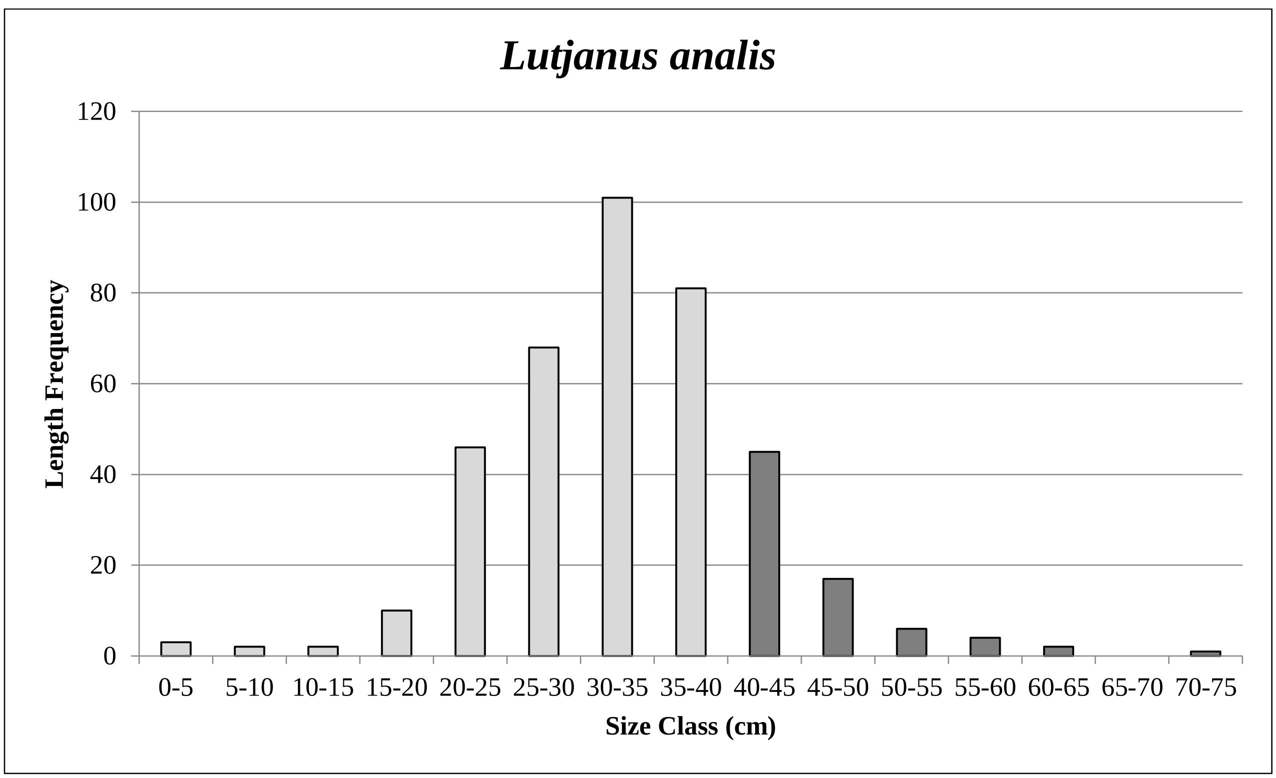

***Figure 29.** Length frequency of Mutton snapper (*Lutjanus analis*) by size class. Darker grey indicates exploited size classes.*

4.1.11. Discussion of Gray Snapper

Gray snapper (*Lutjanus griseus*) was the 55th most frequently observed species, with an average percent occurrence (*P*) of 12.0 and average density (*D*) of 0.45 fishes/SSU (Appendix 7). Comparatively, the data suggest that southeast FL has fewer gray snappers than the FL Keys (*P*=27.5, *D*=2.27) and Dry Tortugas (*P*=15.2, *D*=2.73). Examination of *L. griseus* densities by habitat strata (Figure 30) reveals a moderate amount of inter-annual variation, with the deep ridge complex (DPRC) and ridge-deep (RGDP in Martin County) strata exhibiting by far the greatest densities in 2013. When low-high slope pairings within strata are compared, there does not seem to be any preference for low versus high slope until the deeper habitats are examined. For both DPRC and RGDP strata, the high relief sites had considerably greater densities in 2013. The average size of exploited-phase individuals was 30.1 cm, and 39.2% of the total number observed qualified as legal size (≥25cm). Gray snappers of legal size were not encountered in every habitat. They were seen infrequently in the shallower NEAR, INNR, PTSH, MIDR, and OFFR habitats, with the vast majority being found in the deeper DPRC and RGDP habitats. There was also a trend of increasing size from south to north and from shallow to deep.

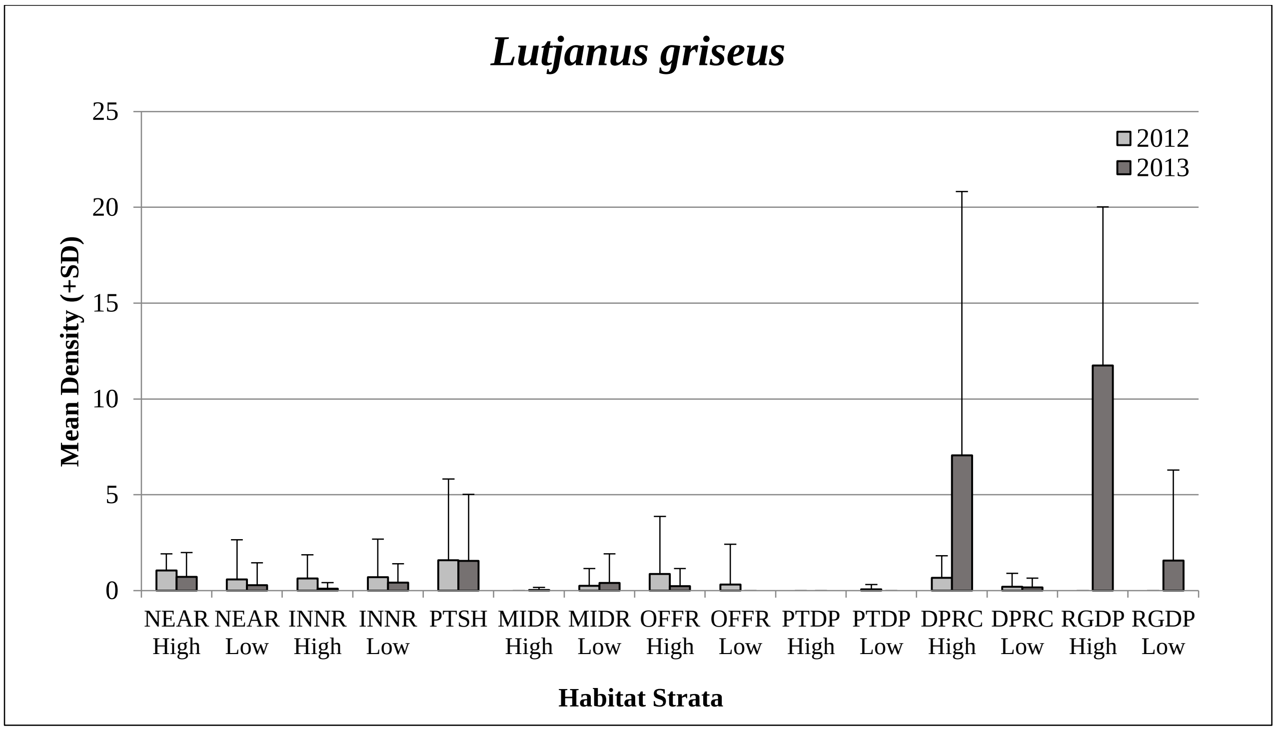

Figure 30. *Gray snapper (*Lutjanus griseus*) total mean density per habitat strata; yearly comparison.*

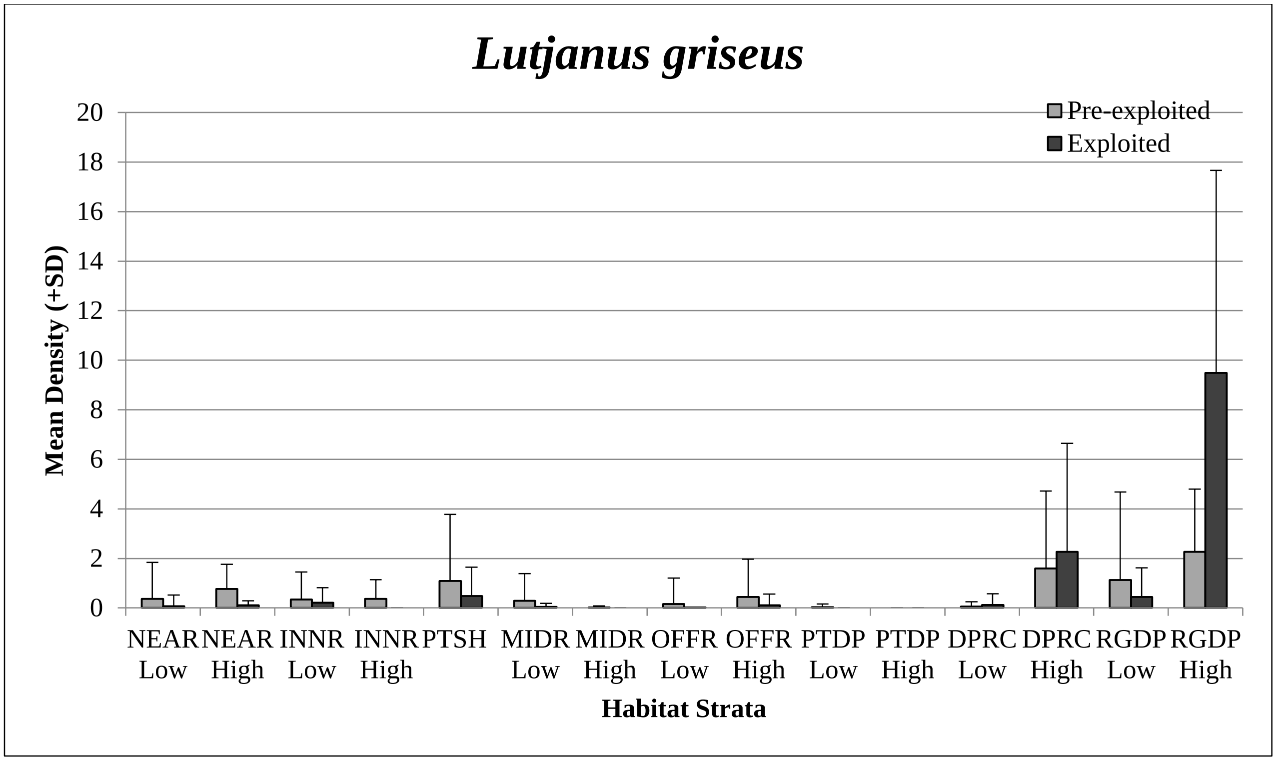

Figure 31. *Gray snapper (*Lutjanus griseus*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2012 and 2013 combined.*

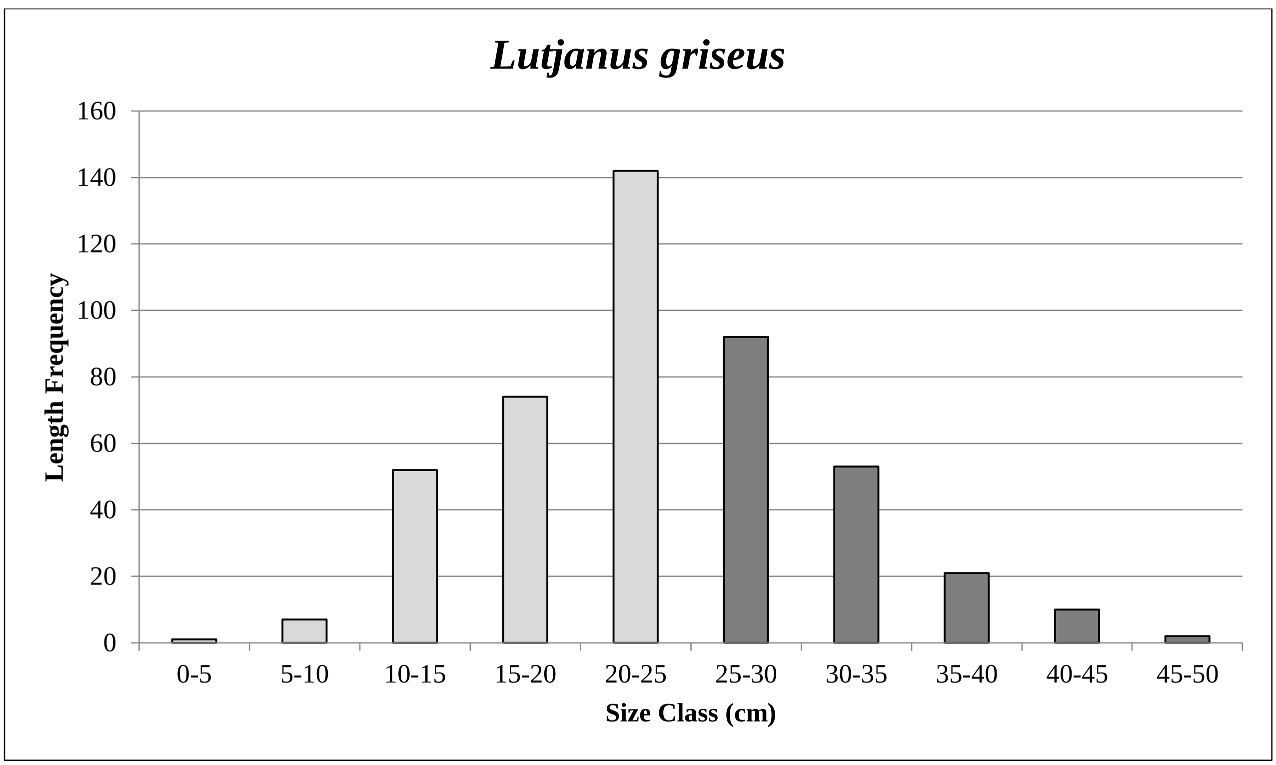

Figure 32. *Length frequency of Gray snapper (*Lutjanus griseus*) by size class. Darker grey indicates exploited size classes.*

4.1.12. Discussion of Yellowtail Snapper

Yellowtail snapper (*Ocyurus chrysurus*) was the 25th most frequently observed species, with an average percent occurrence (*P*) of 28.0 and average density (*D*) of 1.47 fishes/SSU (Appendix 7). Comparatively, the data suggest that southeast FL has fewer yellowtail snappers than the FL Keys (*P*=58.5, *D*=4.12) and Dry Tortugas (*P*=75.7, *D*=7.56). Examination of *Ocyurus chrysurus* densities by habitat strata (Figure 33) reveals a moderate amount of inter-annual variation, with more fishes being observed in 2012 than in 2013. In 2012, yellowtail snappers were most abundant in the INNR, OFFR, and DPRC habitats. When low-high slope pairings within strata are compared, there does appear to be a preference for high-slope habitats. The average size of exploited-phase individuals was 28.7 cm, and 19.4% of the total number observed qualified as legal size (≥25cm). Yellowtail snappers of legal size were encountered in every habitat strata, albeit in relatively low numbers, with the most occurring in the PTSH, DPRC, and RGDP habitats. Greatest density occurred in the South Palm Beach subregion, in the OFFR habitat strata, and in the 10-15m depth range. The largest individuals occurred in the 15-20m and 20-25m depth ranges.

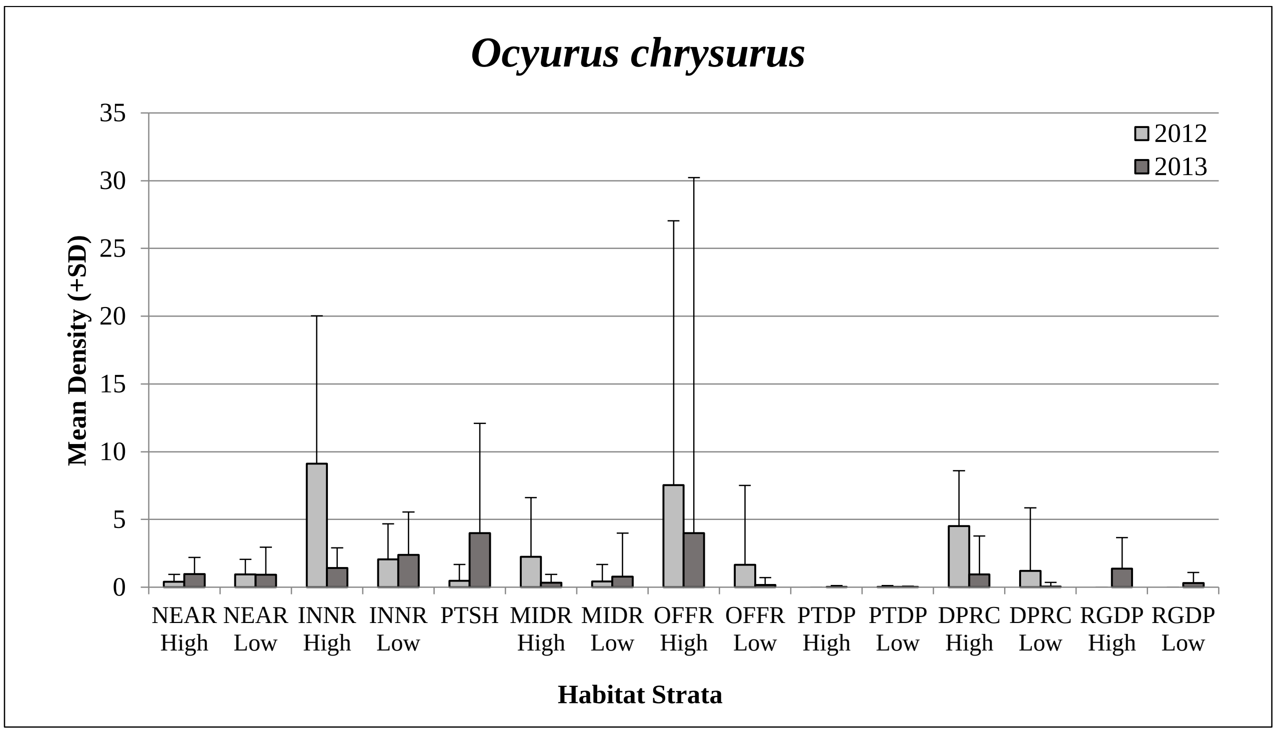

Figure 33*. Yellowtail snapper (*Ocyurus chrysurus*) total mean density per habitat strata; yearly comparison.*

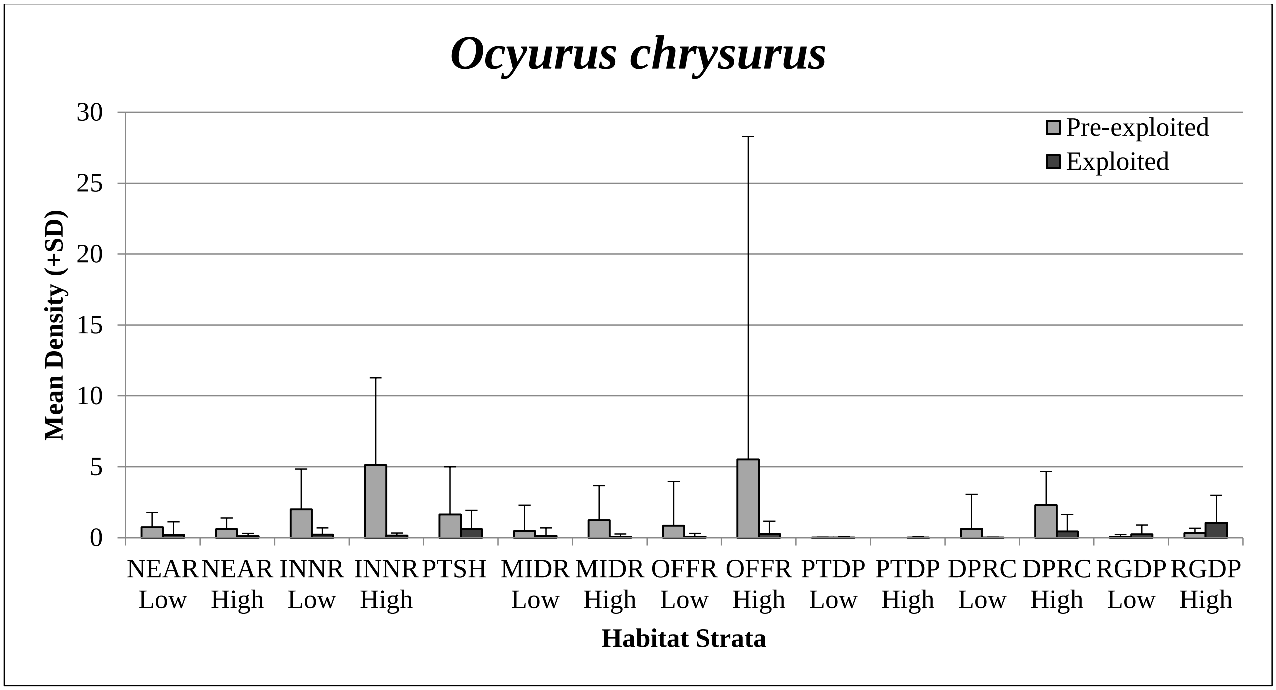

Figure 34. *Yellowtail snapper (*Ocyurus chrysurus*) total mean density per habitat strata; pre-exploited and exploited lifestage comparison; 2013 only.*

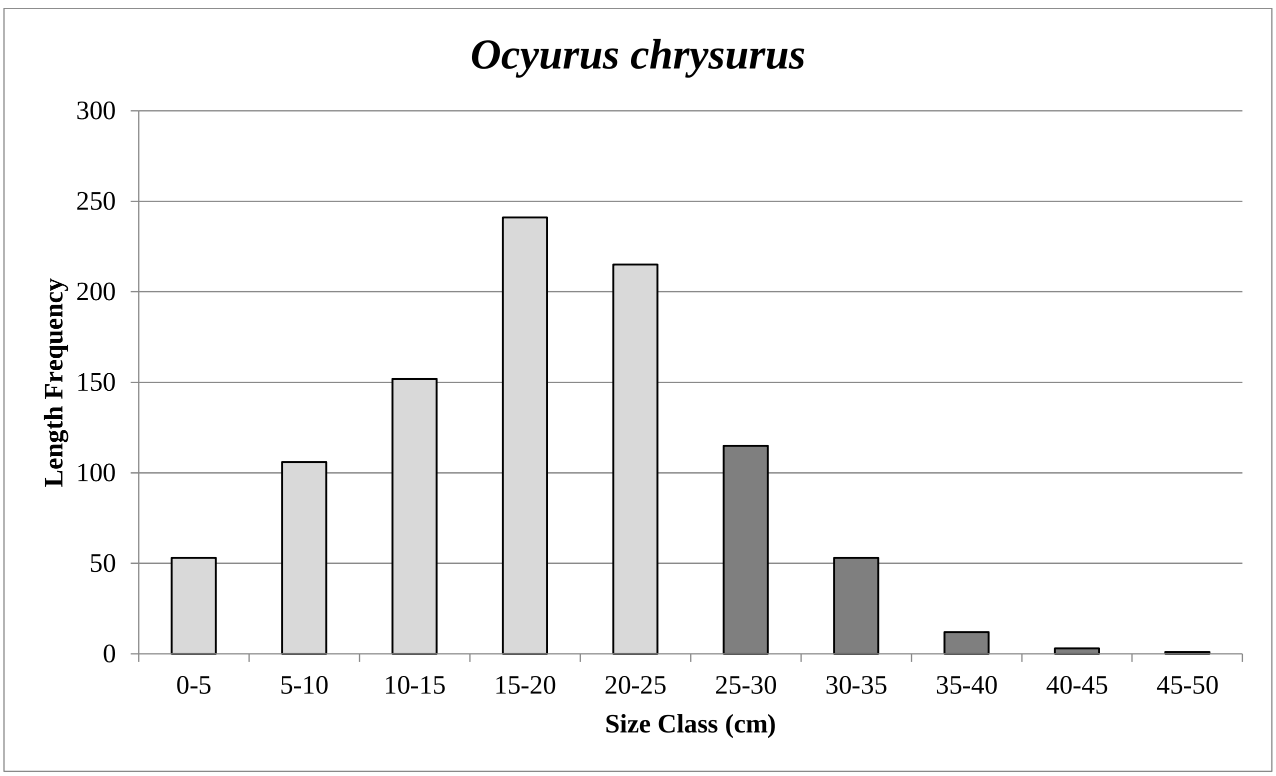

Figure 35. *Length frequency of Yellowtail snapper (*Ocyurus chrysurus*) by size class. Darker grey indicates exploited size classes.*

4.1.11. Discussion of Lionfish

Due to the level of ongoing research and general public interest related to the lionfish invasion in the Western Atlantic, a brief discussion of the data collected for this species (*Pterois spp.* = *Pterois volitans/miles* complex) is included here. Percent occurrence (*P*) for lionfish increased from 12.5 in 2012 to 13.7 in 2013. Mean density (*D*) also increased from 0.11 lionfish/SSU in 2012 to 0.15 lionfish/SSU in 2013. However, multiple reasons could account for the difference between years, including increased sampling effort and the site allocation procedure. When *P* is compared between habitat strata (Figure 36), it is apparent that the likelihood of encountering a lionfish increases as one moves from the shallower habitats towards the deeper ones. This seems to be further supported by an examination of subregional trends, which shows greater occurrence in the subregions that are primarily characterized by greater prevalence of deeper habitats (Figure 37). A general trend of decreasing availability of shallow water coral reef habitats is present as you move from the southern end of the survey area to the northern end. Consequently, the fact that the South Palm Beach and Martin subregions had the highest occurrence does not directly equate to those areas having more lionfish; those regions have greater relative percentage of the deeper habitats that the data suggests lionfish seem to prefer, therefore they are more likely to be encountered.

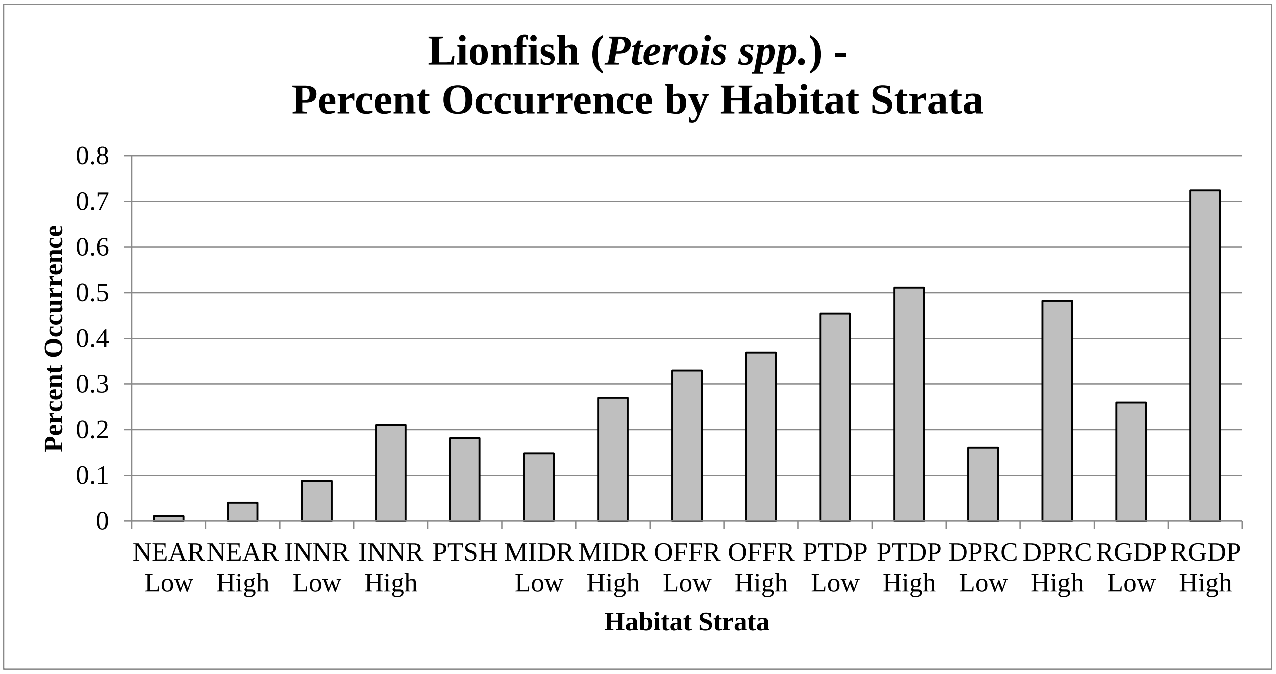

Figure 36. *Percent Occurrence (P) of Lionfish (*Pterois *spp.) by habitat strata.*

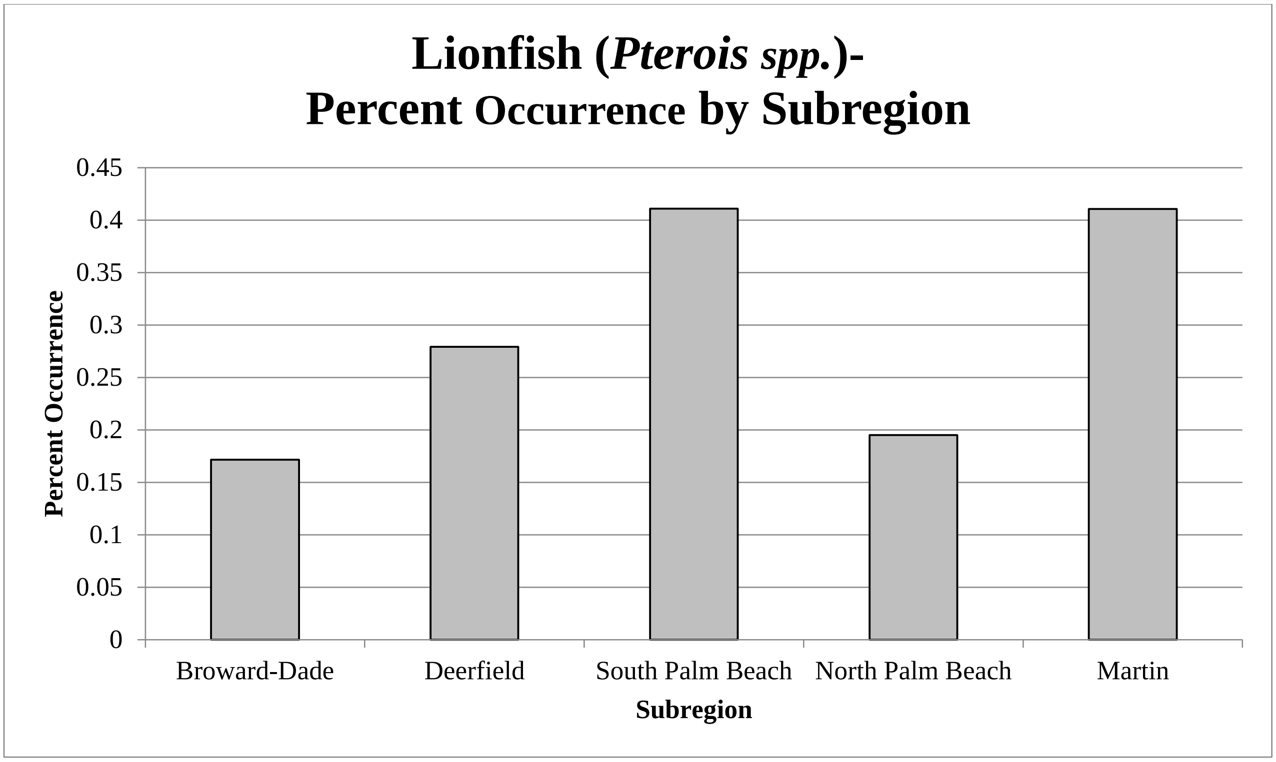

Figure 37. *Percent Occurrence (P) of Lionfish (*Pterois *spp.) by subregion.*

4.1.12. Comparison of Southeast Florida to the Florida Keys and Dry Tortugas

Figures 38 and 39 display the percent occurrence (*P*) and mean density (*D*) values for a select group of species from all 3 sampled regions of the Florida Reef Tract: southeast Florida, the Florida Keys, and the Dry Tortugas. Values represented in the figures are taken from Appendix 7, which utilizes the new data from southeast Florida (i.e., this report) along with previously published data from Smith et al. (2011). The species displayed in these figures include the previously discussed 8 target species along with some additional commercially and recreationally important species of interest. As a general trend, many species show a pattern of increasing percent occurrence and density as you move from southeast Florida down through the Florida Keys and into the Dry Tortugas. However, there are several exceptions: Porkfish (*A. virginicus*) had a higher *P* and *D* in southeast Florida, French grunts (*H. flavolineatum*) had higher *D*, and Mutton snappers (*L. analis*) had slightly higher *P*. With those exceptions aside, it is noted that Tomtate (*H. aurolineatum*), White grunt (*H. plumieri*), Yellowtail snapper (*O. chrysurus*), Graysby (*C. cruentatus*), Red grouper (*E. morio*), and Black grouper (*M. bonaci*) all showed a distinct trend of elevated *P* and *D* in the FL Keys and Dry Tortugas as compared to southeast Florida.

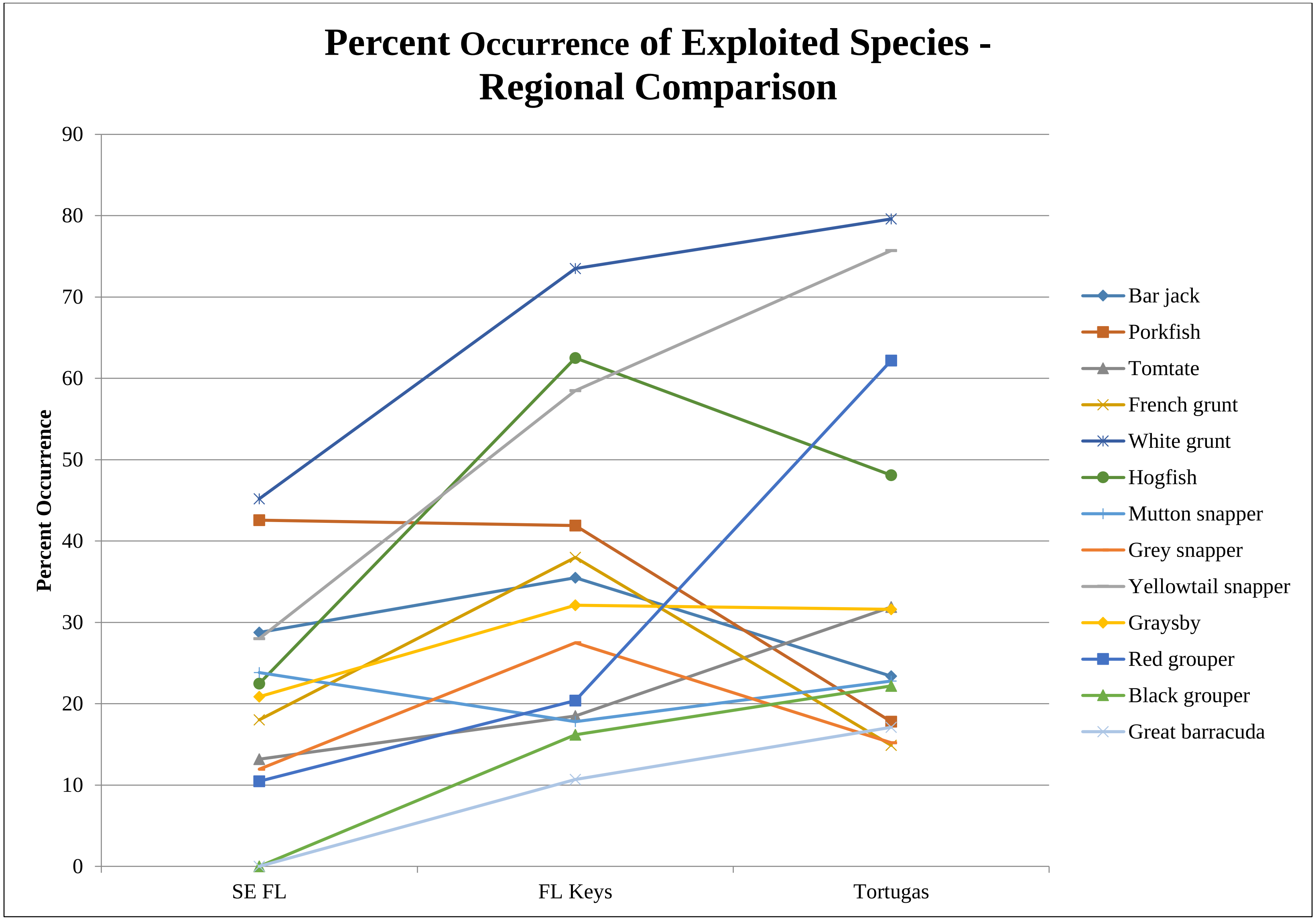

Figure 38. *Exploited species – comparison of SE Florida region to FL Keys and Dry Tortugas by percent occurrence (P).*

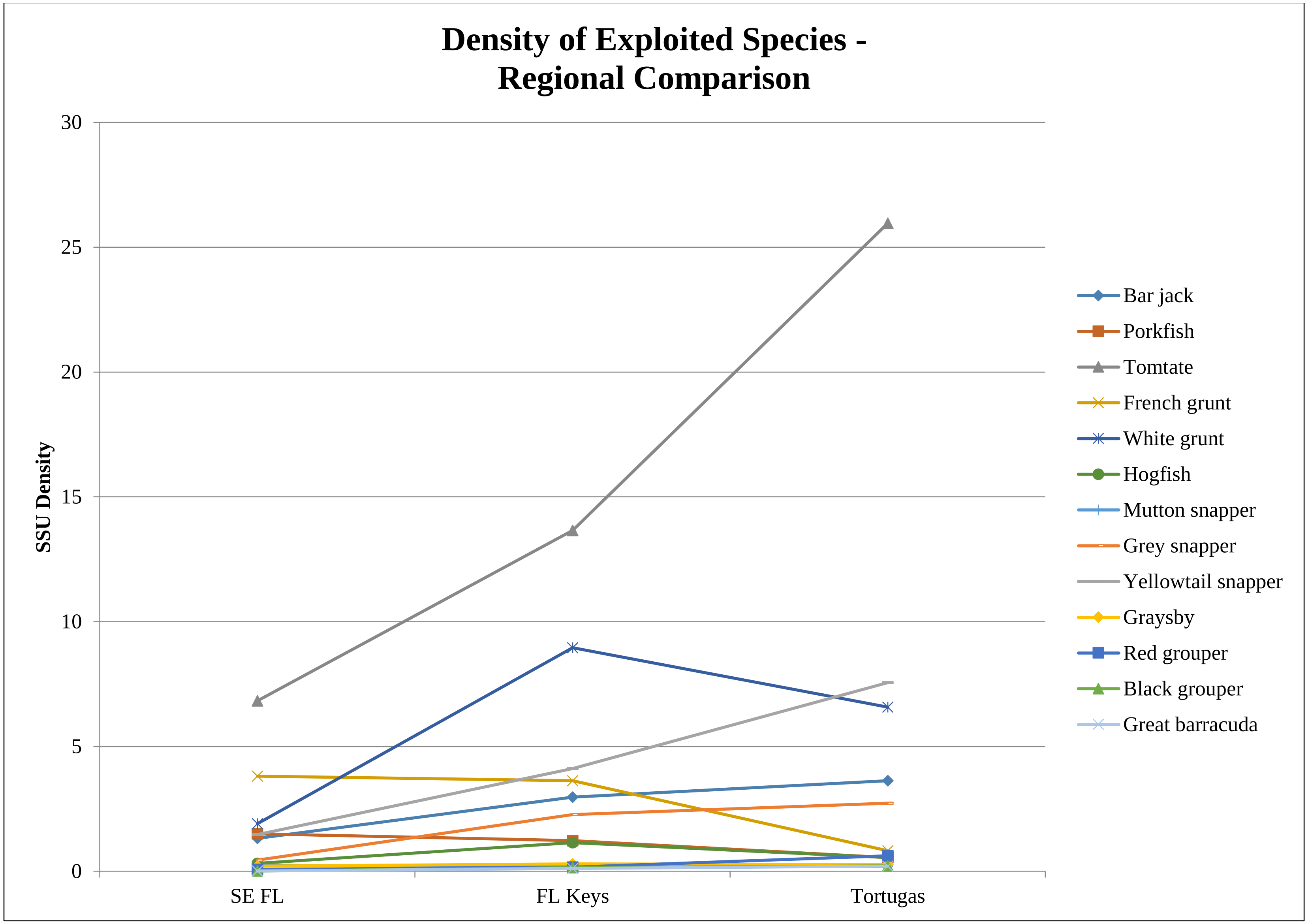

Figure 39. *Exploited species – comparison of SE Florida region to FL Keys and Dry Tortugas by mean (SSU) density (D).*

4.2. Sampling Effort and Allocation Performance

The 2012 sampling allocation was guided by the proportion of mapped habitats in the 100 x 100 m sampling frame, with the exception that all strata receive at least five sites and none more than 50. This design had its advantages and disadvantages.

One potential problem with using the 100 m PSU grid sampling frame to allocate sites is that it may not accurately represent the actual mapped habitat. The 100 m PSU grid was assigned habitat values by the majority of habitat in that cell. For example, if a cell was 20% sand, 30% patch reef, and 50% Outer Reef, the cell was classified as Outer Reef. This method for classifying the PSU becomes especially problematic along habitat borders and for habitats that are small relative to the grid size (e.g. high slope reef edges, patch reefs), where it can drastically over or under estimate habitat extents. To investigate this further, the area of each habitat strata was calculated in GIS for the habitat map and the PSU grid. The results showed that the PSU grid overestimated the area of 24 habitat types by more than one km^2 (eleven 1 - 2km^2, five $2 \leq 3$ km^2, four $3 \leq 4$ km^2, and four > 4 km^2). The PSU grid also underestimated the area of Broward-Miami Low Slope Spur and Groove, Outer Reef, and Aggregated Patch Reef Deep by 1.2 km^2, 1.997 km^2, and 2.042 km^2 respectively. This comparison indicated that the area of many habitats is not well-represented in the PSU grid.

In terms of this study's design, however, the area of habitat was not as important as the habitat proportion. Since site allocations were made based on the proportion of each stratum, it was important that the PSU grid contain similar ratios of each habitat as the original habitat map. A comparison of habitat proportions between the habitat map and the PSU grid showed a similar distribution (Figure 40). The PSU grid had 89% (74/83) of the strata with less than 1% difference from the habitat map. The largest differences were with the North Palm Beach Deep Ridge Complex Low Slope, where the PSU grid had a proportion 5.4% less than the habitat map, and the Broward-Miami Colonized Pavement Shallow Low Slope, which was underestimated by 2.49%. However, these underestimations of habitat proportions did not affect the allocation because they were the two largest strata and were capped with a maximum of 50 sites. Thus the allocation of sites based on the proportion of strata in the PSU grid was very similar to an allocation using the habitat map.

In terms of the eight targeted fisheries species (*B. capriscus*, *E. morio, H. plumieri*, *H. sciurus, L. maximus*, *L. analis*, *L. griseus*, and *O. chrysurus*), the stratification seemed to perform well. One way to gauge performance is by plotting the average density of the species by the standard deviation. It is expected that low average density per strata will have a low standard deviation while high average density will have a high standard deviation. This was true in most cases for all eight species which helps substantiate the overall strategy sampling (Figure 41).

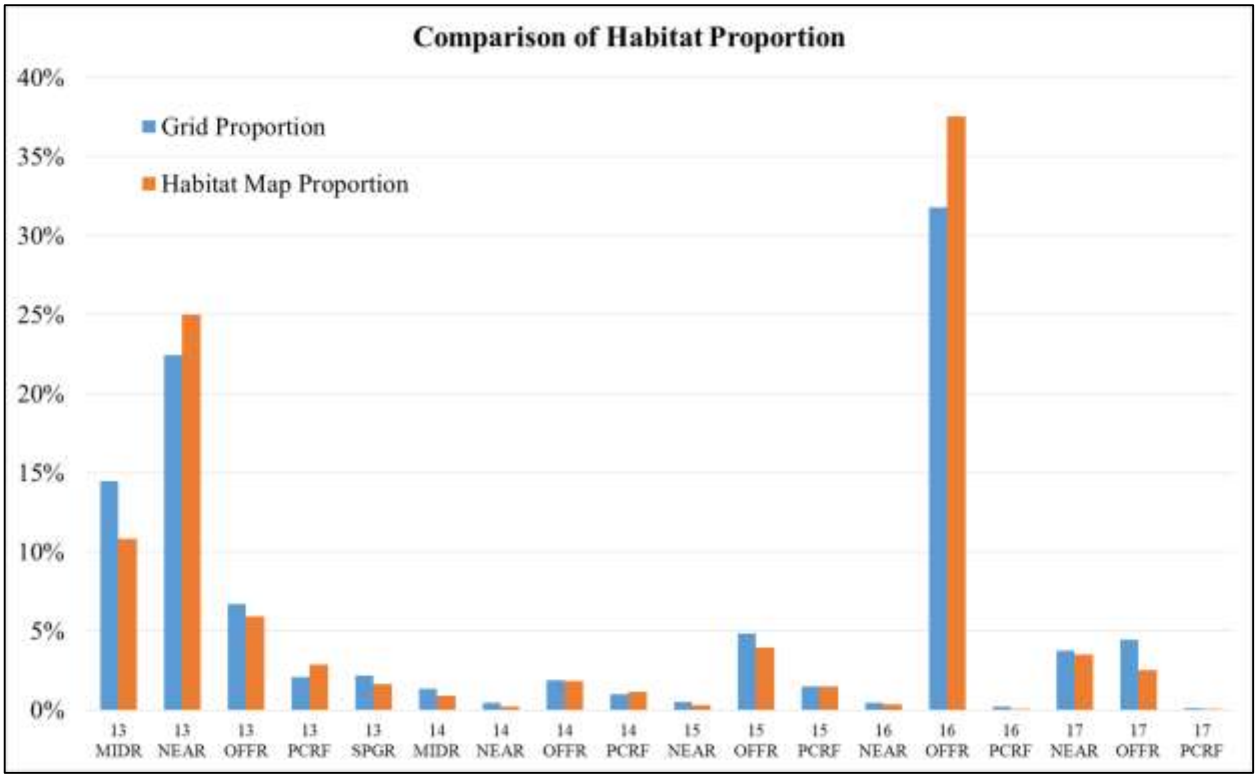

Figure 40. *A comparison of the habitat proportion in each stratum relative to the mapped domain. Blue is the percent area of the 100 m PSU grid and orange is the percent area of the map polygons.*

Of the 720 secondary sample units (SSU) allocated to strata, a total of 432 were completed in 2012 due to unanticipated funding delays compressing the field season and unforeseen logistical problems reducing the effort of local partners (Appendix 1). These issues were resolved in the 2013 survey. The incompletion of the total allocation in 2012 left large gaps in certain strata because strata were not targeted proportionally throughout the survey period. For example, 17 of the 100 allocated SSUs in the North Palm Beach Deep Ridge Complex Low Slope strata were surveyed. Figure 42 shows a map of the difference between the projected allocation and the actual surveyed sites by strata in 2012. High values (in oranges and red) indicate strata that were under surveyed and green values are strata that were over surveyed. Most under surveyed strata were in the northern regions (Martin and North Palm Beach), however, the high slope offshore strata in Broward-Miami and South Palm Beach were also lacking. These strata were not missed due to lack of effort, but rather shortcomings in the survey design. Because the high slope stratum does not dominate entire 100 m grid cells, it was often missed when finding the site. This was mostly because the site locations are determined by the center of the secondary sampling unit (one of four 50 m cells nested in the 100 m cell). When divers were deployed on a high slope target, they were not instructed to seek high slope, thus in many cases, the divers sampled lower relief features leaving a gap in the high slope surveys.

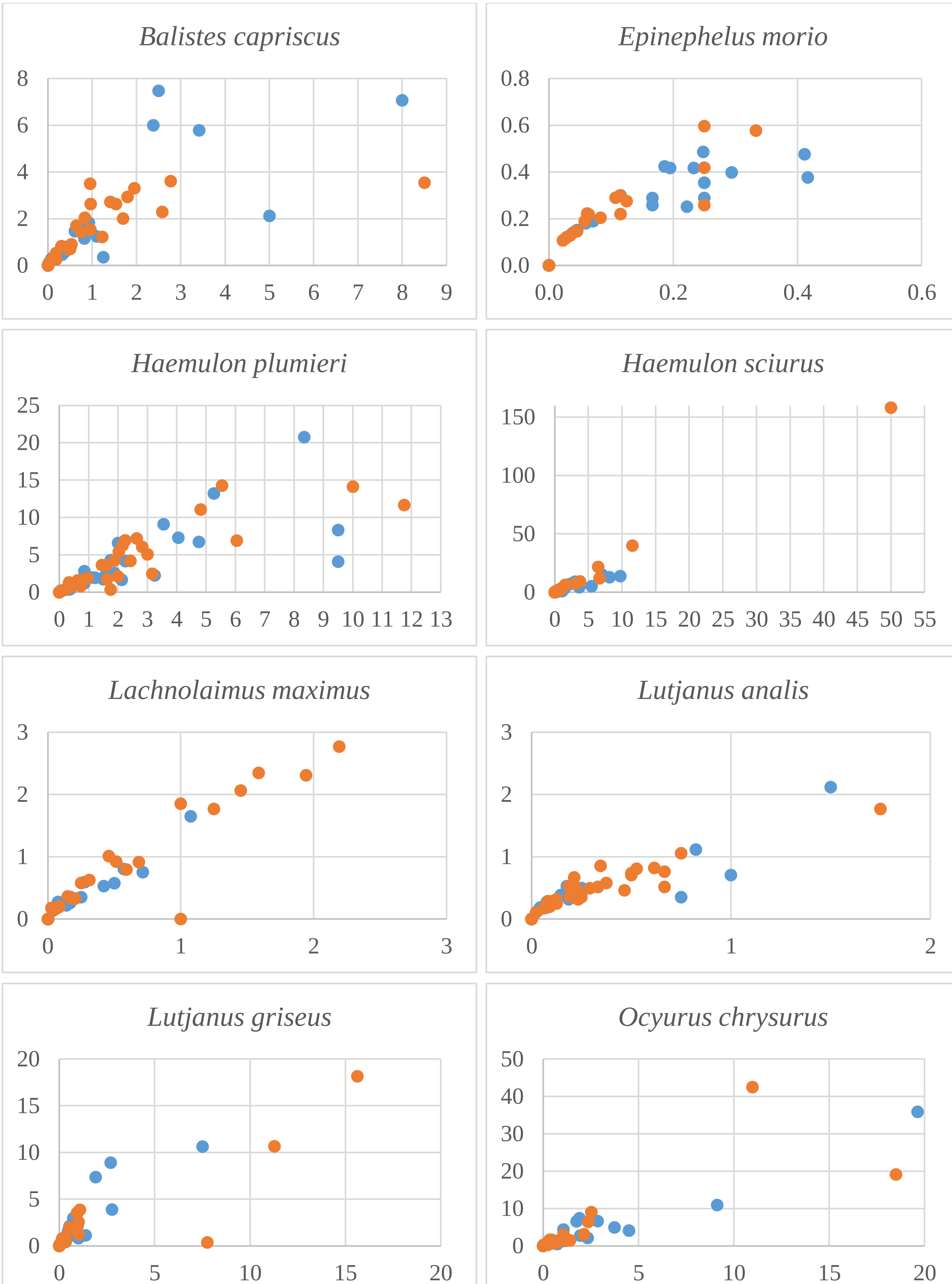

Figure 41. *Scatterplots of average mean density (x axis) versus standard deviation (y axis) by each strata for the eight key fisheries species targeted. A linear relationship is expected and indicates good site stratification and allocation. H. plumierii had the most variability in higher densities. Blue = 2012 and Orange = 2013.*

Several steps were taken during the 2013 site allocation process to help correct the 2012 site allocation problems. First, the 2013 site targets were divided into two groups based on the 2012 effort, called Core and Tier 2 sites. The same number of total sites (720) was projected to be the target for 2013. To prevent large gaps in strata if the groups do not meet their projection, 520 sites were randomly selected as Core sites based on the map strata proportions. Once all Core sites were completed by each group, they were given the Tier 2 sites to complete. This ensured that if total site projections were not met, at least a core set of data was complete for all strata, reducing regional habitat-specific surveying gaps. Appendix 4 contains maps of all 2013 Core, Tier 2, and actual survey sites.

As discussed above, a result of the gridded sampling array is that many times the targeted habitat does not span the entire 100^2 m cell. The site target coordinate is the geographic center of the randomly chosen cell. This becomes problematic when trying to hit specific habitats, especially high relief and patch reef sites. The second step to help correct for allocation problems for 2013 is that every secondary stage site target was evaluated in GIS. Each site was plotted and cross referenced by the habitat map, LIDAR bathymetry, and aerial photography (where possible) to see if the location of the point reflected the intended target. If they did not agree, the location was moved to the nearest area in the map that indicated the intended target strata. Thus high relief sites were moved to obvious areas of high relief in the bathymetry and sites that plotted away from the edges of habitats were moved inside.

The third correction for 2013 is that divers were instructed to find high slope sites when sampling those strata. In combination, these corrections facilitated the field operations and provided a better chance of the divers surveying the intended strata (Figure 43). The Nearshore habitats in Martin were not surveyed as much as planned, however most of the surveys in other habitats were much closer to the allocation targets than in 2012.

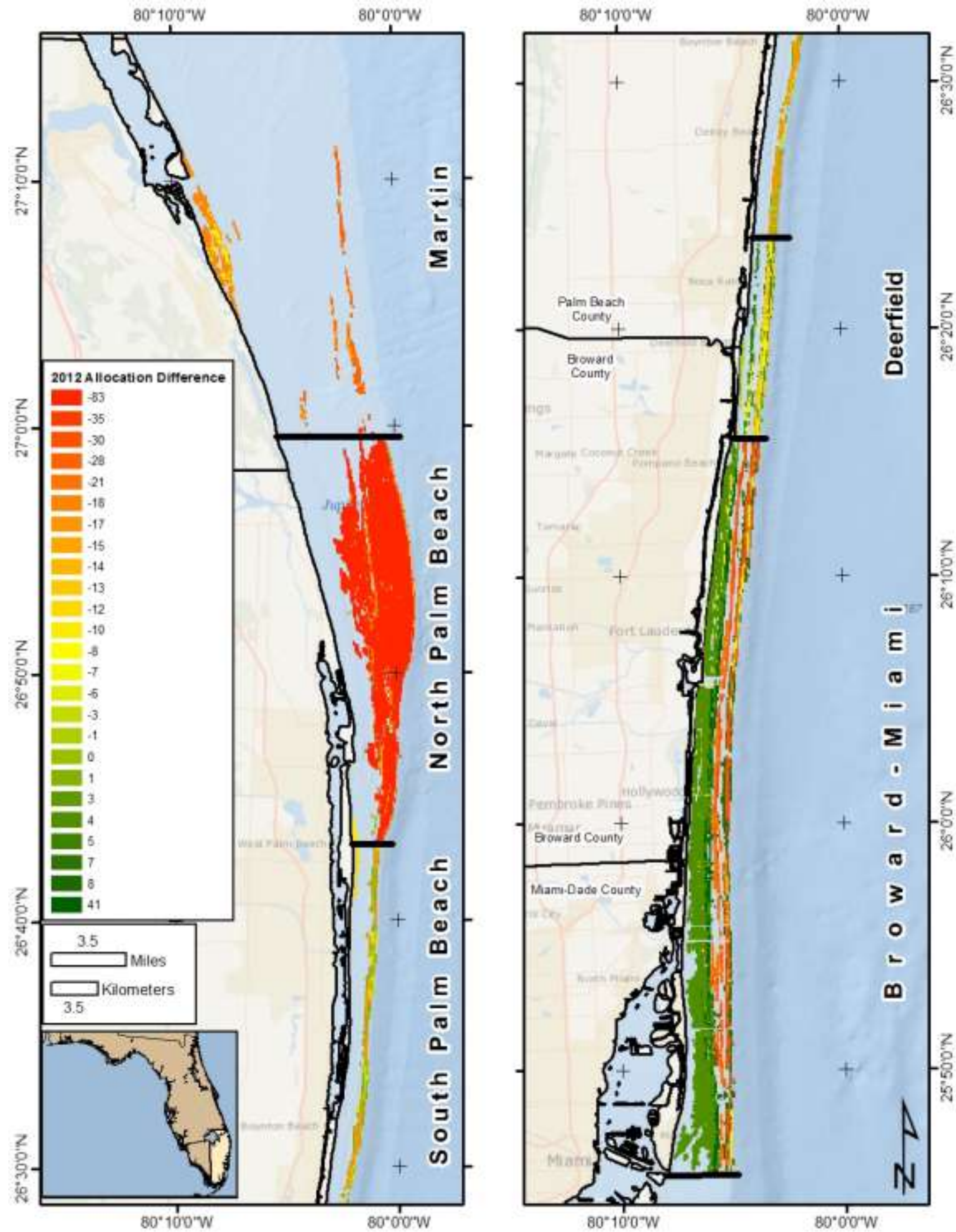

Figure 42. *Map showing the 2012 100 m grid strata symbolized by the difference in projected allocation v. realized from Table 2. Most extreme gaps were in the northern regions. Red values are lower than projected and green are higher.*

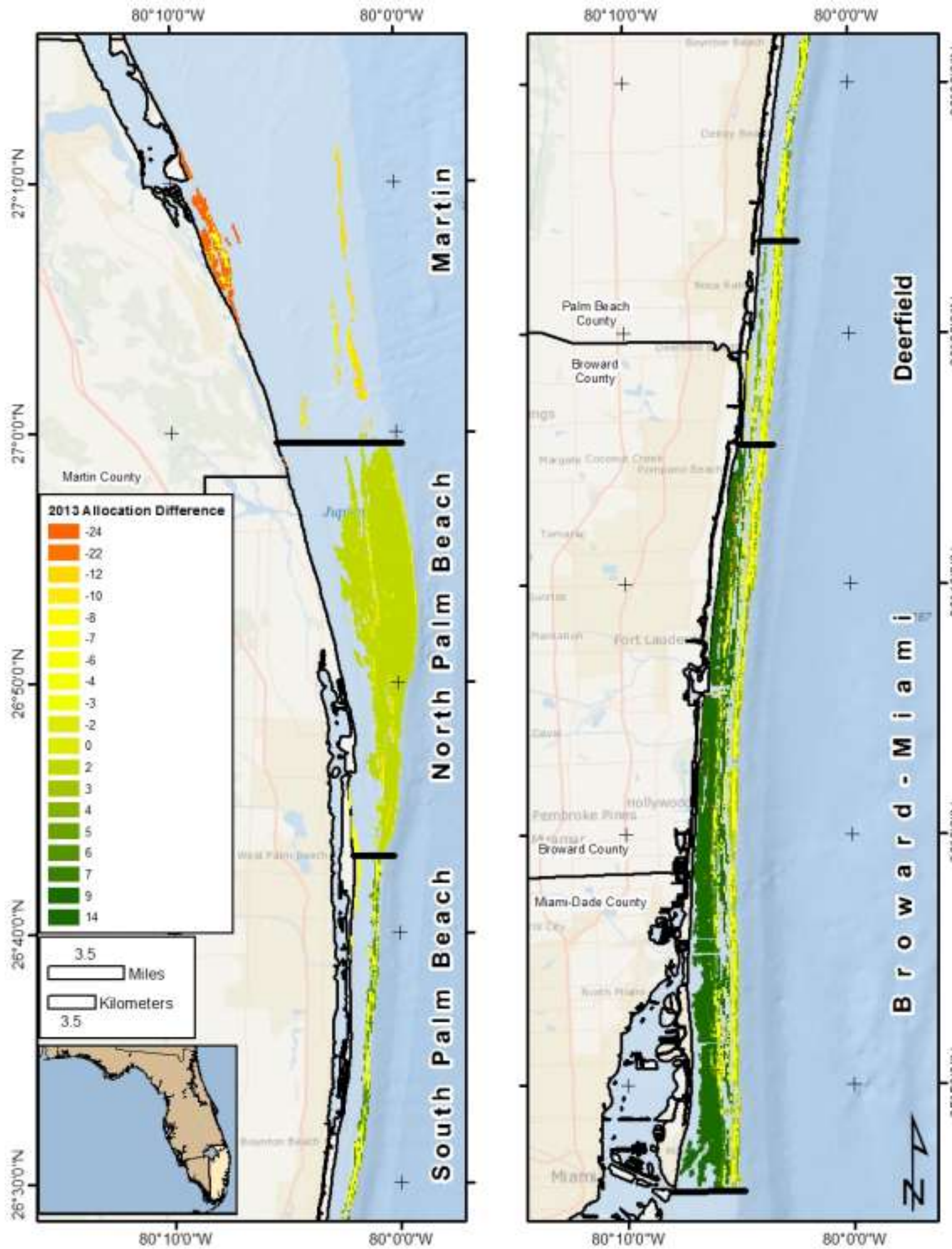

Figure 43. *Map showing the 2013 100 m grid strata symbolized by the difference in projected allocation v. realized from Table 2. Many gaps were corrected in 2013. A large deficit in survey coverage remained in Nearshore Martin habitats. Red values are fewer surveys than projected and green are higher.*

5. CONCLUSIONS

This report is a synoptic view of a large database. It provides summary statistics and graphs of fish richness and abundance, assemblage distribution, and select species distribution of the southeast Florida Reef Tract. The dataset provides a baseline for these variables which is critical information for the local management of fishery resources now and in the future. Further, the dataset, in its entirety, provides the opportunity for further mining to examine specific species and assemblage correlations with a host of abiotic and biotic variables. Thus, from both management and ecological sciences perspectives it is a valuable resource. It is already clear there are significant differences in the current geographic distribution of the local reef fishes. There are interacting strata and latitude differences in total abundance, species, sizes, and assemblages within the northern FRT. Comparing data here with a previously published dataset (Smith et al., 2011) shows a pattern of increasing percent occurrence and density of most, but not all, target species from southeast Florida down through the Florida Keys and into the Dry Tortugas. Parsing these differences further into species-specific and assemblage-specific correlates is beyond the scope of this report.

However we caution against drawing premature conclusions from a limited dataset. Many factors can contribute to differences in community structure and abundance of reef fishes. The assemblages targeted in this study are influenced by a combination of abiotic and biotic variables, such as: reef morphology, water chemistry, temperature, depth, current regimes, terrestrial influences (i.e. runoff, sedimentation, nutrient levels), extreme weather events (hurricanes, cold snaps), large scale climate changes, benthic community composition, stochastic settlement and recruitment dynamics (i.e. larval supply, predation, competition, etc.), and changes in biogeographic distribution of species. In addition, anthropogenic impacts (pollution, construction) and associated management practices (beach nourishment, fishing regulations) are an influential presence in the coastal marine environment as well. Removal of select species from upper trophic levels via extractive means (fishing) can have trickle down effects on assemblage structure, and the cumulative long-term effects of such practices can alter the entire system at every level from the top down. Thus, interpretation of community-level and species-specific trends based on limited data should be undertaken with caution. Many trends fluctuate on seasonal or multi-year scales in response to a combination of the aforementioned variables, even in a closed system with no extraction or other anthropogenic influences. Considering that population levels can fluctuate greatly from year to year, even a three-year dataset may be misleading for extrapolating the trends that are detected within that timeframe. Understanding of how these variables interact with one another and change in response to management practices will be improved with a long-term dataset. Further, because effective management of fish resources demands effective monitoring of the populations of early life-stages and their habitats we recommend this be taken into account in future surveys.

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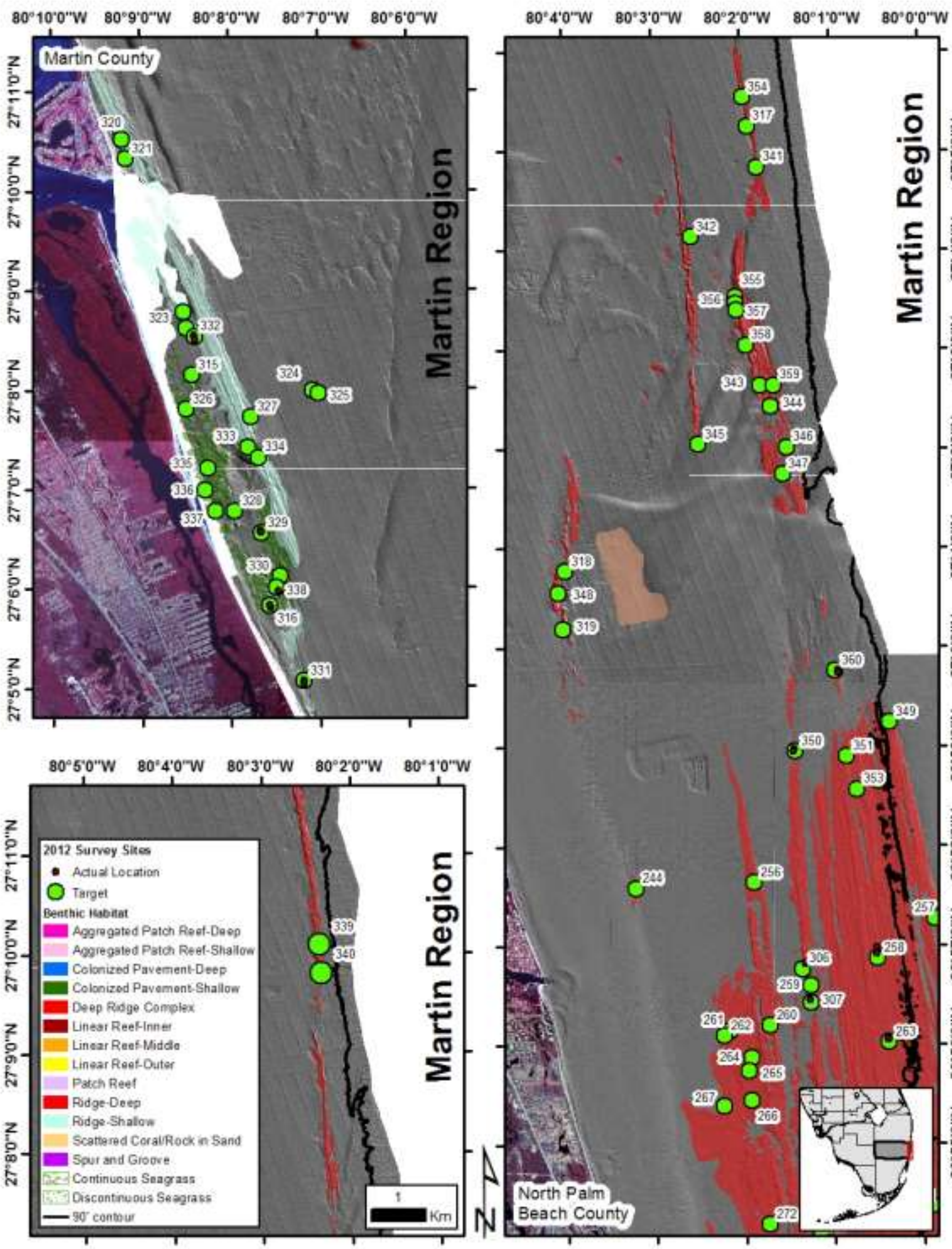
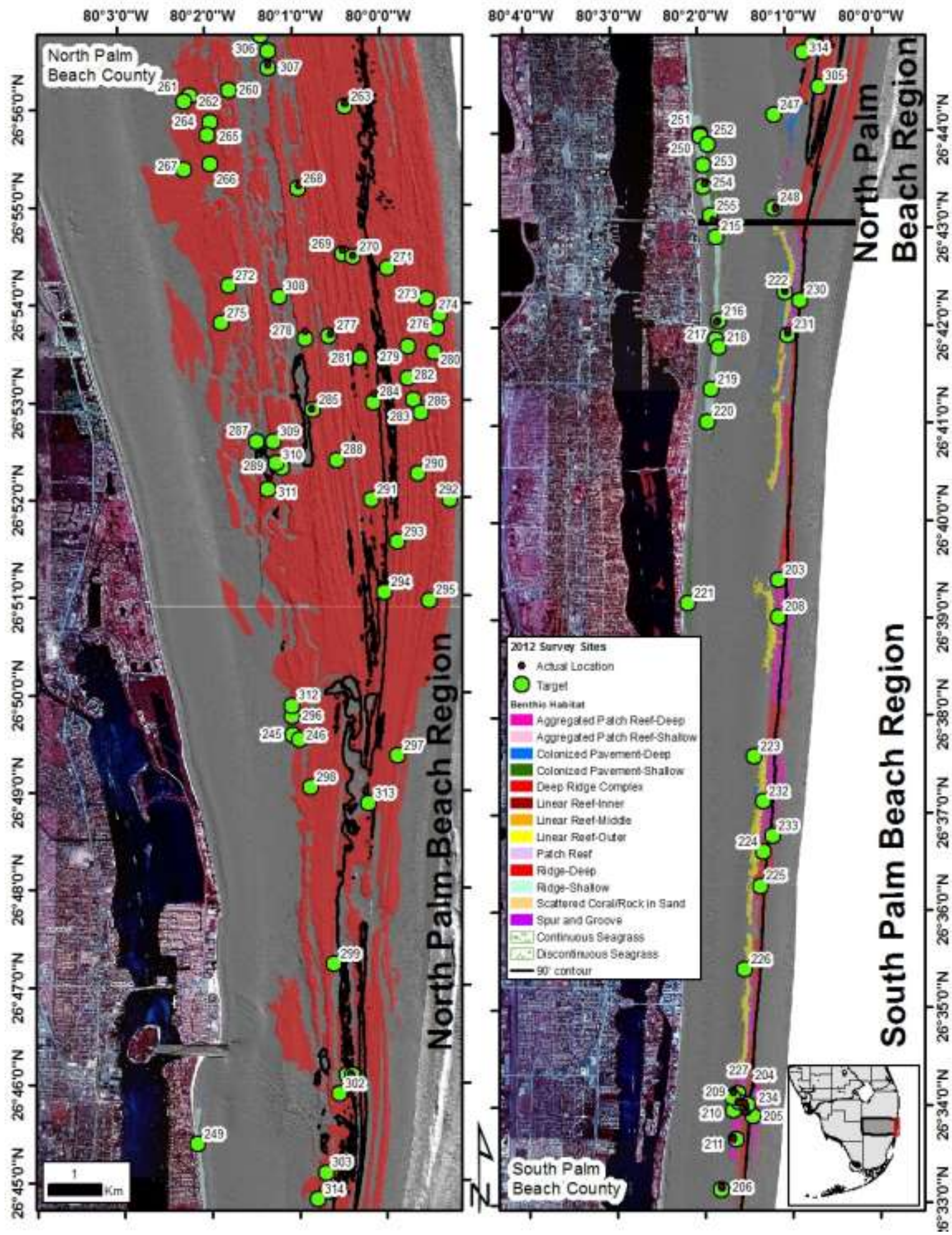
7. APPENDICES

APPENDIX 1. Effort allocation for targeted secondary sampling unit (SSU) locations and realized sampling locations by strata for each year. Strata: Subregion, Habitat, Slope.

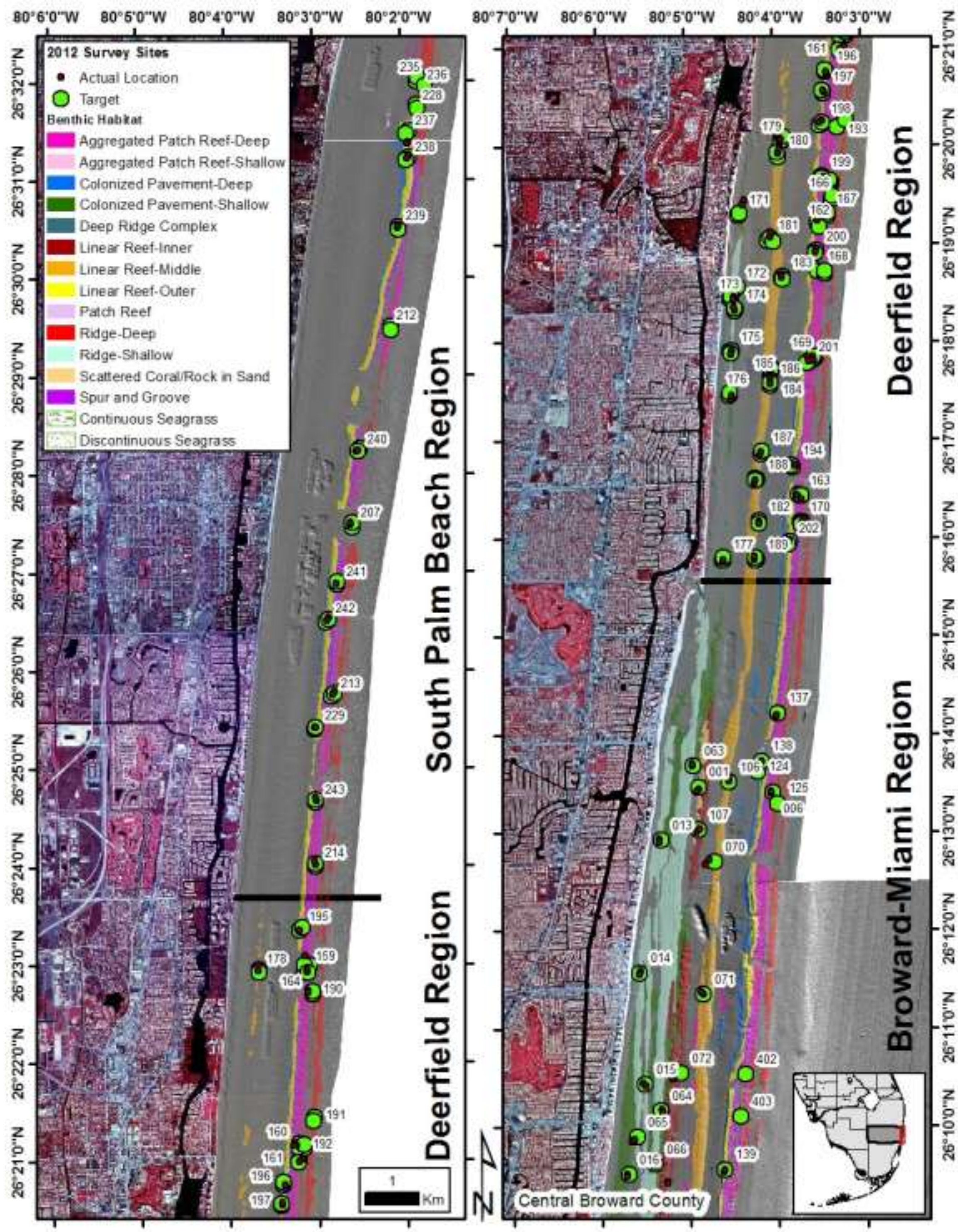
Strata	2012 Target	2012 Realized	2013 Target	2013 Realized	Total Target	Total Realized
Broward-Miami INNR High	0	4	20	12	20	16
Broward-Miami INNR Low	0	41	26	33	26	74
Broward-Miami MIDR High	36	1	20	13	56	14
Broward-Miami MIDR Low	72	51	26	35	98	86
Broward-Miami NEAR High	14	4	30	8	44	12
Broward-Miami NEAR Low	100	104	100	114	200	218
Broward-Miami OFFR High	44	14	60	52	104	66
Broward-Miami OFFR Low	26	34	26	29	52	63
Broward-Miami PTDP High	14	6	14	19	28	25
Broward-Miami PTDP Low	10	7	10	3	20	10
Broward-Miami PTSH N/D	0	11	0	2	0	13
Deerfield MIDR High	14	6	14	7	28	13
Deerfield MIDR Low	10	17	10	15	20	32
Deerfield NEAR Low	14	13	14	14	28	27
Deerfield OFFR High	16	3	20	12	36	15
Deerfield OFFR Low	10	15	16	20	26	35
Deerfield PTDP High	14	7	14	14	28	21
Deerfield PTDP Low	10	13	10	8	20	21
Deerfield PTSH N/D	0	1	0	0	0	1
South Palm Beach NEAR High	0	0	0	2	0	2
South Palm Beach NEAR Low	14	2	14	10	28	12
South Palm Beach OFFR High	28	11	28	22	56	33
South Palm Beach OFFR Low	16	17	14	20	30	37
South Palm Beach PTDP High	0	0	14	6	14	6
South Palm Beach PTDP Low	10	4	10	16	20	20
South Palm Beach PTSH N/D	14	6	0	2	14	8
North Palm Beach DPRC High	18	3	18	8	36	11
North Palm Beach DPRC Low	100	17	76	78	176	95
North Palm Beach NEAR Low	14	4	14	8	28	12
North Palm Beach OFFR Low	0	0	0	2	0	2
North Palm Beach PTDP High	0	0	4	2	4	2
North Palm Beach PTDP Low	0	0	6	6	6	6
North Palm Beach PTSH N/D	10	2	0	2	10	4
Martin DPRC High	0	0	0	4	0	4
Martin DPRC Low	0	2	0	4	0	6
Martin NEAR High	14	4	14	6	28	10
Martin NEAR Low	24	6	24	0	48	6
Martin PTSH N/D	10	0	10	2	20	2
Martin RGDP High	14	0	14	11	28	11
Martin RGDP Low	30	2	30	18	60	20
Total	720	432	720	639	1440	1071

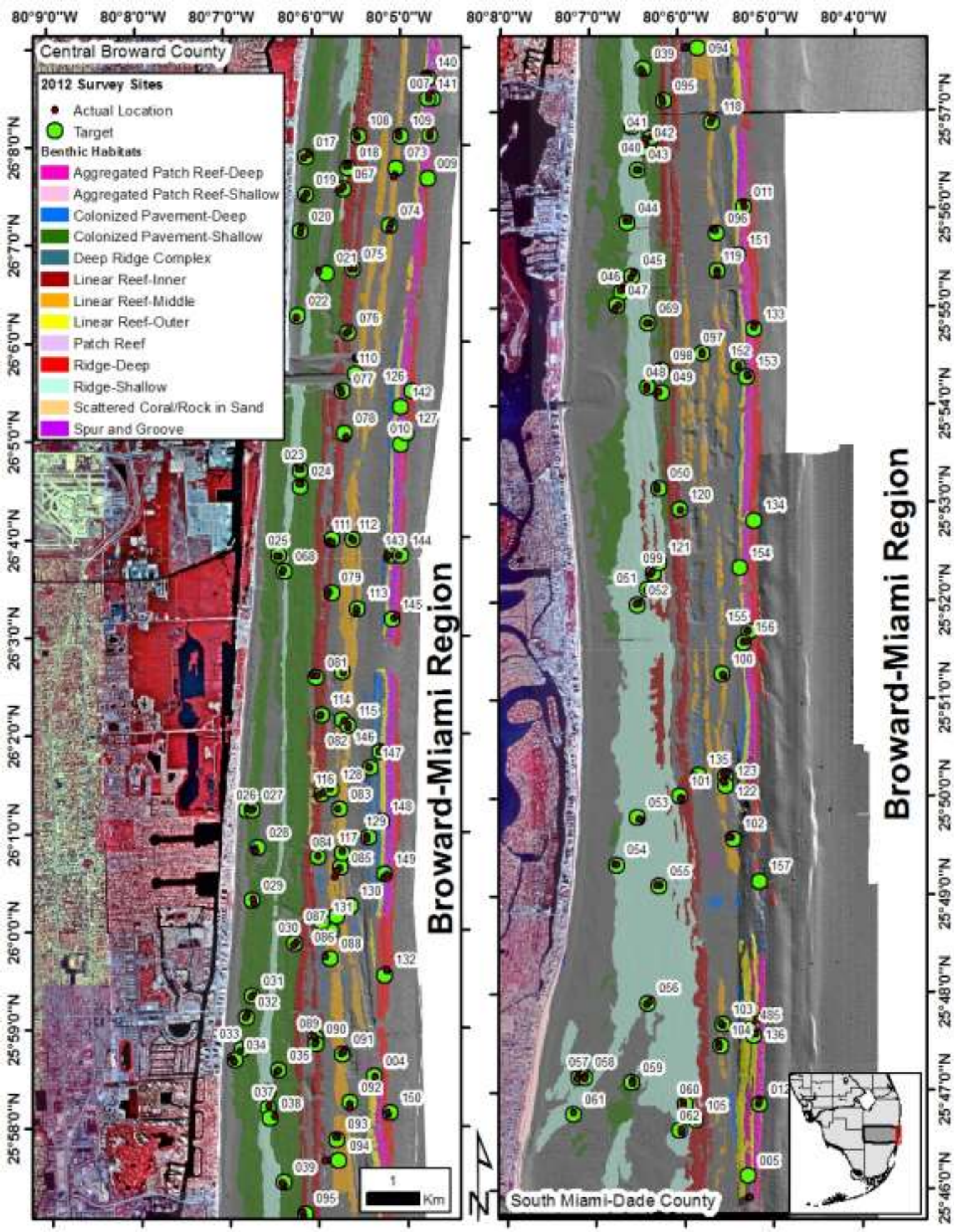
APPENDIX 2. 2012 site maps. Green indicates Target Site and small points indicate actual survey locations. Target sites without corresponding "actual" sites were not surveyed.



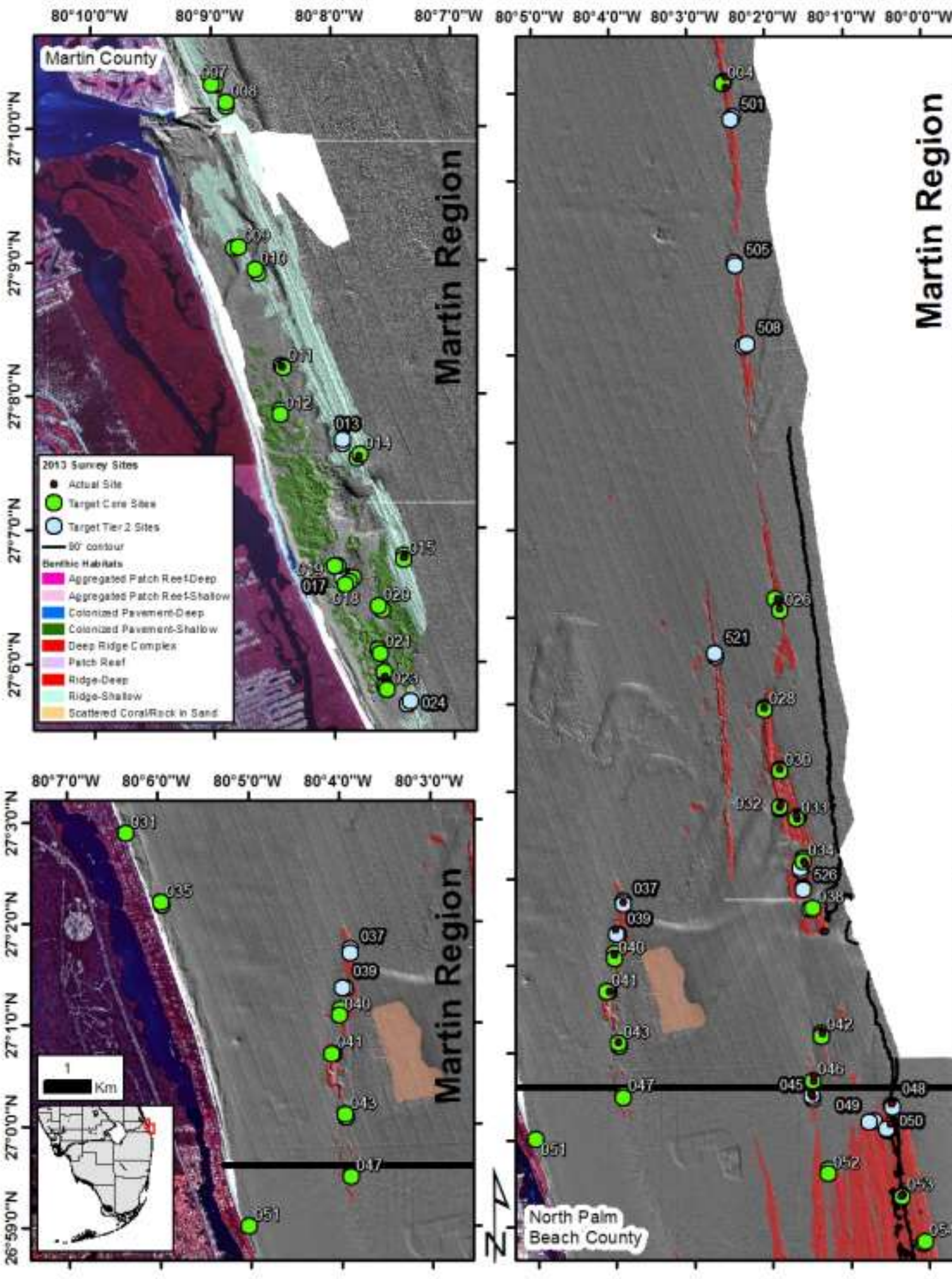


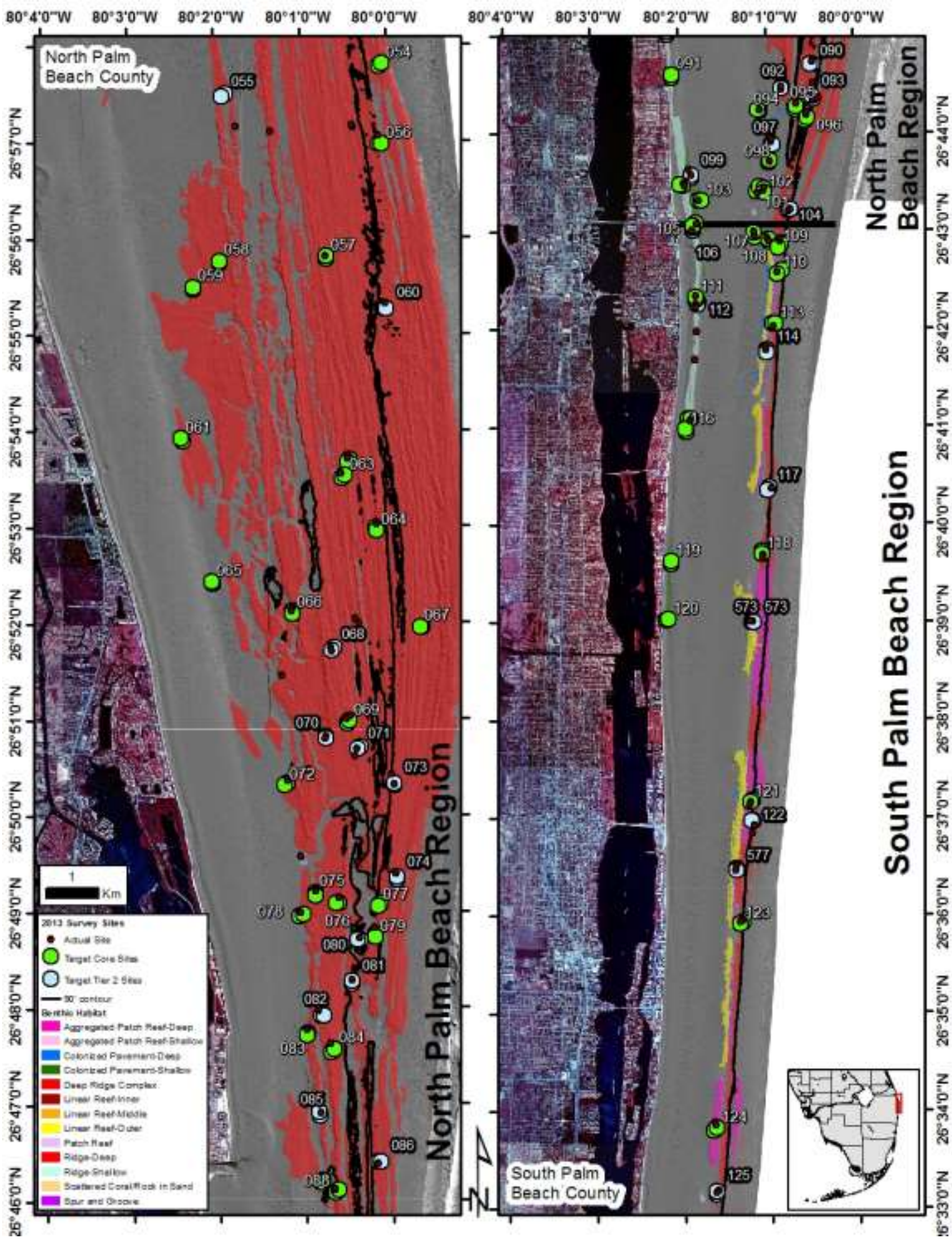
North Palm Beach County
North Palm Beach Region
South Palm Beach Region
South Palm Beach County
2012 Survey Sites
Actual Location
Target
Benthic Habitat
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Colonized Pavement-Deep
Colonized Pavement-Shallow
Deep Ridge Complex
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Scattered Coral/Rock in Sand
Spur and Groove
Continuous Seagrass
Discontinuous Seagrass
90' contour
Km

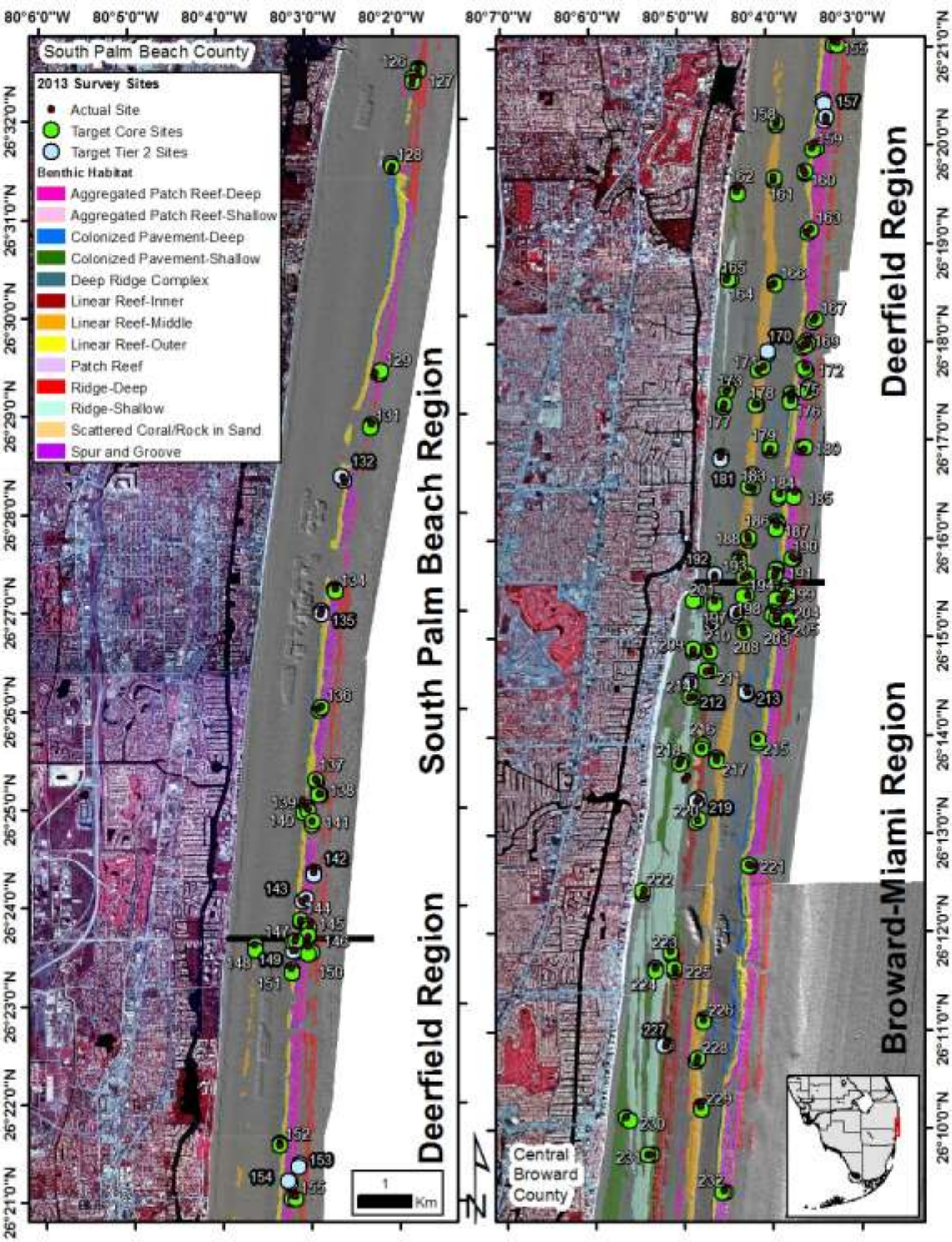

2012 Survey Sites
Actual Location
Target
Benthic Habitat
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Colonized Pavement-Deep
Colonized Pavement-Shallow
Deep Ridge Complex
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Scattered Coral/Rock in Sand
Spur and Groove
Continuous Seagrass
Discontinuous Seagrass
South Palm Beach Region
Deerfield Region
Deerfield Region
Broward-Miami Region
Central Broward County
1
Km
N

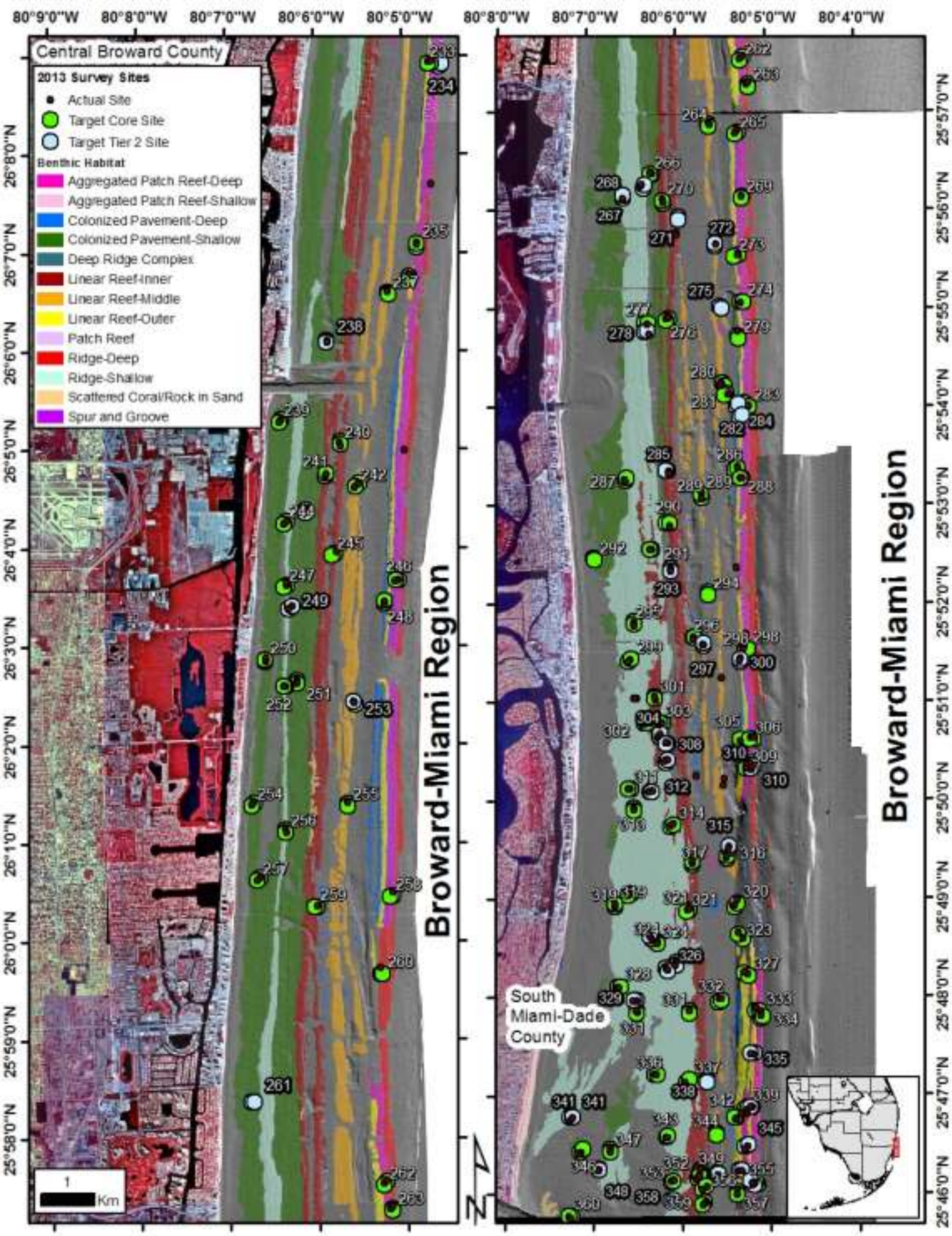

Central Broward County
2012 Survey Sites
Actual Location
Target
Benthic Habitats
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Colonized Pavement-Deep
Colonized Pavement-Shallow
Deep Ridge Complex
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Scattered Coral/Rock in Sand
Spur and Groove
Broward-Miami Region
South Miami-Dade County
Broward-Miami Region
1 Km

APPENDIX 3. 2013 site maps. Green indicates Core Target Site, Blue indicates Tier 2 Target Site, and small points indicate actual survey locations. Target sites without corresponding "Actual" sites were not surveyed.

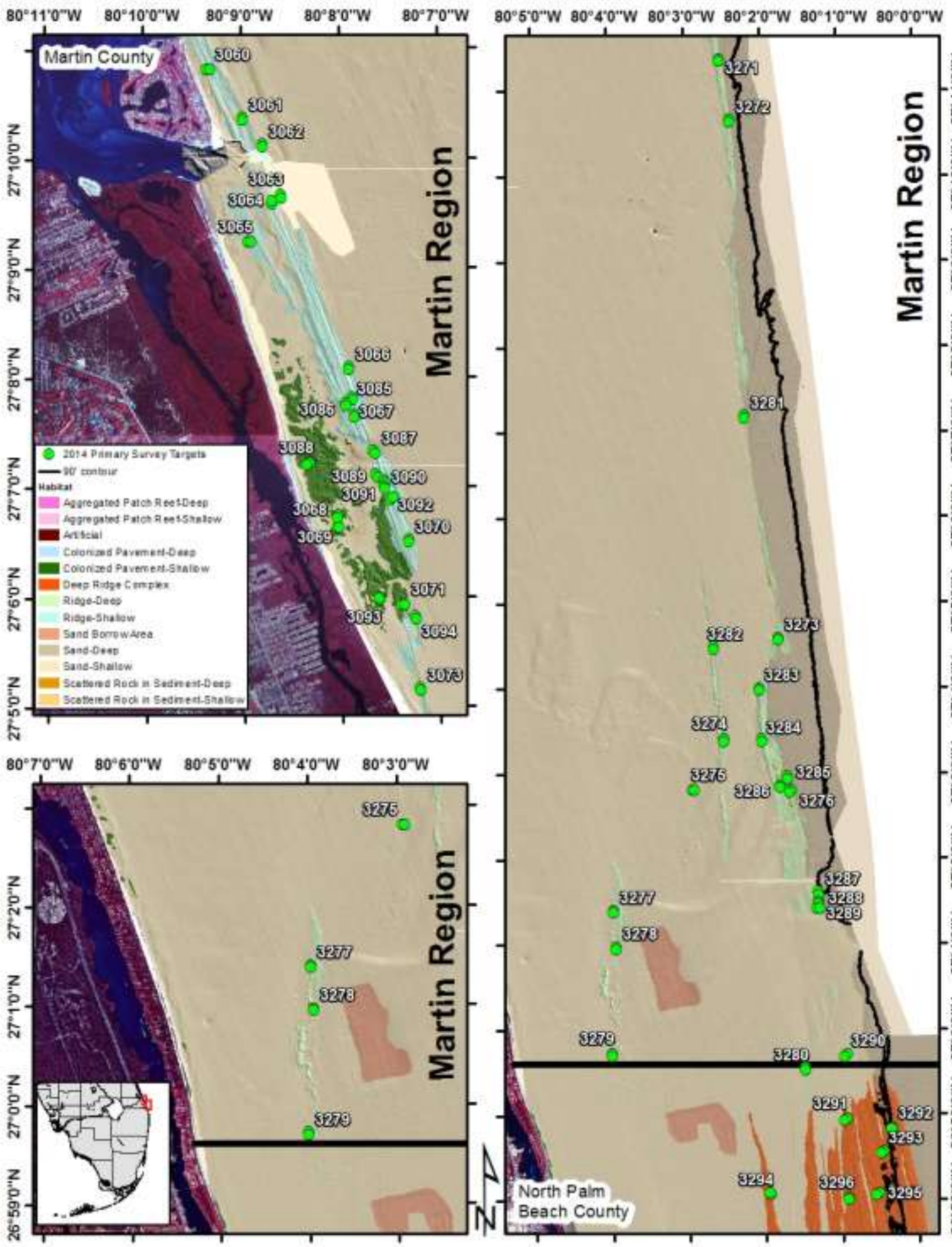


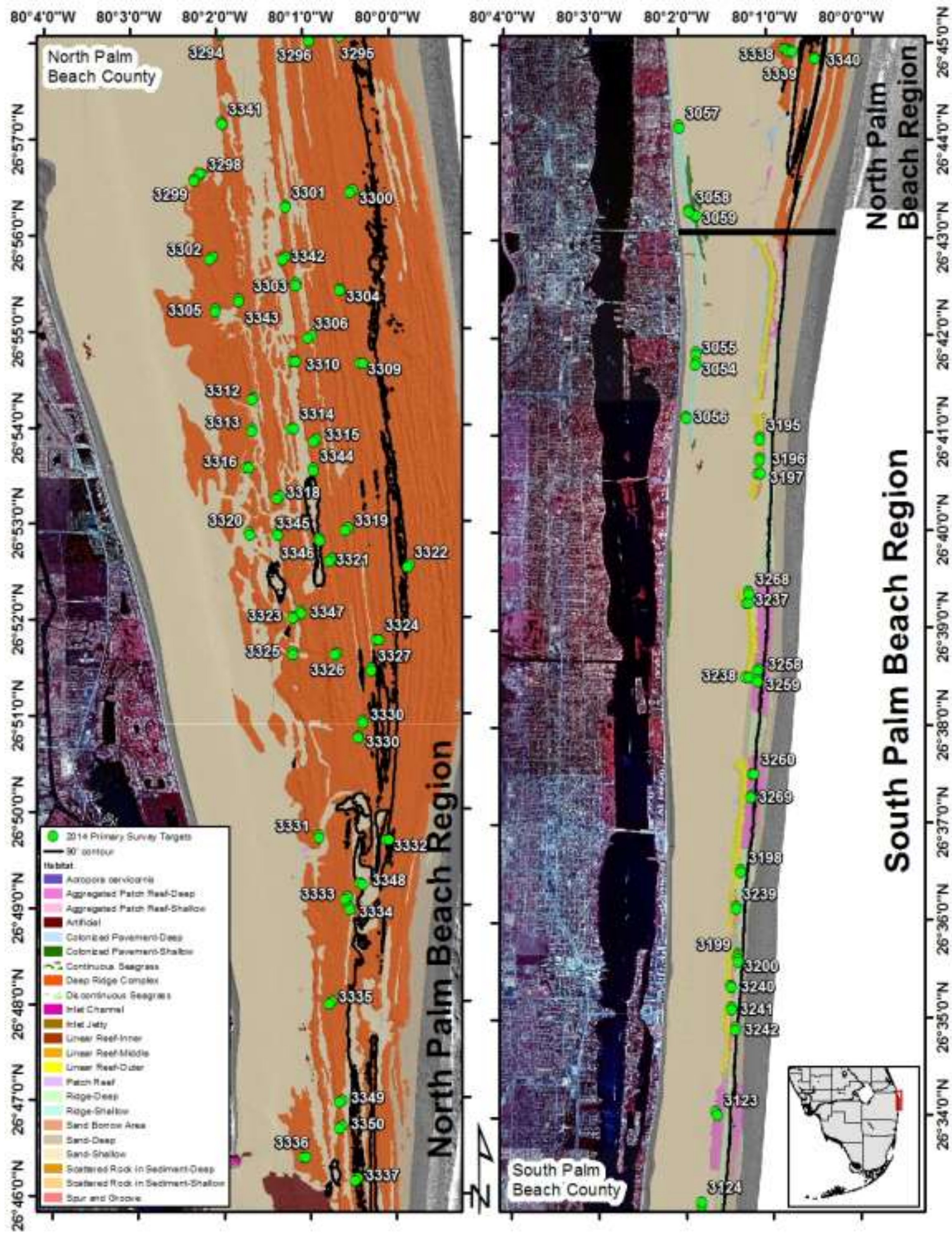

North Palm
Beach County
North Palm Beach Region
South Palm
Beach County
South Palm Beach Region
North Palm
Beach Region
2013 Survey Sites
Actual Site
Target Core Sites
Target Tier 2 Sites
30' contour
Benthic Habitat
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Colonized Pavement-Deep
Colonized Pavement-Shallow
Deep Ridge Complex
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Scattered Coral/Rock in Sand
Spur and Groove

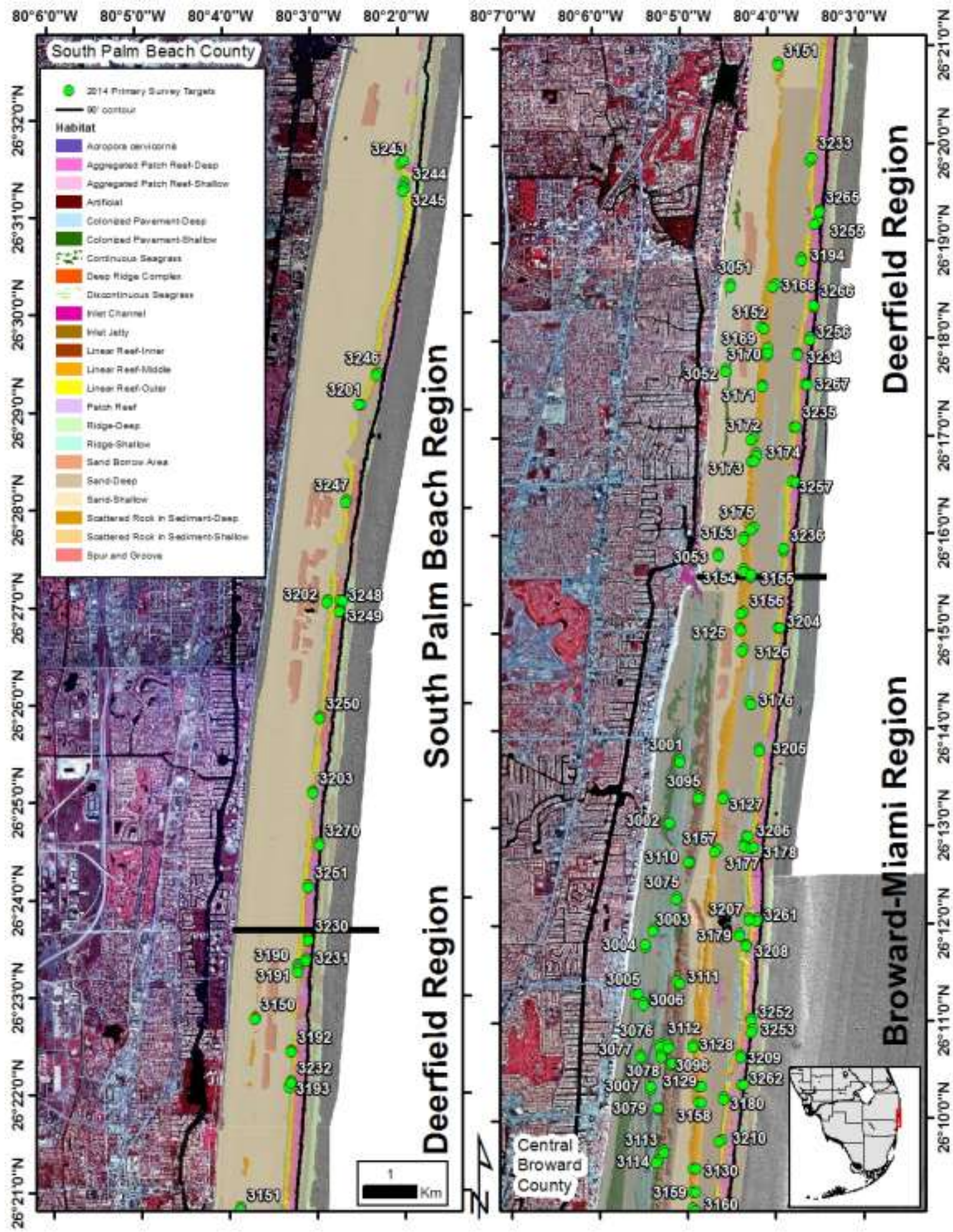

South Palm Beach County
2013 Survey Sites
Actual Site
Target Core Sites
Target Tier 2 Sites
Benthic Habitat
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Colonized Pavement-Deep
Colonized Pavement-Shallow
Deep Ridge Complex
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Scattered Coral/Rock in Sand
Spur and Groove
South Palm Beach Region
Deerfield Region
Broward-Miami Region
Central Broward County
1 Km
N

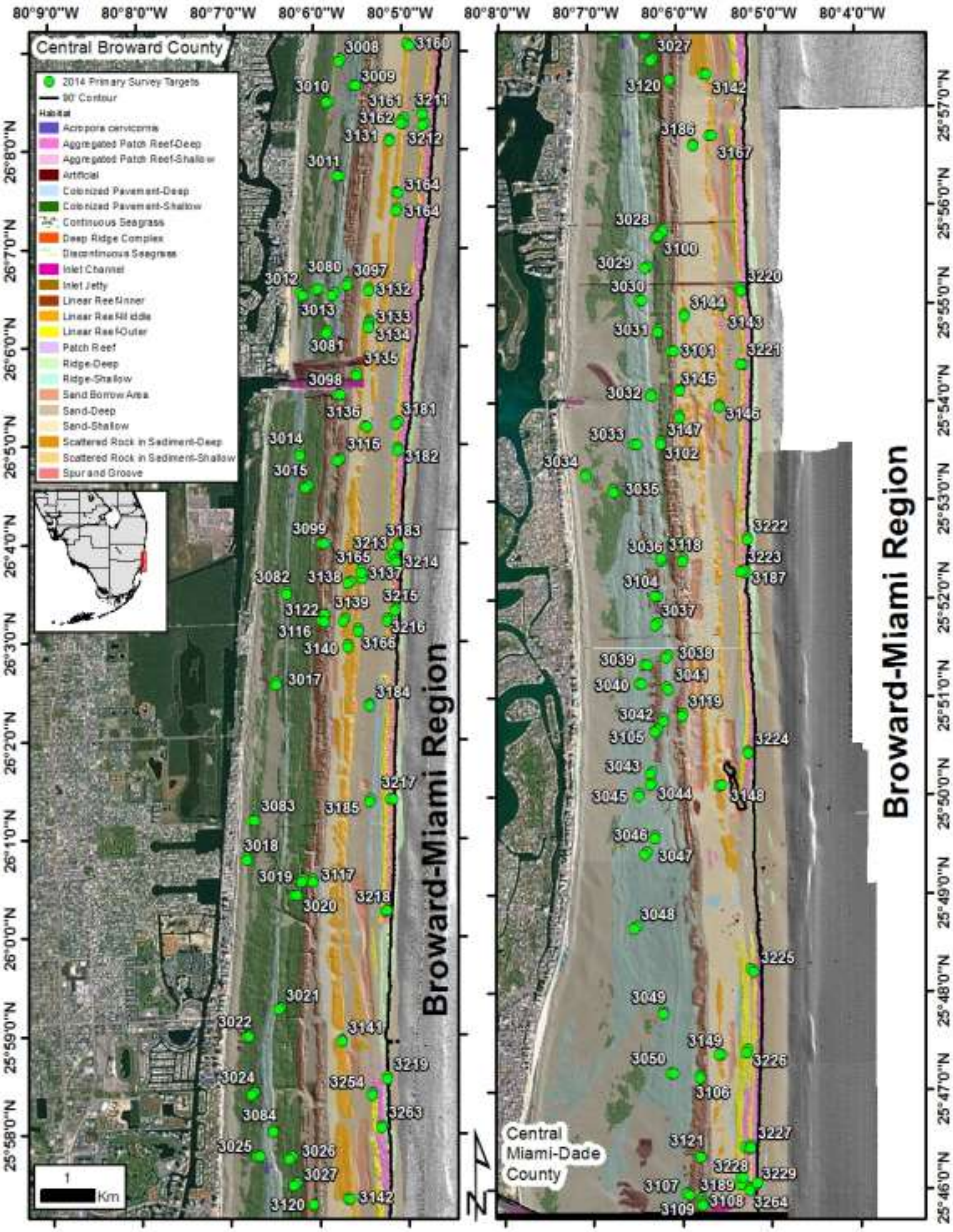

Central Broward County
2013 Survey Sites
Actual Site
Target Core Site
Target Tier 2 Site
Benthic Habitat
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Colonized Pavement-Deep
Colonized Pavement-Shallow
Deep Ridge Complex
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Scattered Coral/Rock in Sand
Spur and Groove
Broward-Miami Region
Broward-Miami Region
South Miami-Dade County
1 Km
80°9'0"W 80°8'0"W 80°7'0"W 80°6'0"W 80°5'0"W
80°8'0"W 80°7'0"W 80°6'0"W 80°5'0"W 80°4'0"W
26°8'0"N 26°7'0"N 26°6'0"N 26°5'0"N 26°4'0"N 26°3'0"N 26°2'0"N 26°1'0"N 26°0'0"N 25°59'0"N 25°58'0"N
25°57'0"N 25°56'0"N 25°55'0"N 25°54'0"N 25°53'0"N 25°52'0"N 25°51'0"N 25°50'0"N 25°49'0"N 25°48'0"N 25°47'0"N 25°46'0"N

APPENDIX 4. 2014 site maps. Green indicates Core Target Site, Blue indicates Tier 2 Target Site, and small points indicate actual survey locations. Target sites without corresponding "Actual" sites were not surveyed.




North Palm Beach County
South Palm Beach County
North Palm Beach Region
South Palm Beach Region
2014 Primary Survey Targets
90' contour
Habitat
Acropora cervicornis
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Artificial
Colonized Pavement-Deep
Colonized Pavement-Shallow
Continuous Seagrass
Deep Ridge Complex
Discontinuous Seagrass
Inlet Channel
Inlet Jetty
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Sand Borrow Area
Sand-Deep
Sand-Shallow
Scattered Rock in Sediment-Deep
Scattered Rock in Sediment-Shallow
Spur and Groove


South Palm Beach County
2014 Primary Survey Targets
Habitat
Acropora cervicornis
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Artificial
Colonized Pavement-Deep
Colonized Pavement-Shallow
Continuous Seagrass
Deep Ridge Complex
Discontinuous Seagrass
Inlet Channel
Inlet Jetty
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Sand Borrow Area
Sand-Deep
Sand-Shallow
Scattered Rock in Sediment-Deep
Scattered Rock in Sediment-Shallow
Spur and Groove
South Palm Beach Region
Deerfield Region
Broward-Miami Region
Central Broward County
Km


Central Broward County
2014 Primary Survey Targets
90' Contour
Habitat
Acropora cervicornis
Aggregated Patch Reef-Deep
Aggregated Patch Reef-Shallow
Artificial
Colonized Pavement-Deep
Colonized Pavement-Shallow
Continuous Seagrass
Deep Ridge Complex
Discontinuous Seagrass
Inlet Channel
Inlet Jetty
Linear Reef-Inner
Linear Reef-Middle
Linear Reef-Outer
Patch Reef
Ridge-Deep
Ridge-Shallow
Sand Borrow Area
Sand-Deep
Sand-Shallow
Scattered Rock in Sediment-Deep
Scattered Rock in Sediment-Shallow
Spur and Groove
Broward-Miami Region
Central Miami-Dade County
Broward-Miami Region
1 Km

Appendix 5. Average percent occurrence ($\overline{P}$) per SSU, average density ($\boldsymbol{D}$) per SSU, survey precision (CV of $\boldsymbol{D}$, percent) and range of CV for the 2 year period 2012-2013 for the SEFCRI region (2 annual surveys) and 15 year period 1999-2013 for the Florida Keys (10 annual surveys) and the Dry Tortugas (5 annual surveys). Species analyzed had average percent occurrence greater than 10% (75 species total). Species with values highlighted in pink were not observed with greater than 10% occurrence in the SEFCRI region. Species with values highlighted in grey were not observed with greater than 10% occurrence in the Florida Keys and Dry Tortugas.

Species	Family	SEFCRI REGION			FLORIDA KEYS			DRY TORTUGAS		
EXPLOITED		***P***	***D***	**CV(*D*), Range**	***P***	***D***	**CV(*D*), Range**	***P***	***D***	**CV(*D*), Range**
***Gray triggerfish** (*Balistes capriscus*)	Balistidae	35.4	0.78	22.0 (12.6, 31.4)	-	-	-	-	-	-
Bar jack (*Caranx ruber*)	Carangidae	28.8	1.32	22.8 (18.1, 27.4)	35.5	2.97	24.2 (18.5, 40.0)	23.4	3.63	26.8 (20.4, 36.8)
Porkfish (*Anisotremus virginicus*)	Haemulidae	42.6	1.50	18.8 (16.8, 20.8)	41.9	1.23	18.3 (11.9, 52.9)	17.8	0.55	34.0 (17.1, 60.4)
Tomtate (*Haemulon aurolineatum*)	Haemulidae	13.2	6.83	23.1 (22.5, 23.7)	18.5	13.66	34.9 (23.6, 73.9)	31.9	25.96	22.5 (13.8, 29.8)
French grunt (*Haemulon flavolineatum*)	Haemulidae	18.0	3.81	28.8 (23.0, 34.6)	38.0	3.63	19.7 (15.4, 30.0)	14.9	0.82	30.7 (18.4, 39.7)
***White grunt** (*Haemulon plumieri*)	Haemulidae	45.2	1.91	11.5 (10.8, 12.1)	73.5	8.96	14.1 (7.6, 22.8)	79.6	6.58	17.2 (13.8, 21.8)
***Bluestriped grunt** (*Haemulon sciurus*)	Haemulidae	17.5	1.36	35.1 (18.7, 51.5)	-	-	-	-	-	-
***Hogfish** (*Lachnolaimus maximus*)	Labridae	22.5	0.32	11.6 (10.0, 13.1)	62.5	1.15	10.1 (6.6, 13.6)	48.1	0.55	10.7 (8.6, 13.6)
***Mutton snapper** (*Lutjanus analis*)	Lutjanidae	23.8	0.25	18.2 (10.4, 26.0)	17.8	0.18	17.5 (10.0, 29.2)	22.8	0.19	14.8 (9.0, 21.8)
***Gray snapper** (*Lutjanus griseus*)	Lutjanidae	12.0	0.45	25.1 (23.0, 27.1)	27.5	2.27	22.9 (16.8, 34.0)	15.2	2.73	49.7 (18.3, 70.0)
***Yellowtail snapper** (*Ocyurus chrysurus*)	Lutjanidae	28.0	1.47	32.8 (30.5, 35.1)	58.5	4.12	12.3 (7.4, 18.0)	75.7	7.56	15.1 (7.9, 26.9)
Graysby (*Cephalopholis cruentata*)	Serranidae	20.9	0.21	17.6 (9.0, 26.3)	32.1	0.30	10.6 (7.1, 14.7)	31.6	0.27	10.7 (7.0, 13.8)
***Red grouper** (*Epinephelus morio*)	Serranidae	10.5	0.07	18.5 (18.0, 18.9)	20.4	0.16	14.2 (10.7, 20.0)	62.2	0.62	6.7 (5.9, 7.8)
Black grouper (*Mycteroperca bonaci*)	Serranidae	0.015	0.008	40.6 (35.9, 45.3)	16.2	0.14	16.2 (11.2, 27.0)	22.2	0.22	14.1 (9.6, 18.4)
Gag (*Mycteroperca microlepis*)	Serranidae	0.006	0.004	48.6 (38.9, 58.3)	-	-	-	-	-	-
Scamp (*Mycteroperca phenax*)	Serranidae	0.010	0.006	41.7 (29.0, 54.5)	-	-	-	-	-	-
Great barracuda (*Sphyraena barracuda*)	Sphyraenidae	0.015	0.018	51.0 (49.2, 52.8)	10.7	0.11	23.3 (15.5, 33.7)	17.1	0.21	30.1 (14.9, 52.0)
NON-TARGET & AQUARIUM										
Ocean surgeon (*Acanthurus bahianus*)	Acanthuridae	78.3	4.61	5.9 (5.5, 6.3)	79.7	3.53	7.3 (5.7, 10.9)	60.5	1.21	10.5 (8.0, 14.4)
Doctorfish (*Acanthurus chirurgus*)	Acanthuridae	61.7	2.73	9.1 (6.6, 11.6)	56.2	2.18	12.0 (8.5, 17.0)	30.0	0.50	16.8 (14.5, 19.0)
Blue tang (*Acanthurus coeruleus*)	Acanthuridae	46.9	1.63	13.3 (9.5, 17.1)	77.5	2.92	9.7 (6.4, 15.8)	77.7	2.25	8.1 (7.0, 10.1)
Seaweed blenny (*Parablennius marmoreus*)	Blenniidae	10.8	0.11	22.5 (18.7, 26.3)	-	-	-	-	-	-
Foureye butterflyfish (*Chaetodon capistratus*)	Chaetodontidae	11.0	0.14	18.3 (12.6, 24.1)	41.5	0.60	10.5 (7.0, 24.5)	39.8	0.59	9.1 (6.0, 10.9)
Spotfin butterflyfish (*Chaetodon ocellatus*)	Chaetodontidae	26.2	0.35	12.3 (8.5, 16.0)	42.8	0.53	8.5 (6.2, 12.1)	53.7	0.69	6.9 (5.3, 7.6)
Reef butterflyfish (*Chaetodon sedentarius*)	Chaetodontidae	40.3	0.74	6.5 (5.8, 7.2)	32.5	0.45	10.4 (7.2, 14.7)	27.0	0.29	13.3 (10.6, 17.1)

Species	Family	SEFCRI REGION			FLORIDA KEYS			DRY TORTUGAS		
Appendix 5 Continued		***P***	***D***	**CV(*D*), Range**	***P***	***D***	**CV(*D*), Range**	***P***	***D***	**CV(*D*), Range**
Bridled goby (*Coryphopterus glaucofraenum*)	Gobiidae	20.1	0.38	17.4 (16.4, 18.5)	-	-	-	-	-	-
Masked goby (*Coryphopterus personatus*)	Gobiidae	17.7	6.51	17.2 (14.6, 19.8)	-	-	-	-	-	-
Neon goby (*Elacatinus oceanops*)	Gobiidae	11.3	0.17	23.3 (16.2, 30.5)	-	-	-	-	-	-
Grunt species (*Haemulon* spp.)	Haemulidae	15.4	4.90	27.1 (25.0, 29.2)	-	-	-	-	-	-
Squirrelfish (*Holocentrus adscensionis*)	Holocentridae	14.7	0.15	19.0 (14.0, 24.0)	10.2	0.14	24.6 (19.6, 36.5)	13.4	0.17	26.7 (16.8, 41.0)
Spanish hogfish (*Bodianus rufus*)	Labridae	31.4	0.35	13.6 (9.9, 17.4)	23.8	0.25	13.7 (9.6, 19.1)	21.5	0.19	14.6 (8.8, 18.5)
Creole wrasse (*Clepticus parrae*)	Labridae	10.9	2.16	27.5 (19.3, 35.7)	-	-	-	-	-	-
Slippery dick (*Halichoeres bivittatus*)	Labridae	65.0	4.09	8.5 (7.6, 9.5)	70.0	4.85	8.8 (7.6, 10.7)	77.2	7.18	7.8 (6.0, 9.6)
Yellowcheek wrasse (*Halichoeres cyanocephalus*)	Labridae	10.5	0.08	30.9 (20.9, 40.9)	-	-	-	-	-	-
Yellowhead wrasse (*Halichoeres garnoti*)	Labridae	59.6	4.64	8.4 (6.8, 9.9)	67.7	3.30	8.3 (5.1, 18.5)	81.6	3.95	7.4 (4.2, 11.8)
Clown wrasse (*Halichoeres maculipinna*)	Labridae	43.4	1.79	12.2 (10.8, 13.7)	56.4	2.31	8.7 (6.7, 11.4)	42.6	0.89	13.0 (9.6, 20.3)
Puddingwife (*Halichoeres radiatus*)	Labridae	0.06	0.04	37.9 (37.5, 38.2)	27.2	0.25	12.1 (7.9, 18.7)	11.9	0.09	21.3 (15.3, 36.2)
Bluehead (*Thalassoma bifasciatum*)	Labridae	78.3	15.49	9.1 (7.7, 10.5)	92.1	17.69	6.6 (4.0, 9.4)	94.8	15.58	8.1 (4.8, 15.8)
Green razorfish (*Xyrichtys splendens*)	Labridae	19.1	0.98	42.6 (20.5, 64.7)	-	-	-	-	-	-
Scrawled filefish (*Aluterus scriptus*)	Monacanthidae	13.9	0.10	16.7 (13.0, 20.5)	-	-	-	-	-	-
Orangespotted filefish (*Cantherhines pullus*)	Monacanthidae	11.6	0.07	17.0 (13.7, 20.3)	-	-	-	-	-	-
Spotted goatfish (*Pseudupeneus maculatus*)	Mullidae	47.0	1.02	10.6 (8.4, 12.9)	35.9	0.67	19.1 (8.4, 57.0)	62.0	1.10	9.7 (8.0, 12.0)
Yellowhead jawfish (*Opistognathus aurifrons*)	Opistignathidae	11.2	0.21	25.4 (17.1, 33.7)	10.7	0.25	26.7 (16.8, 46.1)	49.8	2.59	14.2 (10.1, 17.5)
Scrawled cowfish (*Acanthostracion quadricornis*)	Ostraciidae	10.0	0.07	23.4 (15.1, 31.7)	-	-	-	-	-	-
Smooth Trunkfish (*Rhinesomus triqueter*)	Ostraciidae	11.2	0.07	15.5 (14.3, 16.6)	-	-	-	-	-	-
Blue angelfish (*Holacanthus bermudensis*)	Pomacanthidae	18.9	0.20	20.4 (11.6, 29.2)	16.6	0.14	16.5 (12.2, 23.3)	57.1	0.83	7.2 (5.5, 8.6)
Queen angelfish (*Holacanthus ciliaris*)	Pomacanthidae	16.9	0.16	18.5 (12.2, 24.8)	27.2	0.23	12.7 (7.9, 19.7)	23.4	0.20	12.9 (9.0, 15.3)
Rock beauty (*Holacanthus tricolor*)	Pomacanthidae	32.6	0.46	11.2 (6.3, 16.1)	-	-	-	-	-	-
Gray angelfish (*Pomacanthus arcuatus*)	Pomacanthidae	42.2	0.52	10.8 (7.4, 14.2)	58.1	0.82	10.1 (5.4, 23.1)	46.0	0.58	12.7 (7.6, 27.3)
French angelfish (*Pomacanthus paru*)	Pomacanthidae	24.1	0.26	17.1 (10.4, 23.8)	21.1	0.19	14.8 (11.9, 20.1)	14.3	0.12	17.3 (13.5, 20.7)
Sergent major (*Abudefduf saxatilis*)	Pomacentridae	15.2	1.82	25.1 (19.1, 31.0)	-	-	-	-	-	-
Blue chromis (*Chromis cyanea*)	Pomacentridae	17.4	1.94	21.9 (14.3, 29.5)	21.9	1.37	17.2 (12.4, 27.2)	23.3	0.95	24.7 (11.3, 43.9)
Yellowtail reeffish (*Chromis enchrysura*)	Pomacentridae	16.6	0.67	34.3 (23.7, 44.8)	-	-	-	-	-	-
Sunshinefish (*Chromis insolata*)	Pomacentridae	15.3	0.97	22.9 (13.1, 32.7)	-	-	-	-	-	-
Brown chromis (*Chromis multilineata*)	Pomacentridae	10.0	1.13	36.1 (26.0, 46.1)	-	-	-	-	-	-
Purple reeffish (*Chromis scotti*)	Pomacentridae	10.6	0.86	34.1 (22.7, 45.5)	-	-	-	-	-	-
Beaugregory (*Stegastes leucostictus*)	Pomacentridae	18.3	0.31	17.6 (17.3, 17.9)	24.2	0.27	14.8 (8.7, 23.9)	34.6	0.58	12.0 (10.1, 13.5)
Bicolor damselfish (*Stegastes partitus*)	Pomacentridae	74.1	19.37	8.4 (5.6, 11.2)	81.0	19.55	8.4 (5.7, 12.2)	73.9	7.71	8.6 (6.7, 11.2)

Species	**Family**	**SEFCRI REGION**			**FLORIDA KEYS**			**DRY TORTUGAS**		
Threespot damselfish (*Stegastes planifrons*)	Pomacentridae	0.03	0.04	30.9 (29.7, 32.2)	28.6	0.61	14.5 (9.9, 20.2)	36.0	1.08	12.1 (8.7, 20.5)
Appendix 5 Continued		***P***	***D***	**CV(*D*), Range**	***P***	***D***	**CV(*D*), Range**	***P***	***D***	**CV(*D*), Range**
Cocoa damselfish (*Stegastes variabilis*)	Pomacentridae	38.0	0.75	16.9 (8.9, 24.8)	55.1	0.89	9.5 (5.8, 14.0)	91.8	5.07	5.2 (4.3, 6.5)
Bluelip parrotfish (*Cryptotomus roseus*)	Scaridae	20.6	0.61	17.2 (12.0, 22.4)	-	-	-	-	-	-
Striped parrotfish (*Scarus iseri*)	Scaridae	35.7	2.31	12.1 (9.4, 14.7)	80.2	7.55	7.1 (5.2, 9.9)	91.6	11.22	13.4 (4.5, 41.5)
Princess parrotfish (*Scarus taeniopterus*)	Scaridae	24.4	0.72	11.9 (11.5, 12.3)	16.7	0.34	21.5 (12.5, 27.4)	12.0	0.28	21.7 (13.0, 30.8)
Greenblotch parrotfish (*Sparisoma atomarium*)	Scaridae	41.9	1.23	13.9 (11.0, 16.8)	40.9	1.01	12.3 (7.7, 18.4)	49.7	1.10	12.9 (9.0, 22.5)
Redband parrotfish (*Sparisoma aurofrenatum*)	Scaridae	60.6	3.33	7.7 (7.6, 7.8)	88.5	3.97	6.0 (3.9, 8.2)	83.9	2.94	13.0 (4.8, 23.2)
Redtail parrotfish (*Sparisoma chrysopterum*)	Scaridae	0.09	0.14	24.5 (17.3, 31.8)	27.3	0.57	18.4 (12.2, 25.6)	14.5	0.18	25.7 (18.8, 32.5)
Yellowtail parrotfish (*Sparisoma rubripinne*)	Scaridae	11.0	0.15	22.7 (21.4, 23.9)	19.7	0.34	20.9 (12.2, 30.1)	11.0	0.13	23.0 (15.9, 30.3)
Stoplight Parrotfish (*Sparisoma viride*)	Scaridae	31.1	0.54	10.6 (9.0, 12.3)	64.2	1.41	8.7 (6.4, 11.9)	60.5	1.20	9.9 (5.8, 12.5)
High-hat (*Pareques acuminatus*)	Sciaenidae	10.9	0.20	29.2 (28.7, 29.7)	-	-	-	-	-	-
Lionfish (*Pterois volitans/miles*)	Scorpanidae	13.1	0.13	24.2 (17.5, 30.9)	-	-	-	-	-	-
Butter hamlet (*Hypoplectrus unicolor*)	Serranidae	19.7	0.28	24.8 (19.4, 30.3)	32.9	0.33	11.1 (7.2, 19.4)	48.4	0.62	9.4 (5.9, 17.3)
Lantern bass (*Serranus baldwini*)	Serranidae	18.1	0.18	21.3 (13.8, 28.9)	-	-	-	-	-	-
Tobaccofish (*Serranus tabacarius*)	Serranidae	9.6	0.11	16.9 (16.0, 17.9)	9.9	0.12	23.6 (16.9, 32.5)	14.6	0.18	23.7 (19.2, 36.0)
Harlequin bass (*Serranus tigrinus*)	Serranidae	31.9	0.40	9.6 (7.3, 11.8)	35.4	0.35	9.6 (7.6, 12.5)	34.0	0.34	12.2 (8.7, 17.9)
Saucereye porgy (*Calamus calamus*)	Sparidae	13.5	0.15	23.7 (16.1, 31.3)	35.3	0.45	13.1 (9.4, 25.1)	75.5	1.43	8.8 (7.1, 11.5)
Littlehead porgy (*Calamus proridens*)	Sparidae	13.1	0.16	27.9 (25.8, 30.0)	-	-	-	-	-	-
Sharpnose puffer (*Canthigaster rostrata*)	Tetraodontidae	79.3	2.45	5.8 (5.8, 5.8)	44.4	0.48	8.7 (5.7, 12.4)	30.9	0.28	13.3 (7.1, 19.0)
Bandtail puffer (*Sphoeroides spengleri*)	Tetraodontidae	12.5	0.10	21.0 (13.9, 28.1)	-	-	-	-	-	-

Appendix 6. Percent Occurrence (*P*), Mean Density (*D*), and Coefficient of Variation (CV) for all species observed from both years, in alphabetical order by family.

Common Name	Species	Family	2012 *P*	2012 *D*	2012 CV(*D*)	2013 *P*	2013 *D*	2013 CV(*D*)
Ocean surgeon	*Acanthurus bahianus*	Acanthuridae	0.85	4.74	5.49	0.71	4.48	6.29
Doctorfish	*Acanthurus chirurgus*	Acanthuridae	0.58	2.51	11.56	0.65	2.94	6.64
Blue tang	*Acanthurus coeruleus*	Acanthuridae	0.47	1.86	17.07	0.47	1.40	9.48
Surgeonfish species	*Acanthurus* spp.	Acanthuridae	0.10	0.30	30.72	0.04	0.07	46.55
Cardinalfish species	*Astrapogon* spp.	Apogonidae	0.005	0.003	92.02	0.003	0.003	80.19
Barred cardinalfish	*Apogon binotatus*	Apogonidae	0.004	0.002	49.20	0.004	0.003	50.17
Flamefish	*Apogon maculatus*	Apogonidae	0.008	0.004	46.23	0.01	0.02	61.82
Twospot cardinalfish	*Apogon pseudomaculatus*	Apogonidae	0.004	0.008	88.90	0.02	0.05	51.97
Sawcheek cardinalfish	*Apogon quadrisquamatus*	Apogonidae	-	-	-	0.001	0.001	100.57
Belted cardinalfish	*Apogon townsendi*	Apogonidae	-	-	-	0.006	0.004	48.61
Trumpetfish	*Aulostomus maculatus*	Aulostomidae	0.12	0.13	25.23	0.06	0.05	26.85
Gray triggerfish	*Balistes capriscus*	Balistidae	0.31	0.63	31.38	0.39	0.93	12.58
Queen triggerfish	*Balistes vetula*	Balistidae	0.03	0.01	86.51	0.03	0.02	33.54
Ocean triggerfish	*Canthidermis sufflamen*	Balistidae	0.01	0.007	42.10	0.02	0.02	34.08
Oyster toadfish	*Opsanus tau*	Batrachoididae	-	-	-	0.004	0.003	99.53
Blenny species	Blenny spp.	Blenniidae	0.01	0.006	40.29	0.02	0.01	41.85
Barred blenny	*Hypleurochilus bermudensis*	Blenniidae	0.003	0.002	80.01	0.003	0.002	100.05
Redlip blenny	*Ophioblennius macclurei*	Blenniidae	-	-	-	0.007	0.005	70.08
Seaweed blenny	*Parablennius marmoreus*	Blenniidae	0.11	0.12	26.31	0.11	0.11	18.67
Molly miller	*Scartella cristata*	Blenniidae	0.01	0.02	54.40	0.002	0.004	100.26
Peacock flounder	*Bothus lunatus*	Bothidae	-	-	-	0.0003	0.0002	102.72
Eyed flounder	*Bothus ocellatus*	Bothidae	-	-	-	0.001	0.003	97.68
Black brotula	*Stygnobrotula latebricola*	Bythitidae	0.001	0.001	98.00	-	-	-

Yellow jack	*Carangoides bartholomaei*	Carangidae	0.08	0.12	51.21	0.06	0.09	26.87
Bar jack	*Caranx ruber*	Carangidae	0.34	2.09	27.39	0.24	0.54	18.13
Jack species	*Caranx* spp.	Carangidae	0.01	0.28	51.68	0.003	0.001	68.18
Blue runner	*Caranx crysos*	Carangidae	0.07	0.70	35.38	0.10	0.62	25.60
Crevalle jack	*Caranx hippos*	Carangidae	0.004	0.006	84.90	0.005	0.009	49.56
Horse-eye jack	*Caranx latus*	Carangidae	-	-	-	0.001	0.007	100.57
Black jack	*Caranx lugubris*	Carangidae	-	-	-	0.002	0.001	100.26
Atlantic bumper	*Chloroscombrus chrysurus*	Carangidae	0.006	0.24	88.48	0.006	0.94	93.58
Scad species	*Decapterus* spp.	Carangidae	-	-	-	0.001	0.05	100.57
Mackerel scad	*Decapterus macarellus*	Carangidae	0.01	1.04	56.03	0.008	0.91	67.05
Round scad	*Decapterus punctatus*	Carangidae	0.005	0.47	61.78	0.02	2.19	47.50
Rainbow runner	*Elagatis bipinnulata*	Carangidae	-	-	-	0.01	0.14	44.75
Leatherjack	*Oligoplites saurus*	Carangidae	0.001	0.002	101.80	-	-	-
Greater amberjack	*Seriola dumerili*	Carangidae	0.003	0.005	88.57	0.005	0.02	56.92
Almaco jack	*Seriola rivoliana*	Carangidae	0.09	0.22	41.97	0.01	0.03	59.59
Jack species	*Seriola* spp.	Carangidae	-	-	-	0.001	0.002	83.72
Banded rudderfish	*Seriola zonata*	Carangidae	-	-	-	0.0005	0.0002	100.69
Permit	*Trachinotus falcatus*	Carangidae	0.003	0.001	100.77	-	-	-
Rough scad	*Trachurus lathami*	Carangidae	-	-	-	0.001	0.004	102.25
Bull shark	*Carcharhinus leucas*	Carcharhinidae	0.005	0.003	99.58	0.001	0.000	97.68
Lemon shark	*Negaprion brevirostris*	Carcharhinidae	-	-	-	0.004	0.002	89.35
Roughhead blenny	*Acanthemblemaria aspera*	Chaenopsidae	0.01	0.008	51.02	0.002	0.001	100.26
Secretary blenny	*Acanthemblemaria maria*	Chaenopsidae	-	-	-	0.0005	0.0002	106.61
Sailfin blenny	*Emblemaria pandionis*	Chaenopsidae	0.02	0.01	34.81	0.003	0.003	66.22
Wrasse blenny	*Hemiemblemaria simulus*	Chaenopsidae	-	-	-	0.001	0.001	102.25
Foureye butterflyfish	*Chaetodon capistratus*	Chaetodontidae	0.12	0.16	24.05	0.10	0.13	12.57
Spotfin butterflyfish	*Chaetodon ocellatus*	Chaetodontidae	0.29	0.39	16.02	0.24	0.31	8.53

Reef butterflyfish	*Chaetodon sedentarius*	Chaetodontidae	0.39	0.71	7.24	0.41	0.76	5.80
Banded butterflyfish	*Chaetodon striatus*	Chaetodontidae	0.08	0.09	33.16	0.05	0.05	22.01
Longsnout butterflyfish	*Prognathodes aculeatus*	Chaetodontidae	0.001	0.001	101.80	0.001	0.0004	102.25
Redspotted hawkfish	*Amblycirrhitus pinos*	Cirrhitidae	-	-	-	0.004	0.002	56.69
Herring species	*Jenkinsia* spp.	Clupeidae	0.002	0.51	100.17	0.004	2.97	89.74
Spanish sardine	*Sardinella aurita*	Clupeidae	-	-	-	0.001	0.003	105.47
Brown garden eel	*Heteroconger longissimus*	Congridae	-	-	-	0.004	0.03	50.24
Flying gurnard	*Dactylopterus volitans*	Dactylopteridae	0.001	0.0004	97.54	-	-	-
Southern stingray	*Dasyatis americana*	Dasyatidae	0.01	0.006	58.73	0.003	0.002	64.29
Bridled burrfish	*Chilomycterus antennatus*	Diodontidae	-	-	-	0.001	0.0004	97.56
Spotfin burrfish	*Chilomycterus reticulatus*	Diodontidae	0.003	0.001	77.11	-	-	-
Striped burrfish	*Chilomycterus schoepfii*	Diodontidae	0.003	0.001	77.11	0.002	0.004	87.11
Puffer species	*Diodon* spp.	Diodontidae	0.001	0.000	100.69	0.004	0.005	96.22
Balloonfish	*Diodon holocanthus*	Diodontidae	0.07	0.04	17.00	0.08	0.05	14.87
Porcupine puffer	*Diodon hystrix*	Diodontidae	0.02	0.008	51.87	0.02	0.010	31.44
Sharksucker	*Echeneis naucrates*	Echeneidae	0.009	0.005	55.76	0.01	0.01	45.16
Whitefin sharksucker	*Echeneis neucratoides*	Echeneidae	-	-	-	0.002	0.001	98.67
Shark species	*Elasmobranch* spp.	Elasmobranchiomorphi	-	-	-	0.001	0.001	77.71
Anchovy species	*Anchoa* spp.	Engraulidae	-	-	-	0.001	0.001	105.85
Atlantic spadefish	*Chaetodipterus faber*	Ephippidae	0.03	0.22	56.78	0.04	0.18	54.31
Cornetfish	*Fistularia tabacaria*	Fistulariidae	0.04	0.02	55.76	0.02	0.02	29.09
Yellow fin mojarra	*Gerres cinereus*	Gerreidae	0.02	0.02	39.37	0.01	0.54	97.03
Mottled mojarra	*Ulaema lefroyi*	Gerreidae	-	-	-	0.002	0.005	100.26
Nurse shark	*Ginglymostoma cirratum*	Ginglymostomatidae	0.02	0.009	46.12	0.03	0.01	26.25
Colon goby	*Coryphopterus dicrus*	Gobiidae	0.01	0.02	45.00	0.02	0.01	36.28
Bridled goby	*Coryphopterus glaucofraenum*	Gobiidae	0.25	0.60	18.47	0.15	0.19	16.38
Masked goby	*Coryphopterus personatus*	Gobiidae	0.21	8.68	19.81	0.15	4.34	14.62

Goby species	*Coryphopterus* spp.	Gobiidae	0.006	0.01	52.40	0.03	0.03	51.98
Pallid goby	*Coryphopterus eidolon*	Gobiidae	0.001	0.0003	103.70	0.01	0.006	48.80
Peppermint goby	*Coryphopterus lipernes*	Gobiidae	0.004	0.002	99.48	0.003	0.002	100.05
Dash goby	*Ctenogobius saepepallens*	Gobiidae	0.003	0.002	59.77	-	-	-
Neon goby	*Elacatinus oceanops*	Gobiidae	0.14	0.25	30.49	0.09	0.10	16.15
Yellowline goby	*Elacatinus horsti*	Gobiidae	-	-	-	0.007	0.006	48.63
Yellowprow goby	*Elacatinus xanthiprora*	Gobiidae	-	-	-	0.001	0.001	76.77
Goldspot goby	*Gnatholepis thompsoni*	Gobiidae	0.09	0.10	30.73	0.11	0.10	17.18
Goby species	*Gobiidae* spp.	Gobiidae	0.008	0.006	46.88	0.003	0.001	99.17
Seminole goby	*Microgobius carri*	Gobiidae	0.004	0.003	99.56	0.002	0.002	100.21
Rusty goby	*Priolepis hipoliti*	Gobiidae	-	-	-	0.003	0.002	100.05
Black margate	*Anisotremus surinamensis*	Haemulidae	0.10	0.13	39.21	0.07	0.11	28.88
Porkfish	*Anisotremus virginicus*	Haemulidae	0.46	1.48	20.83	0.40	1.51	16.80
Tomtate	*Haemulon aurolineatum*	Haemulidae	0.15	7.53	22.51	0.11	6.13	23.70
French grunt	*Haemulon flavolineatum*	Haemulidae	0.22	3.04	22.95	0.14	4.59	34.61
White grunt	*Haemulon plumieri*	Haemulidae	0.51	2.11	12.14	0.39	1.70	10.84
Bluestriped grunt	*Haemulon sciurus*	Haemulidae	0.21	0.93	18.70	0.14	1.80	51.53
Grunt species	*Haemulon* spp.	Haemulidae	0.14	3.86	29.18	0.17	5.92	25.04
White margate	*Haemulon album*	Haemulidae	0.003	0.006	79.93	0.04	0.04	28.11
Caesar grunt	*Haemulon carbonarium*	Haemulidae	0.04	0.26	45.06	0.04	1.10	86.18
Smallmouth grunt	*Haemulon chrysargyreum*	Haemulidae	0.04	0.42	65.06	0.01	0.28	60.48
Spanish grunt	*Haemulon macrostomum*	Haemulidae	0.02	0.03	50.87	0.02	0.010	27.16
Cottonwick	*Haemulon melanurum*	Haemulidae	0.08	1.57	52.62	0.06	0.54	28.49
Sailor's choice	*Haemulon parra*	Haemulidae	0.08	0.16	28.92	0.05	1.02	86.24
Striped grunt	*Haemulon striatum*	Haemulidae	0.02	0.40	56.88	0.02	0.39	32.34
Boga	*Haemulon vittatum*	Haemulidae	-	-	-	0.001	0.16	96.71
Pigfish	*Orthopristis chrysoptera*	Haemulidae	0.003	0.003	89.93	-	-	-

Ballyhoo	*Hemiramphus brasiliensis*	Hemiramphidae	-	-	-	0.010	0.71	75.30
Squirrelfish	*Holocentrus adscensionis*	Holocentridae	0.15	0.15	23.96	0.14	0.15	13.96
Squirrelfish species	*Holocentrus* spp.	Holocentridae	-	-	-	0.003	0.002	49.83
Longspine squirrelfish	*Holocentrus rufus*	Holocentridae	0.04	0.03	43.35	0.04	0.04	30.95
Blackbar soldierfish	*Myripristis jacobus*	Holocentridae	0.05	0.21	65.72	0.02	0.04	45.60
Reef squirrelfish	*Sargocentron coruscum*	Holocentridae	0.002	0.001	100.72	0.001	0.0004	102.25
Dusky squirrelfish	*Sargocentron vexillarium*	Holocentridae	-	-	-	0.002	0.002	100.26
Sailfish	*Istiophorus platypterus*	Istiophoridae	-	-	-	0.003	0.002	100.05
Bermuda Chub	*Kyphosus sectatrix*	Kyphosidae	0.08	0.34	32.09	0.06	0.24	31.13
Spotfin hogfish	*Bodianus pulchellus*	Labridae	0.009	0.004	79.84	0.04	0.04	28.60
Spanish hogfish	*Bodianus rufus*	Labridae	0.34	0.38	17.37	0.29	0.32	9.86
Creole wrasse	*Clepticus parrae*	Labridae	0.13	2.35	35.66	0.08	1.98	19.30
Slippery dick	*Halichoeres bivittatus*	Labridae	0.72	5.46	9.53	0.58	2.72	7.56
Painted wrasse	*Halichoeres caudalis*	Labridae	-	-	-	0.003	0.004	67.76
Yellowcheek wrasse	*Halichoeres cyanocephalus*	Labridae	0.13	0.11	40.90	0.08	0.05	20.92
Yellowhead wrasse	*Halichoeres garnoti*	Labridae	0.64	5.77	9.94	0.55	3.52	6.83
Clown wrasse	*Halichoeres maculipinna*	Labridae	0.46	2.02	13.69	0.41	1.56	10.75
Rainbow wrasse	*Halichoeres pictus*	Labridae	0.004	0.003	59.23	0.006	0.003	61.47
Blackear wrasse	*Halichoeres poeyi*	Labridae	0.07	0.07	27.47	0.07	0.05	22.49
Puddingwife	*Halichoeres radiatus*	Labridae	0.05	0.03	38.18	0.06	0.05	37.52
Wrasse species	*Labridae* spp.	Labridae	0.01	0.03	100.24	-	-	-
Hogfish	*Lachnolaimus maximus*	Labridae	0.19	0.18	13.13	0.26	0.45	10.03
Razorfish species	*Xyrichtys* spp.	Labridae	0.005	0.004	61.25	0.009	0.01	78.17
Bluehead wrasse	*Thalassoma bifasciatum*	Labridae	0.83	15.78	10.49	0.74	15.20	7.65
Rosy razorfish	*Xyrichtys martinicensis*	Labridae	0.04	0.03	26.20	0.02	0.02	39.55
Pearly razorfish	*Xyrichtys novacula*	Labridae	0.02	0.02	46.38	0.005	0.006	62.21
Green razorfish	*Xyrichtys splendens*	Labridae	0.15	1.10	64.68	0.23	0.86	20.47

Downy blenny	*Labrisomus kalisherae*	Labrisomidae	-	-	-	0.002	0.001	100.26
Hairy blenny	*Labrisomus nuchipinnis*	Labrisomidae	0.009	0.005	50.98	0.01	0.009	42.22
Rosy blenny	*Malacoctenus macropus*	Labrisomidae	0.03	0.03	39.09	0.05	0.03	24.12
Saddled blenny	*Malacoctenus triangulatus*	Labrisomidae	0.11	0.09	16.56	0.08	0.06	17.52
Mutton snapper	*Lutjanus analis*	Lutjanidae	0.24	0.30	25.95	0.24	0.20	10.38
Schoolmaster	*Lutjanus apodus*	Lutjanidae	0.02	0.06	60.80	0.007	0.14	85.14
Blackfin snapper	*Lutjanus buccanella*	Lutjanidae	-	-	-	0.001	0.0003	105.47
Cubera snapper	*Lutjanus cyanopterus*	Lutjanidae	-	-	-	0.002	0.001	82.63
Gray snapper	*Lutjanus griseus*	Lutjanidae	0.12	0.44	27.07	0.12	0.45	23.03
Dog snapper	*Lutjanus jocu*	Lutjanidae	-	-	-	0.006	0.004	59.20
Mahogany snapper	*Lutjanus mahogoni*	Lutjanidae	0.02	0.02	78.52	0.010	0.06	69.89
Lane snapper	*Lutjanus synagris*	Lutjanidae	0.06	0.61	81.39	0.08	1.49	47.52
Yellowtail snapper	*Ocyurus chrysurus*	Lutjanidae	0.32	1.98	30.46	0.24	0.96	35.05
Vermilion snapper	*Rhomboplites aurorubens*	Lutjanidae	0.02	0.04	79.76	0.001	0.003	84.78
Snapper species	*Lutjanus* spp.	Lutjanidae	0.01	0.005	54.22	0.0005	0.0002	106.61
Sand tilefish	*Malacanthus plumieri*	Malacanthidae	0.03	0.03	52.85	0.05	0.03	22.95
Tarpon	*Megalops atlanticus*	Megalopidae	0.002	0.001	100.17	0.004	0.002	99.40
Giant manta	*Manta birostris*	Mobulidae	0.002	0.002	100.17	-	-	-
Scrawled filefish	*Aluterus scriptus*	Monacanthidae	0.18	0.12	20.46	0.10	0.08	12.94
Filefish species	*Aluterus* spp.	Monacanthidae	0.004	0.002	63.81	0.004	0.02	85.44
Whitespotted filefish	*Cantherhines macrocerus*	Monacanthidae	0.03	0.02	68.35	0.03	0.02	22.15
Orangespotted filefish	*Cantherhines pullus*	Monacanthidae	0.12	0.07	20.27	0.11	0.07	13.65
Slender filefish	*Monacanthus tuckeri*	Monacanthidae	0.06	0.04	41.84	0.06	0.06	20.73
Planehead filefish	*Stephanolepis hispidus*	Monacanthidae	0.06	0.04	21.87	0.05	0.03	19.19
Unicorn filefish	*Aluterus monoceros*	Monacanthidae	-	-	-	0.01	0.03	55.10
Orange filefish	*Aluterus schoepfii*	Monacanthidae	0.01	0.02	99.27	0.02	0.02	47.95
Yellow goatfish	*Mulloidichthys martinicus*	Mullidae	0.01	0.03	82.27	0.001	0.002	74.15

Spotted goatfish	*Pseudupeneus maculatus*	Mullidae	0.42	0.70	12.87	0.52	1.34	8.36
Viper moray	*Enchelycore nigricans*	Muraenidae	-	-	-	0.001	0.001	71.42
Green moray	*Gymnothorax funebris*	Muraenidae	0.009	0.004	54.93	0.01	0.009	32.69
Goldentail moray	*Gymnothorax miliaris*	Muraenidae	0.004	0.002	51.30	0.009	0.006	37.55
Spotted moray	*Gymnothorax moringa*	Muraenidae	0.04	0.02	55.59	0.04	0.02	20.67
Purplemouth moray	*Gymnothorax vicinus*	Muraenidae	0.007	0.003	45.62	0.006	0.003	53.37
Spotted eagle ray	*Aetobatus narinari*	Myliobatidae	0.01	0.005	66.15	0.003	0.002	73.72
Lesser electric ray	*Narcine bancroftii*	Narcinidae	0.002	0.001	100.17	-	-	-
Batfish species	*Ogcocephalus* spp.	Ogcocephalidae	-	-	-	0.001	0.0004	102.25
Sharptail eel	*Myrichthys breviceps*	Ophichthidae	0.002	0.001	71.87	0.005	0.003	69.10
Yellowhead jawfish	*Opistognathus aurifrons*	Opistignathidae	0.14	0.28	33.66	0.09	0.15	17.07
Jawfish species	*Opistognathus* spp.	Opistognathidae	0.009	0.007	52.62	-	-	-
Dusky jawfish	*Opistognathus whitehursti*	Opistognathidae	-	-	-	0.002	0.001	72.73
Scrawled cowfish	*Acanthostracion quadricornis*	Ostraciidae	0.10	0.08	31.69	0.10	0.06	15.12
Honeycomb cowfish	*Acanthostracion polygonius*	Ostraciidae	0.08	0.04	30.43	0.06	0.03	16.68
Spotted trunkfish	*Lactophrys bicaudalis*	Ostraciidae	0.003	0.001	59.28	0.01	0.008	42.30
Smooth trunkfish	*Lactophrys triqueter*	Ostraciidae	0.12	0.07	16.64	0.10	0.07	14.27
Trunkfish	*Lactophrys trigonus*	Ostraciidae	0.005	0.004	57.57	0.01	0.006	44.91
Gulf flounder	*Paralichthys albigutta*	Paralichthyidae	0.002	0.001	100.17	-	-	-
Glassy sweeper	*Pempheris schomburgkii*	Pempheridae	0.03	2.21	98.79	0.004	0.25	90.80
Cherubfish	*Centropyge argi*	Pomacanthidae	0.05	0.05	68.51	0.09	0.19	18.58
Blue angelfish	*Holacanthus bermudensis*	Pomacanthidae	0.21	0.23	29.16	0.17	0.17	11.62
Queen angelfish	*Holacanthus ciliaris*	Pomacanthidae	0.16	0.15	24.84	0.18	0.16	12.24
Townsend angelfish	*Holacanthus townsendi*	Pomacanthidae	0.01	0.009	75.51	0.02	0.01	35.61
Rock beauty	*Holacanthus tricolor*	Pomacanthidae	0.34	0.51	16.14	0.31	0.41	6.28
Gray angelfish	*Pomacanthus arcuatus*	Pomacanthidae	0.44	0.57	14.23	0.41	0.46	7.35
French angelfish	*Pomacanthus paru*	Pomacanthidae	0.21	0.25	23.75	0.27	0.26	10.35

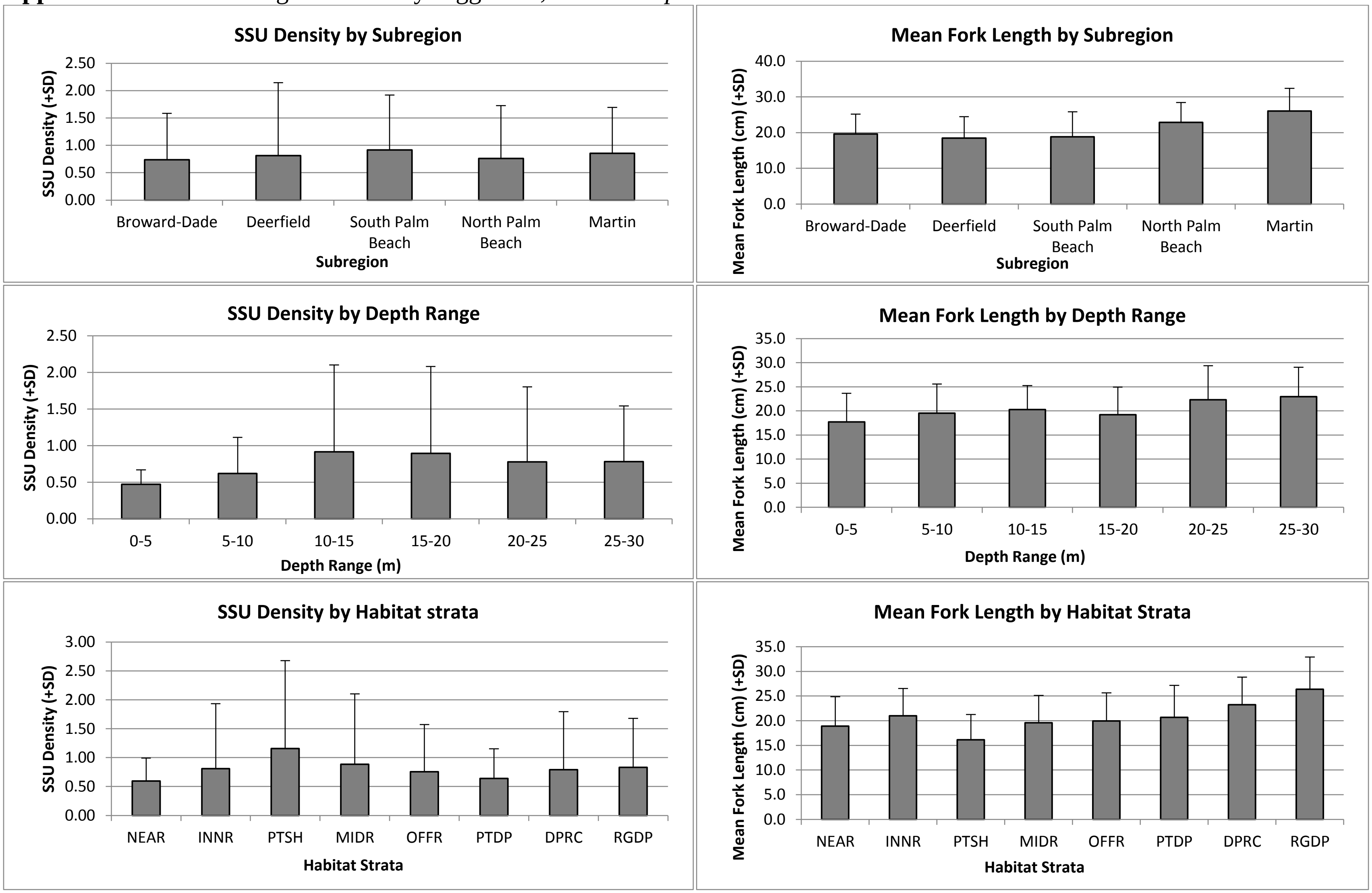
Sergeant major	*Abudefduf saxatilis*	Pomacentridae	0.20	2.05	19.12	0.10	1.59	31.02
Blue chromis	*Chromis cyanea*	Pomacentridae	0.17	2.12	29.48	0.18	1.75	14.28
Yellowtail reeffish	*Chromis enchrysura*	Pomacentridae	0.14	0.53	44.84	0.19	0.81	23.70
Sunshinefish	*Chromis insolata*	Pomacentridae	0.11	0.74	32.74	0.20	1.21	13.13
Brown chromis	*Chromis multilineata*	Pomacentridae	0.14	1.45	26.02	0.06	0.81	46.10
Purple reeffish	*Chromis scotti*	Pomacentridae	0.13	1.25	45.54	0.08	0.46	22.74
Damselfish species	*Stegastes* spp.	Pomacentridae	0.001	0.001	73.39	0.02	0.10	52.61
Yellowtail damselfish	*Microspathodon chrysurus*	Pomacentridae	0.02	0.04	54.79	0.02	0.03	52.87
Dusky damselfish	*Stegastes adustus*	Pomacentridae	0.09	0.11	30.73	0.06	0.08	26.08
Longfin damselfish	*Stegastes diencaeus*	Pomacentridae	0.03	0.07	41.58	0.01	0.01	39.64
Beaugregory	*Stegastes leucostictus*	Pomacentridae	0.23	0.43	17.87	0.13	0.18	17.25
Bicolor damselfish	*Stegastes partitus*	Pomacentridae	0.72	18.91	11.24	0.76	19.83	5.57
Threespot damselfish	*Stegastes planifrons*	Pomacentridae	0.04	0.05	32.15	0.03	0.02	29.70
Cocoa damselfish	*Stegastes variabilis*	Pomacentridae	0.39	0.92	24.83	0.37	0.59	8.94
Glasseye snapper	*Heteropriacanthus cruentatus*	Priacanthidae	0.03	0.24	94.40	0.007	0.005	42.91
Bigeye	*Priacanthus arenatus*	Priacanthidae	0.03	0.05	84.74	0.006	0.02	60.99
Blue dartfish	*Ptereleotris calliura*	Ptereleotridae	0.09	0.22	25.93	0.08	0.10	19.02
Hovering dartfish	*Ptereleotris helenae*	Ptereleotridae	0.03	0.11	36.23	0.03	0.03	36.50
Cobia	*Rachycentron canadum*	Rachycentridae	-	-	-	0.004	0.002	89.35
Atlantic guitarfish	*Rhinobatos lentiginosus*	Rhinobatidae	0.002	0.001	84.49	0.007	0.003	69.90
Bluelip parrotfish	*Cryptotomus roseus*	Scaridae	0.20	0.57	22.42	0.21	0.66	11.98
Emerald parrotfish	*Nicholsina usta*	Scaridae	-	-	-	0.005	0.003	60.09
Midnight parrotfish	*Scarus coelestinus*	Scaridae	0.005	0.003	62.23	0.001	0.005	93.08
Blue parrotfish	*Scarus coeruleus*	Scaridae	0.008	0.008	57.11	0.02	0.02	27.70
Rainbow parrotfish	*Scarus guacamaia*	Scaridae	0.06	0.07	28.19	0.02	0.04	54.17
Striped parrotfish	*Scarus iseri*	Scaridae	0.44	3.60	9.40	0.28	1.03	14.70
Parrotfish species	*Scarus* spp.	Scaridae	0.03	0.09	65.27	0.03	0.02	28.13

Princess parrotfish	*Scarus taeniopterus*	Scaridae	0.29	0.94	12.27	0.20	0.49	11.45
Queen parrotfish	*Scarus vetula*	Scaridae	0.02	0.01	42.86	0.04	0.04	26.66
Greenblotch parrotfish	*Sparisoma atomarium*	Scaridae	0.45	1.62	16.83	0.39	0.83	10.95
Redband parrotfish	*Sparisoma aurofrenatum*	Scaridae	0.63	3.56	7.55	0.58	3.10	7.78
Redtail parrotfish	*Sparisoma chrysopterum*	Scaridae	0.08	0.19	31.75	0.09	0.09	17.30
Bucktooth parrotfish	*Sparisoma radians*	Scaridae	0.02	0.06	48.39	0.07	0.11	22.86
Yellowtail parrotfish	*Sparisoma rubripinne*	Scaridae	0.12	0.19	23.90	0.10	0.11	21.42
Parrotfish species	*Sparisoma* spp.	Scaridae	-	-	-	0.008	0.01	82.40
Stoplight Parrotfish	*Sparisoma viride*	Scaridae	0.32	0.64	12.29	0.30	0.44	9.00
Jackknife fish	*Equetus lanceolatus*	Sciaenidae	0.007	0.006	74.69	0.006	0.008	84.60
Spotted drum	*Equetus punctatus*	Sciaenidae	0.03	0.03	33.47	0.03	0.02	28.90
Reef croaker	*Odontoscion dentex*	Sciaenidae	0.002	0.04	100.72	0.005	0.02	76.99
High-hat	*Pareques acuminatus*	Sciaenidae	0.13	0.27	29.72	0.09	0.13	28.70
Cubbyu	*Pareques umbrosus*	Sciaenidae	0.002	0.009	80.11	0.006	0.04	28.61
Drum species	*Sciaenidae* spp.	Sciaenidae	-	-	-	0.007	0.009	66.80
Little tunny	*Euthynnus alletteratus*	Scombridae	0.007	0.05	97.53	0.01	0.04	50.70
Spanish mackerel	*Scomberomorus maculatus*	Scombridae	0.03	0.03	36.69	0.006	0.09	70.00
Cero	*Scomberomorus regalis*	Scombridae	0.04	0.02	26.00	0.03	0.03	40.94
Lionfish	*Pterois* spp.	Scorpanidae	0.13	0.11	30.90	0.14	0.15	17.46
Spotted scorpionfish	*Scorpaena plumieri*	Scorpaenidae	0.09	0.05	30.80	0.05	0.03	18.35
Mutton hamlet	*Alphestes afer*	Serranidae	-	-	-	0.002	0.001	100.26
Black seabass	*Centropristis striata*	Serranidae	-	-	-	0.05	0.22	57.23
Graysby	*Cephalopholis cruentata*	Serranidae	0.24	0.26	26.30	0.18	0.16	8.99
Coney	*Cephalopholis fulva*	Serranidae	0.007	0.004	35.33	0.03	0.02	28.72
Sand perch	*Diplectrum formosum*	Serranidae	0.05	0.10	33.41	0.05	0.05	31.23
Rock hind	*Epinephelus adscensionis*	Serranidae	0.01	0.007	38.96	0.01	0.008	36.57
Red hind	*Epinephelus guttatus*	Serranidae	0.04	0.05	84.84	0.02	0.010	28.95

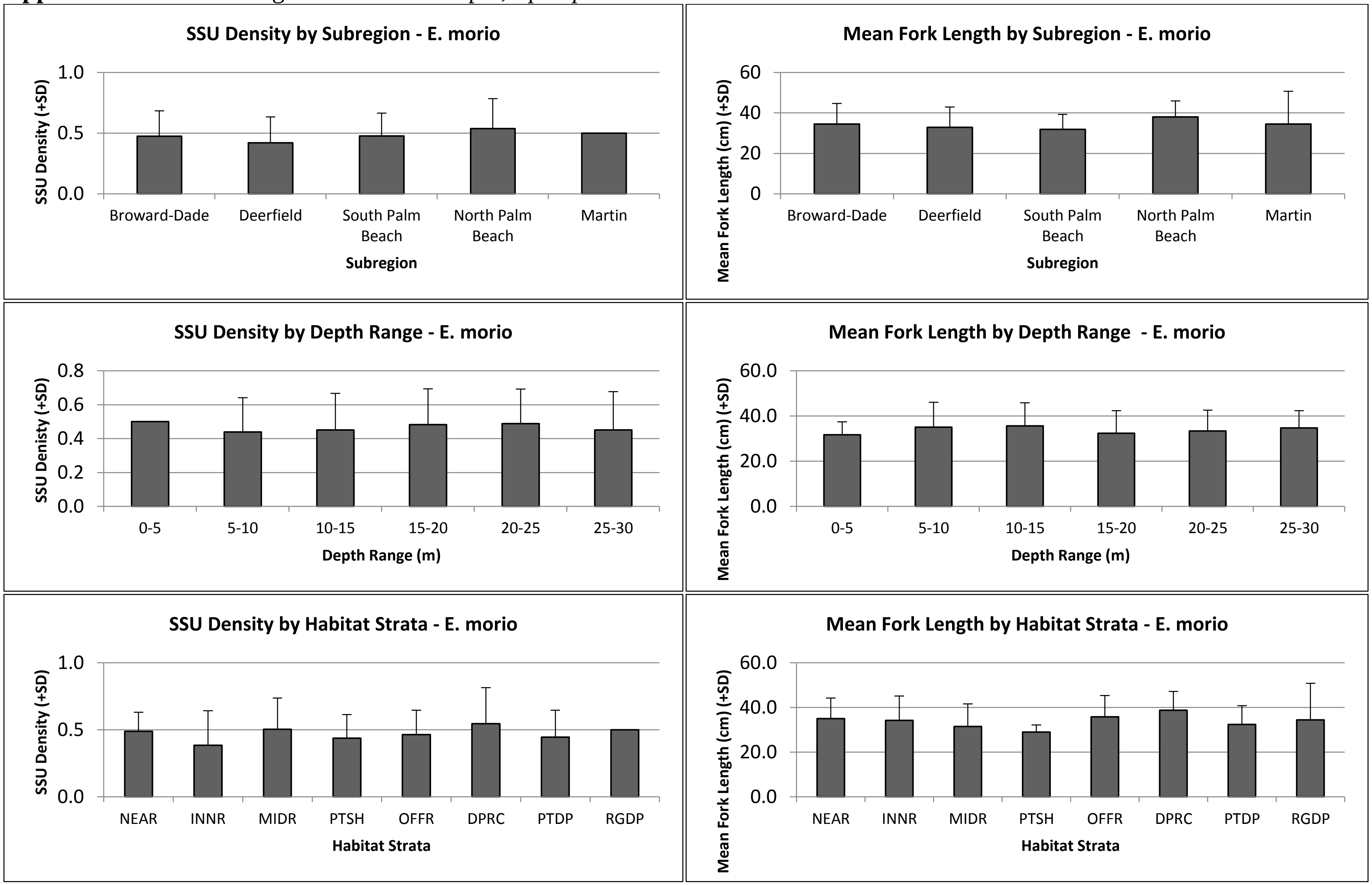
Goliath grouper	*Epinephelus itajara*	Serranidae	0.001	0.001	98.00	0.009	0.01	38.09
Red grouper	*Epinephelus morio*	Serranidae	0.13	0.08	18.92	0.08	0.06	18.01
Hamlet species	*Hypoplectrus* spp.	Serranidae	0.005	0.002	62.70	0.008	0.006	64.34
Tan hamlet	*Hypoplectrus randallorum*	Serranidae	0.001	0.0003	103.70	-	-	-
Butter hamlet	*Hypoplectrus unicolor*	Serranidae	0.28	0.42	19.42	0.11	0.14	30.25
Blue hamlet	*Hypoplectrus gemma*	Serranidae	0.03	0.03	27.28	0.02	0.01	30.65
Shy hamlet	*Hypoplectrus guttavarius*	Serranidae	-	-	-	0.0004	0.0002	102.12
Indigo hamlet	*Hypoplectrus indigo*	Serranidae	-	-	-	0.001	0.001	105.85
Barred hamlet	*Hypoplectrus puella*	Serranidae	0.03	0.02	37.42	0.01	0.007	40.10
Peppermint basslet	*Liopropoma rubre*	Serranidae	0.005	0.008	99.58	-	-	-
Black grouper	*Mycteroperca bonaci*	Serranidae	0.02	0.008	45.32	0.01	0.009	35.93
Gag	*Mycteroperca microlepis*	Serranidae	0.003	0.002	58.33	0.009	0.006	38.86
Scamp	*Mycteroperca phenax*	Serranidae	0.002	0.001	54.46	0.02	0.01	29.00
Atlantic creolefish	*Paranthias furcifer*	Serranidae	-	-	-	0.003	0.02	100.05
Whitespotted soapfish	*Rypticus maculatus*	Serranidae	0.02	0.01	64.15	0.02	0.01	36.08
Greater soapfish	*Rypticus saponaceus*	Serranidae	0.02	0.01	47.34	0.05	0.03	22.86
School bass	*Schultzea beta*	Serranidae	-	-	-	0.01	0.69	59.66
Orangeback bass	*Serranus annularis*	Serranidae	-	-	-	0.0003	0.0002	102.72
Lantern bass	*Serranus baldwini*	Serranidae	0.22	0.25	28.87	0.14	0.10	13.78
Tattler	*Serranus phoebe*	Serranidae	0.02	0.01	99.90	0.005	0.003	70.13
Grouper-sea bass species	*Serranus* spp.	Serranidae	0.002	0.001	99.04	-	-	-
Belted sandfish	*Serranus subligarius*	Serranidae	-	-	-	0.01	0.009	48.26
Tobaccofish	*Serranus tabacarius*	Serranidae	0.12	0.16	15.96	0.07	0.06	17.88
Harlequin bass	*Serranus tigrinus*	Serranidae	0.38	0.53	11.77	0.26	0.28	7.34
Chalk bass	*Serranus tortugarum*	Serranidae	0.09	0.15	24.56	0.04	0.57	73.30
Sheepshead	*Archosargus probatocephalus*	Sparidae	0.001	0.000	96.51	0.04	0.05	30.99
Western Atlantic seabream	*Archosargus rhomboidalis*	Sparidae	-	-	-	0.001	0.002	100.57

Jolthead porgy	*Calamus bajonado*	Sparidae	0.07	0.05	51.02	0.02	0.01	48.00
Saucereye porgy	*Calamus calamus*	Sparidae	0.15	0.19	31.34	0.12	0.11	16.08
Sheepshead porgy	*Calamus penna*	Sparidae	0.11	0.11	45.07	0.07	0.09	30.98
Littlehead porgy	*Calamus proridens*	Sparidae	0.18	0.24	25.82	0.08	0.08	29.99
Porgy species	*Calamus* spp.	Sparidae	0.06	0.06	58.28	0.07	0.11	28.39
Whitebone porgy	*Calamus leucosteus*	Sparidae	-	-	-	0.03	0.06	57.67
Knobbed porgy	*Calamus nodosus*	Sparidae	0.003	0.002	73.87	0.01	0.02	78.81
Silver porgy	*Diplodus argenteus*	Sparidae	0.02	0.03	40.35	0.02	0.04	59.50
Spottail seabream	*Diplodus holbrookii*	Sparidae	0.04	0.39	44.20	0.02	0.08	56.29
Great barracuda	*Sphyraena barracuda*	Sphyraenidae	0.02	0.01	52.79	0.01	0.02	49.23
Southern sennet	*Sphyraena picudilla*	Sphyraenidae	-	-	-	0.001	0.02	102.25
Scalloped hammerhead	*Sphyrna lewini*	Sphyrnidae	0.02	0.02	99.90	-	-	-
Bonnethead	*Sphyrna tiburo*	Sphyrnidae	-	-	-	0.002	0.001	100.26
Pipefish species	*Syngnathus* spp.	Syngnathidae	-	-	-	0.001	0.0005	97.67
Inshore lizardfish	*Synodus foetens*	Synodontidae	0.02	0.007	38.92	0.004	0.002	63.37
Sand diver	*Synodus intermedius*	Synodontidae	0.01	0.008	38.82	0.01	0.008	48.62
Sharpnose puffer	*Canthigaster rostrata*	Tetraodontidae	0.81	2.84	5.83	0.77	2.07	5.80
Southern puffer	*Sphoeroides nephelus*	Tetraodontidae	-	-	-	0.0005	0.0002	100.69
Bandtail puffer	*Sphoeroides spengleri*	Tetraodontidae	0.13	0.10	28.10	0.12	0.09	13.85
Checkered puffer	*Sphoeroides testudineus*	Tetraodontidae	0.02	0.01	88.87	0.010	0.007	60.99
Bandtail searobin	*Prionotus ophryas*	Triglidae	-	-	-	0.0005	0.0002	106.61
Blackwing searobin	*Prionotus rubio*	Triglidae	-	-	-	0.003	0.001	71.92
Unknown species	*Unknown* spp.	unknown	0.003	0.05	99.65	0.007	0.34	99.69
Yellow stingray	*Urobatis jamaicensis*	Urotrygonidae	0.07	0.05	23.30	0.06	0.03	20.36

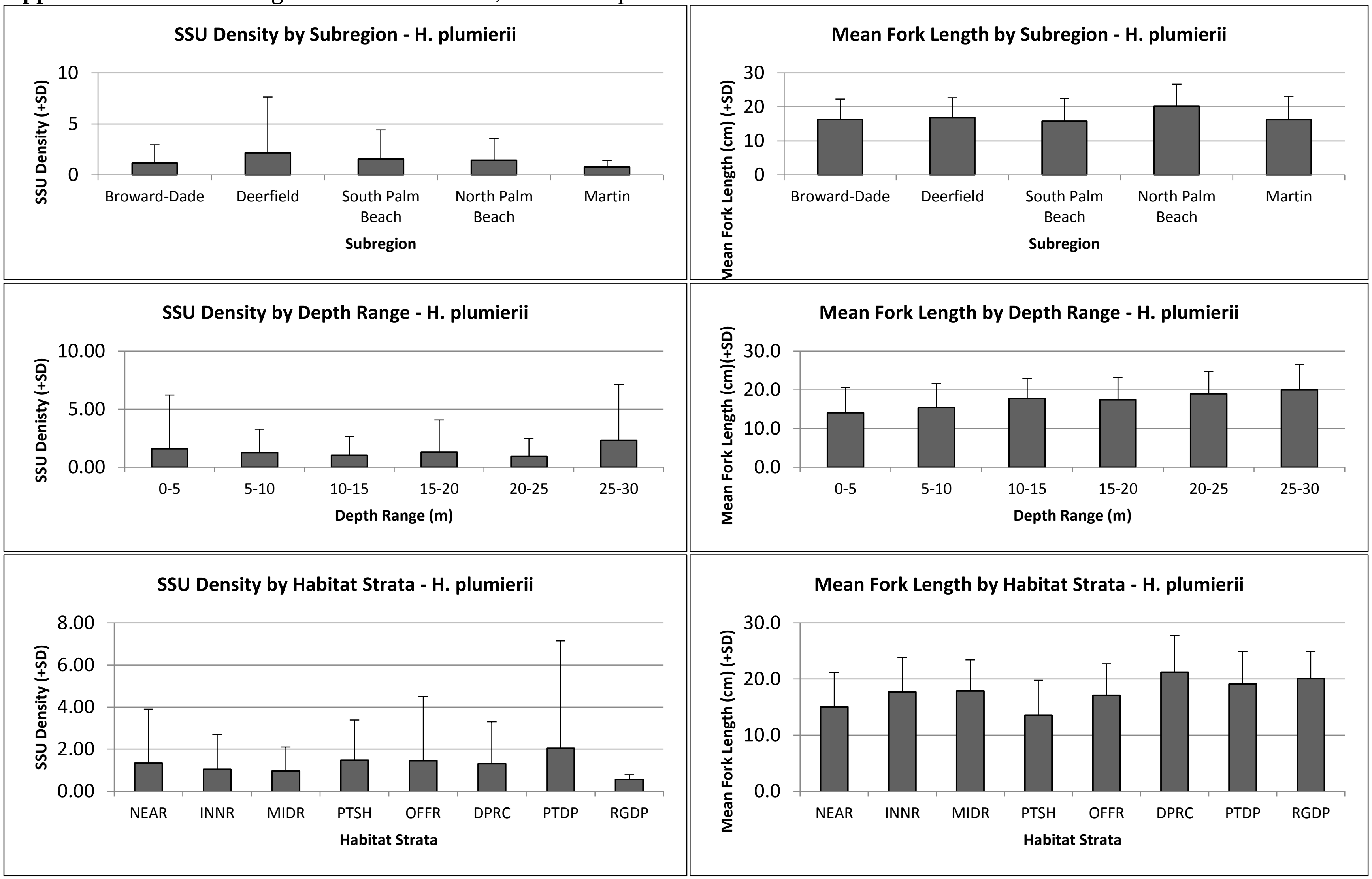
Appendix 7. Additional figures for Gray triggerfish, *Balistes capriscus*.



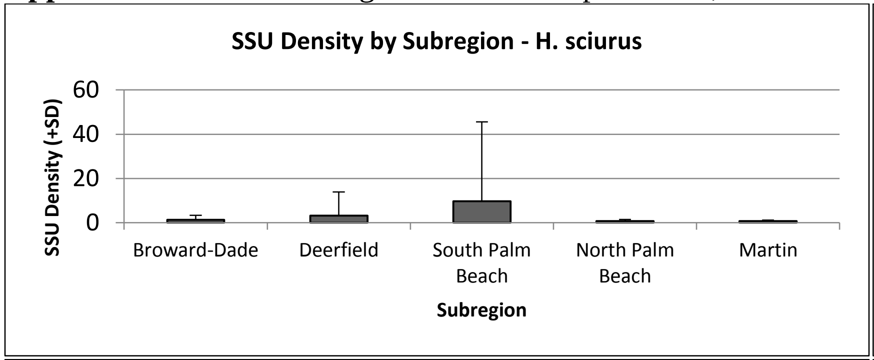
Appendix 8. Additional figures for Red Grouper, *Epinephelus morio.*

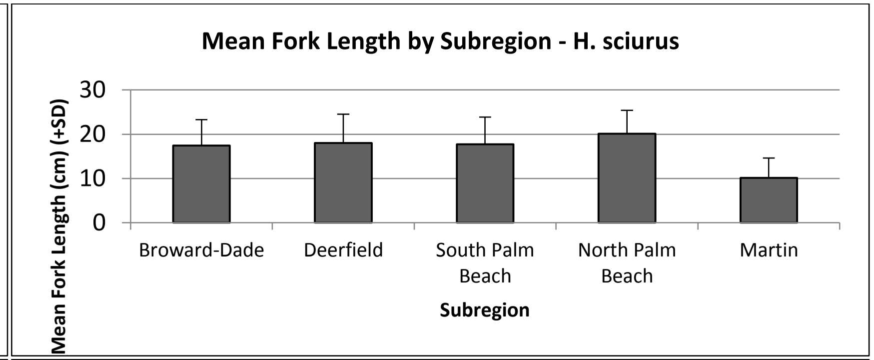


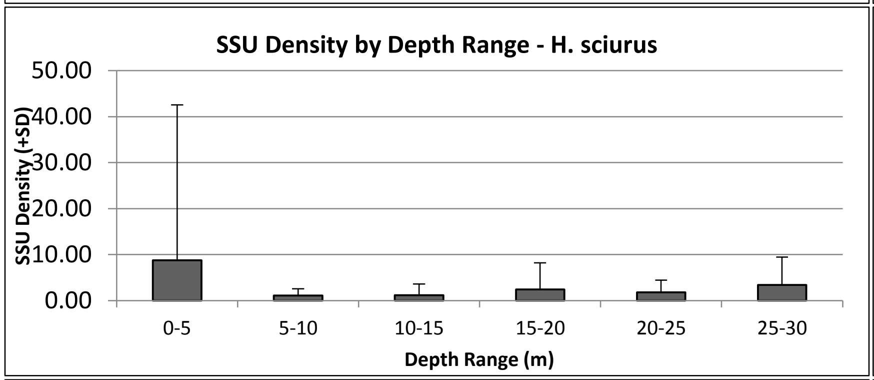
Appendix 9. Additional figures for White Grunt, *Haemulon plumieri*.

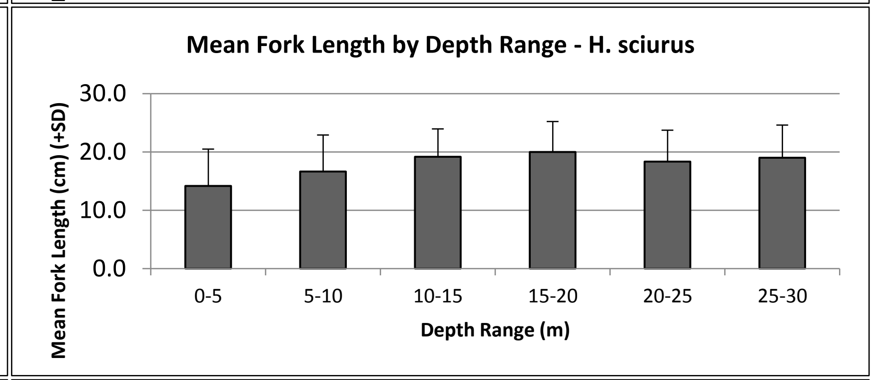


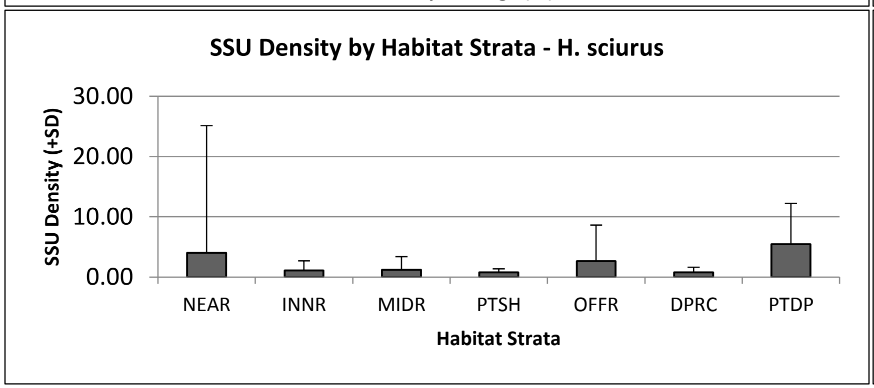
Appendix 10. Additional figures for Bluestriped Grunt, *Haemulon sciurus*.

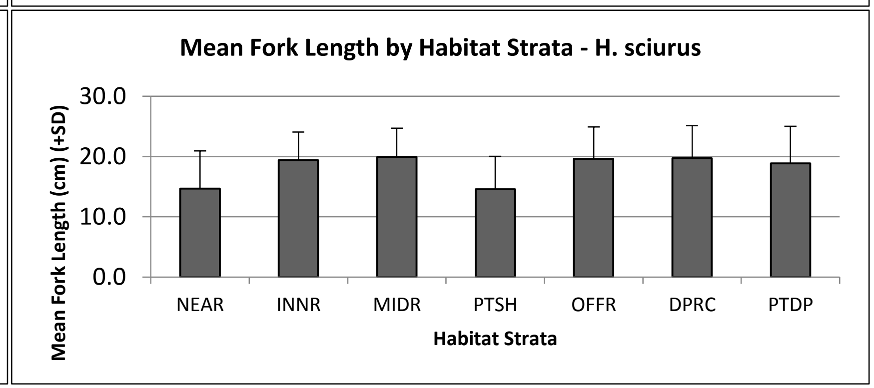




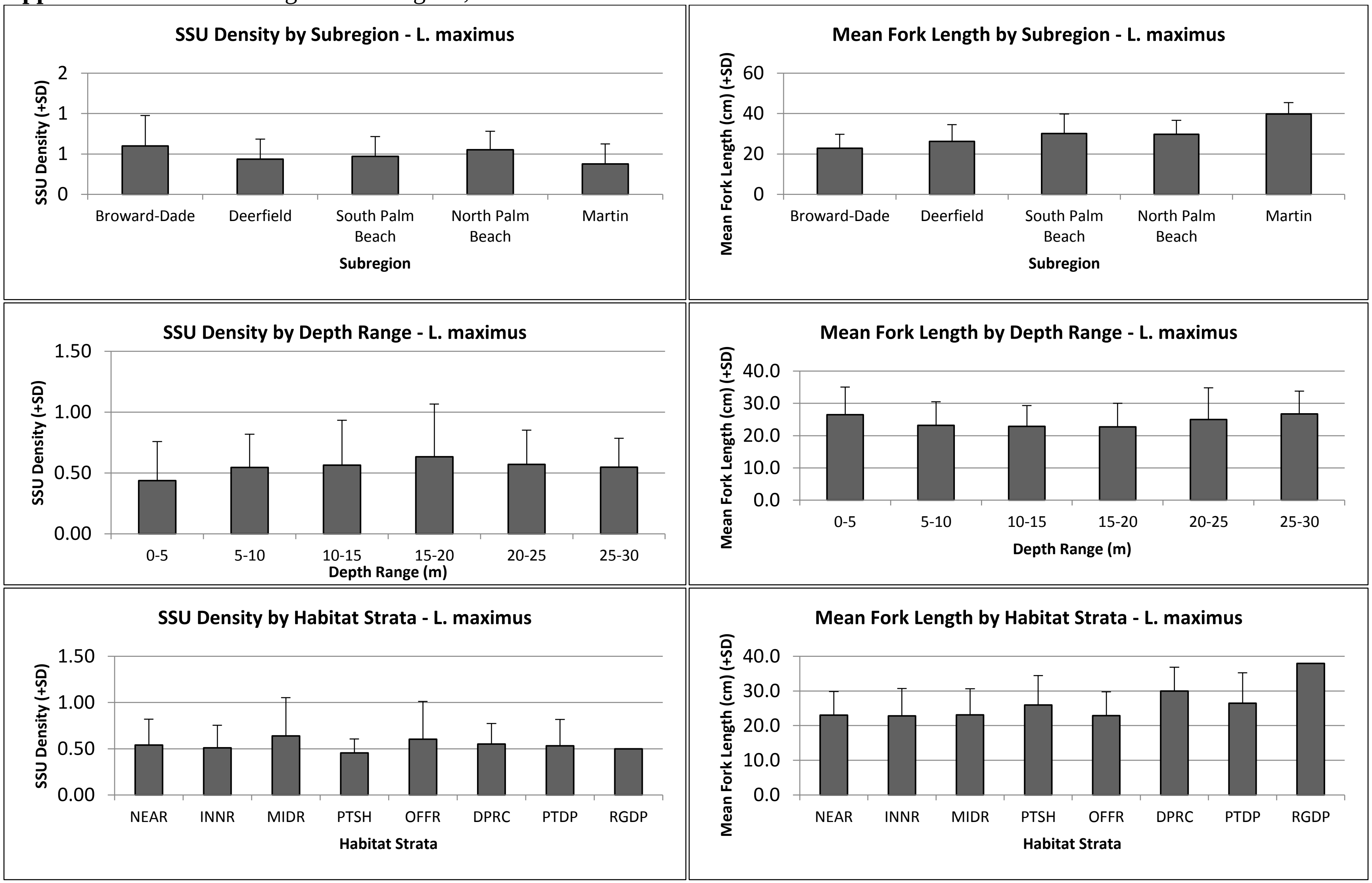




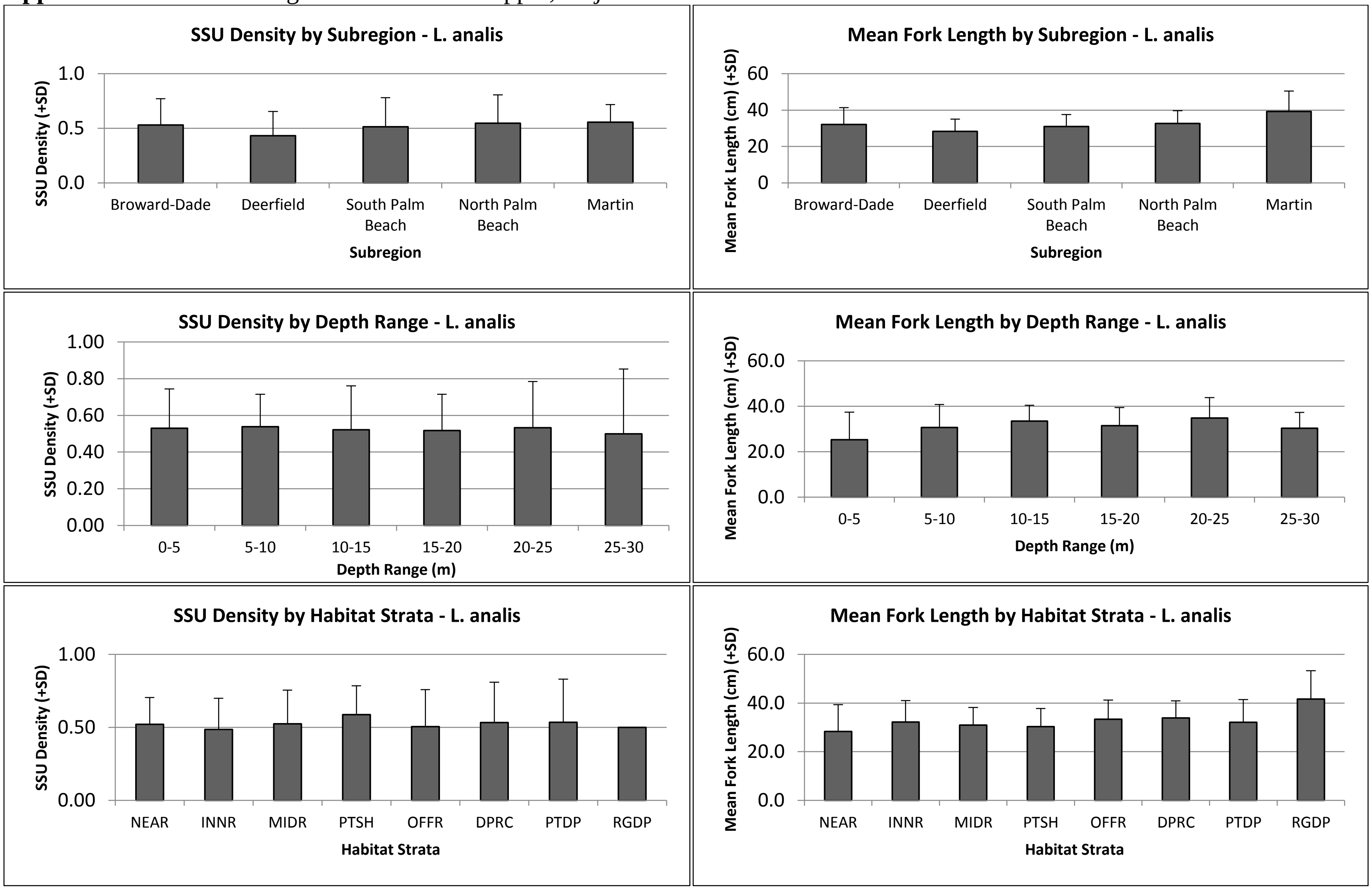




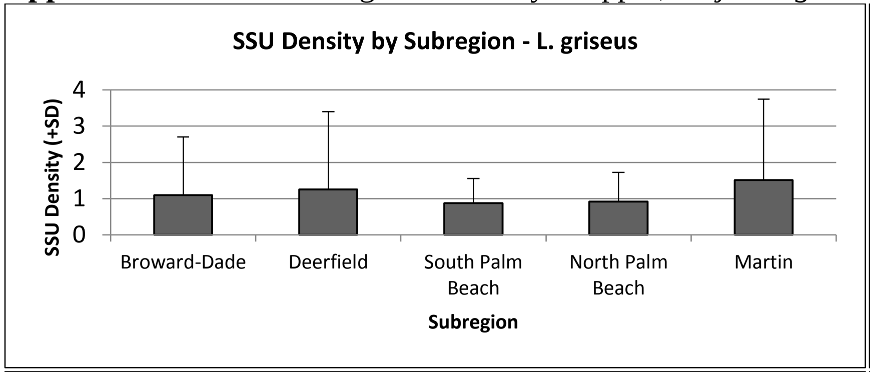
Appendix 11. Additional figures for Hogfish, *Lachnolaimus maximus*.

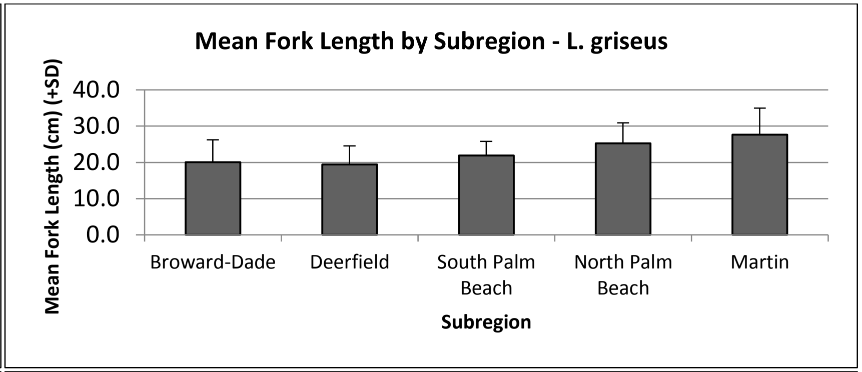


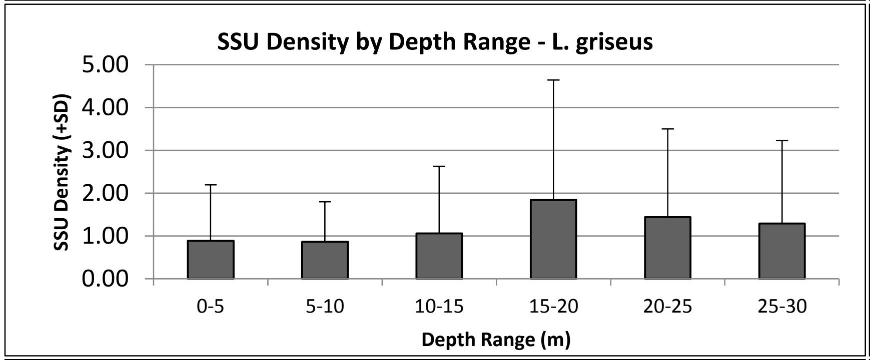
Appendix 12. Additional figures for Mutton Snapper, *Lutjanus analis*.

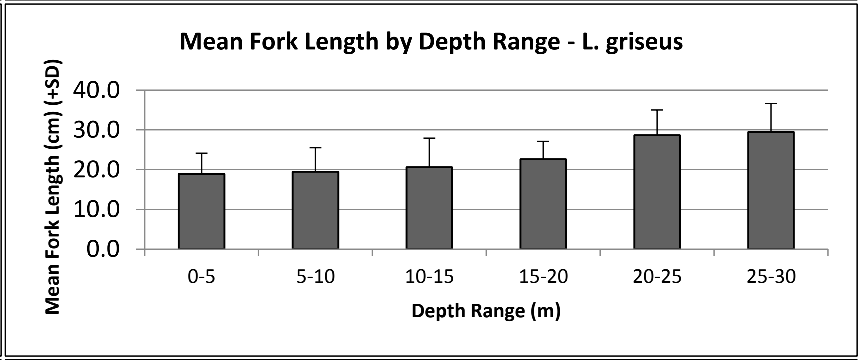


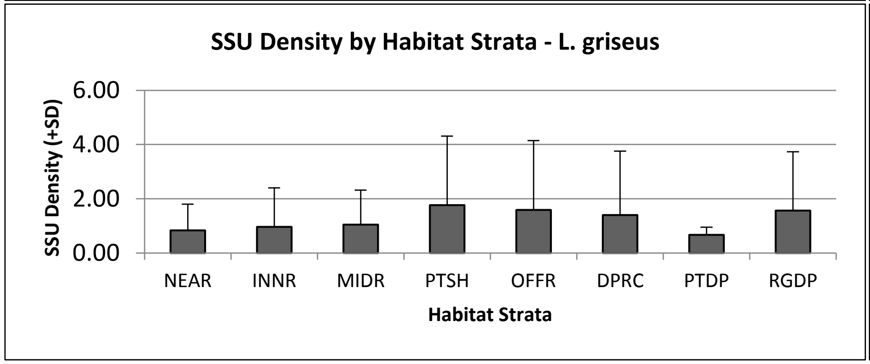
Appendix 13. Additional figures for Gray Snapper, *Lutjanus griseus*.

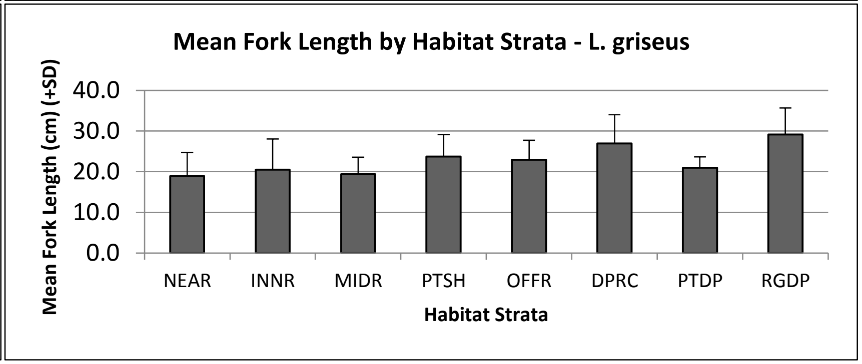












Appendix 14. Additional figures for Yellowtail Snapper, *Ocyururs chrysurus*.