7-1-2005

# The Marine Fishes of Broward County, Florida: Final Report of 1998-2002 Survey Results

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## Recommended Citation

Fleur, F., L.K.B. Jordan, and R.E. Spieler. 2005. The marine fishes of Broward county, Florida: Final Report of 1998-2002 Survey Results. NOAA Technical Memorandum NMFS-SEFSC-532. 73 p.

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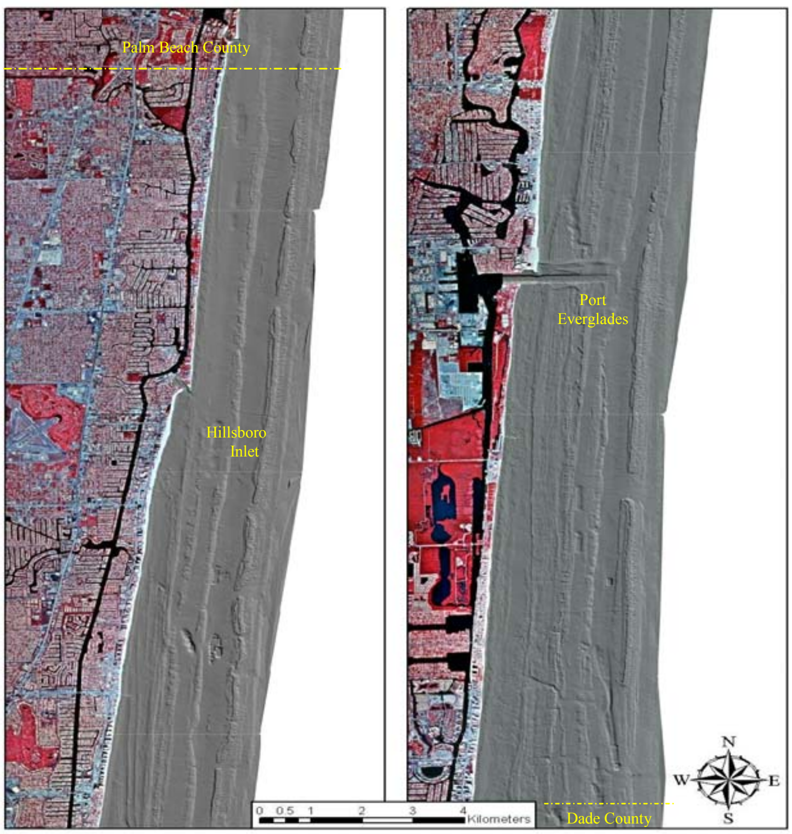


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July 2005

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July 2005

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July 2005

## Executive Summary

We inventoried fishes associated with three hardbottom reef tracts that are separated by sand and run parallel to the coast in sequentially deeper water offshore Broward County, Florida. Using SCUBA and the Bohnsack-Bannerot visual point count method, we recorded fish abundance, species richness, sizes (TL), and general habitat characteristics within an imaginary 15m cylinder extending from the substrate to the surface. Sites were sampled along transects at quarter nautical mile intervals along 18 nautical miles of coastline at western and eastern edges, and crest of each of the three reef tracts.

A total of 86,463 fishes belonging to 208 species and 52 families was censused from 667 sites over four years (August 1998 to November 2002). Mean species richness, mean total abundance and mean total biomass of fishes increased significantly on each reef tract moving offshore ($p<0.05$, ANOVA, SNK). Tract differences may be due to a variety of variables, such as depth, current, refuge, food availability, and other habitat preferences.

Differences were found within reef tracts based on edge or crest sites and position along reefs north or south of Port Everglades and Hillsboro Inlet. Sites within 5 na. mi. south of Port Everglades had lower total abundance and species richness ($p<0.05$, ANOVA) than the same number of sites located within 5 nautical miles north of the port. Also, south of Port Everglades, the western edge of the reef tracts had greater abundance and richness values than the eastern edge or the crest ($p<0.05$, ANOVA). In contrast, the eastern edge predominated in both abundance and richness north of Port Everglades ($p<0.05$, ANOVA). The reason(s) for these differences may be linked to topographic variables. In general, at count sites north of Port Everglades, the eastern edges of the reef tracts had a higher amount of vertical relief, and attendant refuge, than at southern count sites. Likewise, although regressions were weak, differences in species richness and abundance were related to bottom cover, rugosity, and depth to some extent. Hillsboro Inlet showed similar patterns. Sites within 3.75 nautical miles south of the inlet had lower abundance and species richness ($p<0.05$, ANOVA) than the same number of sites north of the inlet. These patterns could be influenced by effluent transport by the predominantly north-bound current running parallel to the coast. Density of juvenile grunts, an important forage base, was similar on the inshore and middle reefs, but was significantly higher than on the offshore reef.

Of management interest, was a scarcity or absence of groupers and snappers observed over four years. Although juvenile red grouper were frequently seen (n = 232 at 667 sites), only two were above legal minimum size. No goliath or black grouper were recorded. A total of 10 gag, yellowfin, or scamp grouper was observed; none were legal. Among six snapper species, 219 of 718 were of legal size.

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# INTRODUCTION

## 1.1. Significance of this Study

The ability to determine change in an environmental resource in response to any anthropogenic activity or natural event requires an accurate inventory of that resource prior to the activity or event occurring. The coral reef fishes in Broward County, Florida, both residents and transients, are subject to multiple environmental stressors, including such activities as heavy fishing pressure (both commercial and recreational), effluent from Fort Lauderdale and Port Everglades, and habitat destruction from anchoring and ship groundings (five major groundings have occurred on Broward County reefs in the last 10 years). Coral reefs are highly productive communities, which are important to the fisheries of southern Florida (Miclat et al. 1981). Multiple local management decisions are being implemented or considered to alleviate depleted fish stocks and marine life or to mitigate damage (e.g., small boat mooring buoys, artificial reefs, fish stocking, and marine protected areas). In addition, management decisions at the state and federal level can potentially impact the reef fishes of Broward County (e.g., catch limits, redirection of fresh water outflow from Everglades restoration projects, creation of reserves for reproductive stock in the Florida Keys).

Management policies are in turn dependent upon reliable fisheries data collection and efficient assessment methods (Beets 1997). The collected data can be utilized for a variety of management strategies (e.g., designing reserve areas) as well as have basic science value (e.g., understanding the organization of reef fish assemblages) (Friedlander & Parrish 1998). Without knowledge of current stocks, the effects of management decisions will be difficult to evaluate accurately. We can also continue to expect a variety of unpredicted natural or anthropogenic factors will affect local fishes (i.e., hurricanes, epizootics, exotic species) (Lassig 1983). It will be impossible to fully assess the changes or damages caused by anthropogenic or natural factors without a baseline for comparison.

## 1.2. Previous Studies

Numerous previous studies have been conducted concerning inshore and offshore reef fish assemblages (Thompson et al. 1990, McGeehee 1994, Chabanet et al. 1997, Williams 1982, Galzin & Legendre 1987). One was done in Broward County by Ettinger et al. in 2001. Other Florida studies have analyzed variables recorded in this project, but differed in terms of methodology, depth, or distance from shore. Lirman (1999) analyzed associations between *Acropora palmata* and complexity with fish abundance, diversity and distribution in Florida and the Virgin Islands but did not include Broward County or a detailed examination of fish assemblage structure. Gilmore (2001) examined the evolution of Florida's fish fauna and its relationship to the Caribbean, but also lacked a detailed analysis of Broward County fishes and the assemblage structure. Grouper and snapper populations, and other reef fish populations in general have been evaluated in the Florida Keys (Ault et al. 1998, Ault et al. 2001, Bohnsack et al 1999, Jones & Thompson 1978, Sluka et al. 2001, Lindeman et al. 2000), but did not extend to Broward County.

Koenig et al. (2000) looked at the shelf edge reefs of southern Florida, but the study sites were so deep (50-120m) that it offered little to compare with this study. Finally, Sutherland et al. (1987) studied fishes off Key Biscayne, which is near Broward County (35km), but they used fish traps, which have a different set of biases from the visual census method used in this study. There has been some sporadic collecting of fish from Broward County as there are specimens from this area in the ichthyology collection at the University of Florida Museum of Natural History (www.flmnh.ufl.edu/fish). However, there have been no prior studies involving an in-depth inventory of Broward County reef fishes.

### 1.3. Statement of Purpose

The objective of this research was to conduct a quantitative study of the coral-reef-associated fishes of Broward County, Florida. These fish are mainly limited to three reef tracts that run parallel to the coast in sequentially deeper water (Goldberg 1973). A preliminary study, spanning a 5 nautical mile (nm) portion of Broward County, south of Port Everglades, found that differences exist among the three reef tracts and among the different reef edges of the tracts (Ettinger et al. 2001). In addition, the reef lines show some differences in morphology and complexity at different latitudes (Moyer et al. 2003). Thus, simple sub-sampling on a single reef tract or a few transects across the three reef tracts would not provide a reliable characterization of the fish assemblages. Therefore, we decided to inventory the fish assemblages at regular intervals along and across the three reef tracts for the length of the Broward County coastline.

## 2.0. METHODS AND MATERIALS

### 2.1. Study Area

This project was conducted within the coastal waters of Broward County, Florida (Figure 1). The nearshore area of Broward County is characterized by three coral reef/hardbottom tracts separated by sand substrate, running parallel to the coast in sequentially deeper water (Goldberg 1973). These reef tracts are found at depths ranging from 3 to 30 meters and are locally referred to as the inshore, middle and offshore reefs (Figure 2). Since the initiation of this project, the geologic structure and associated terminology of the Broward County reef tracts has been reexamined (Moyer et al. 2003). However, we continue to use the older terminology in this paper. Because all the data are associated with Differential Global Positioning System (DGPS) coordinates assures that the inventory will be valid and useful regardless of the terminology.

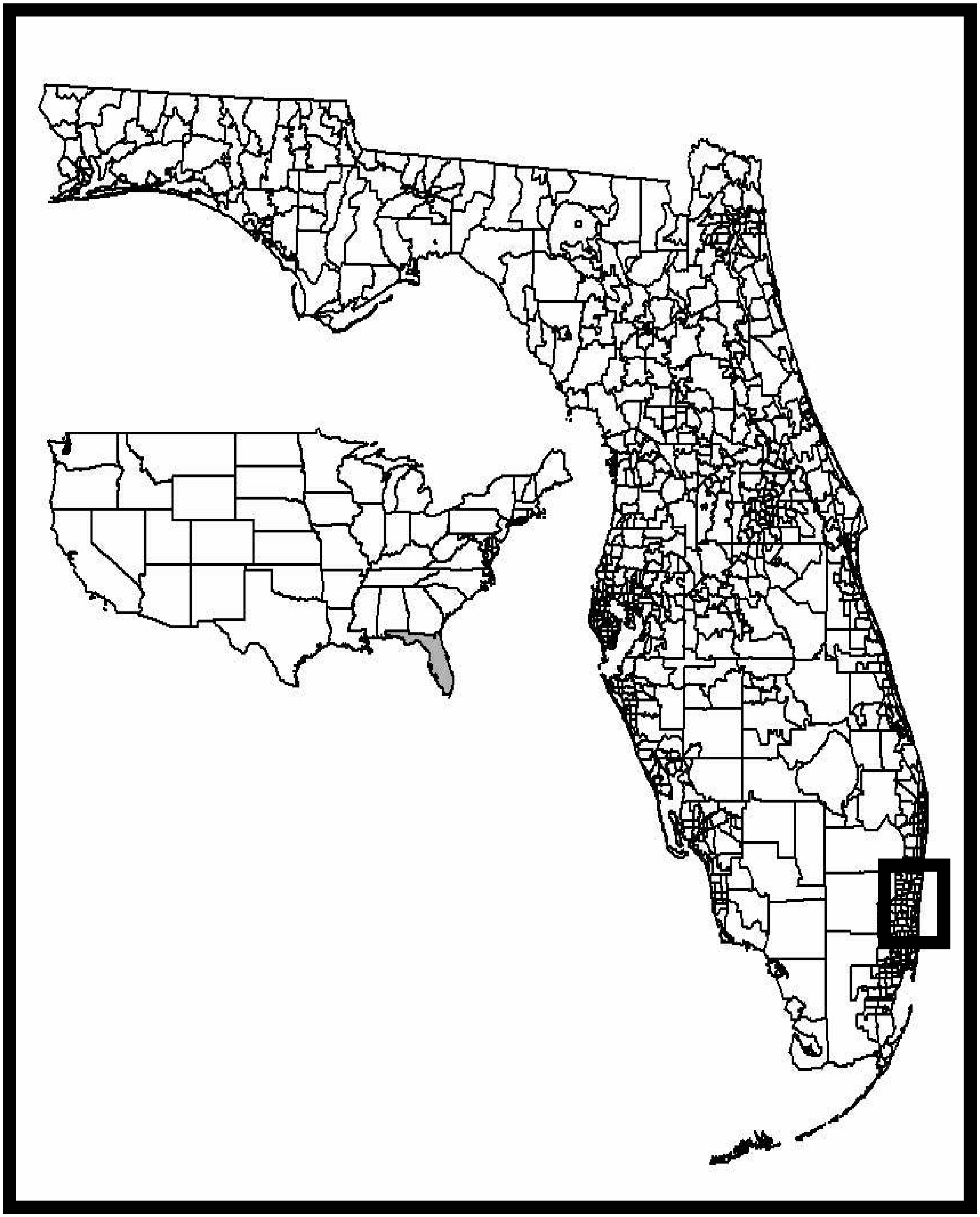

Figure 1. Map of study area. Study was concentrated in Broward County, Florida.

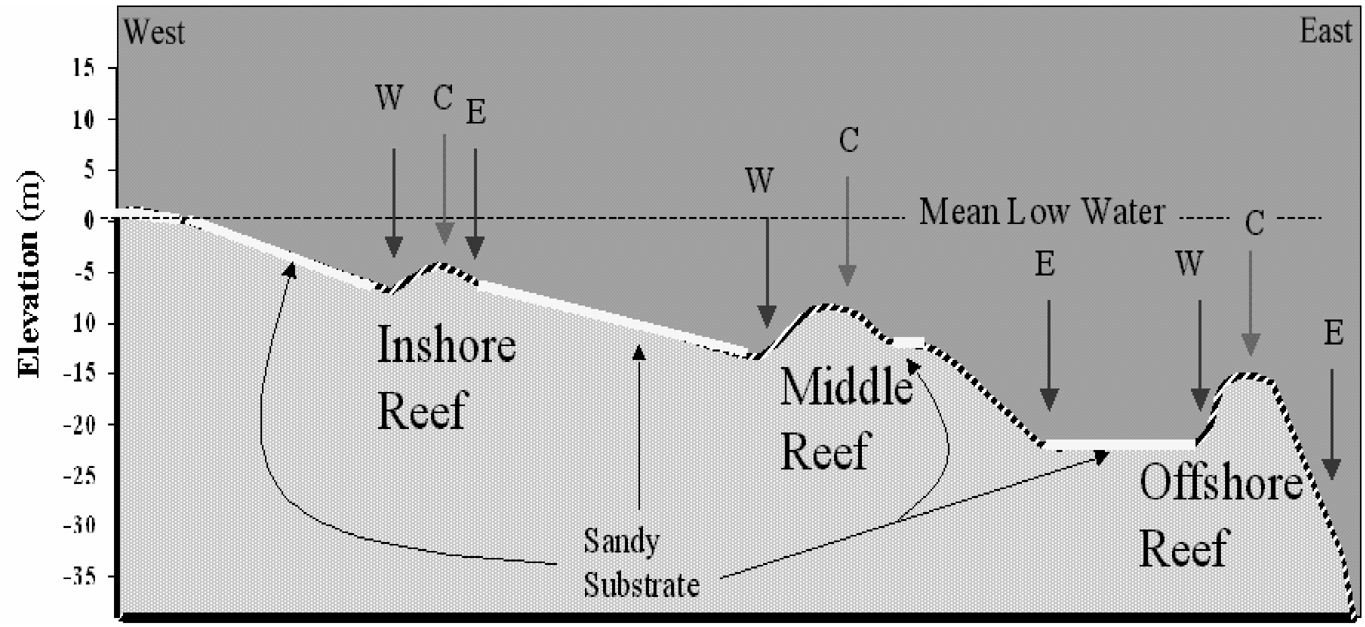


Figure 2. Depth profile of a generalized transect from west to east. Census sites indicated by: W = Western Edges, C = Crests, E = Eastern Edges. Diagram not to scale (from Ettinger et al. 2001).

East-west transects (from the western edge of the inshore reef to the eastern edge of the offshore reef, about 1.5 nautical miles) were conducted every quarter nm from the southern boundary of Broward County (N 26° 00.50') to the northern end of Broward County (N 26° 18.250'), approximately 18 nautical miles (Figure 3). This resulted in 75 east-west transects (numbered 21-95). Also included are some point counts associated with a companion study (Spieler 2003). Along each of these east-west transects was nine count site locations: the east edge, west edge and crest (midpoint if no crest could be determined) of each of the three reef tracts, for a total of 667 planned count site locations. Data from the preliminary study (Ettinger et al. 2001) were combined with the data from this study for analysis in order to cover the entire county.

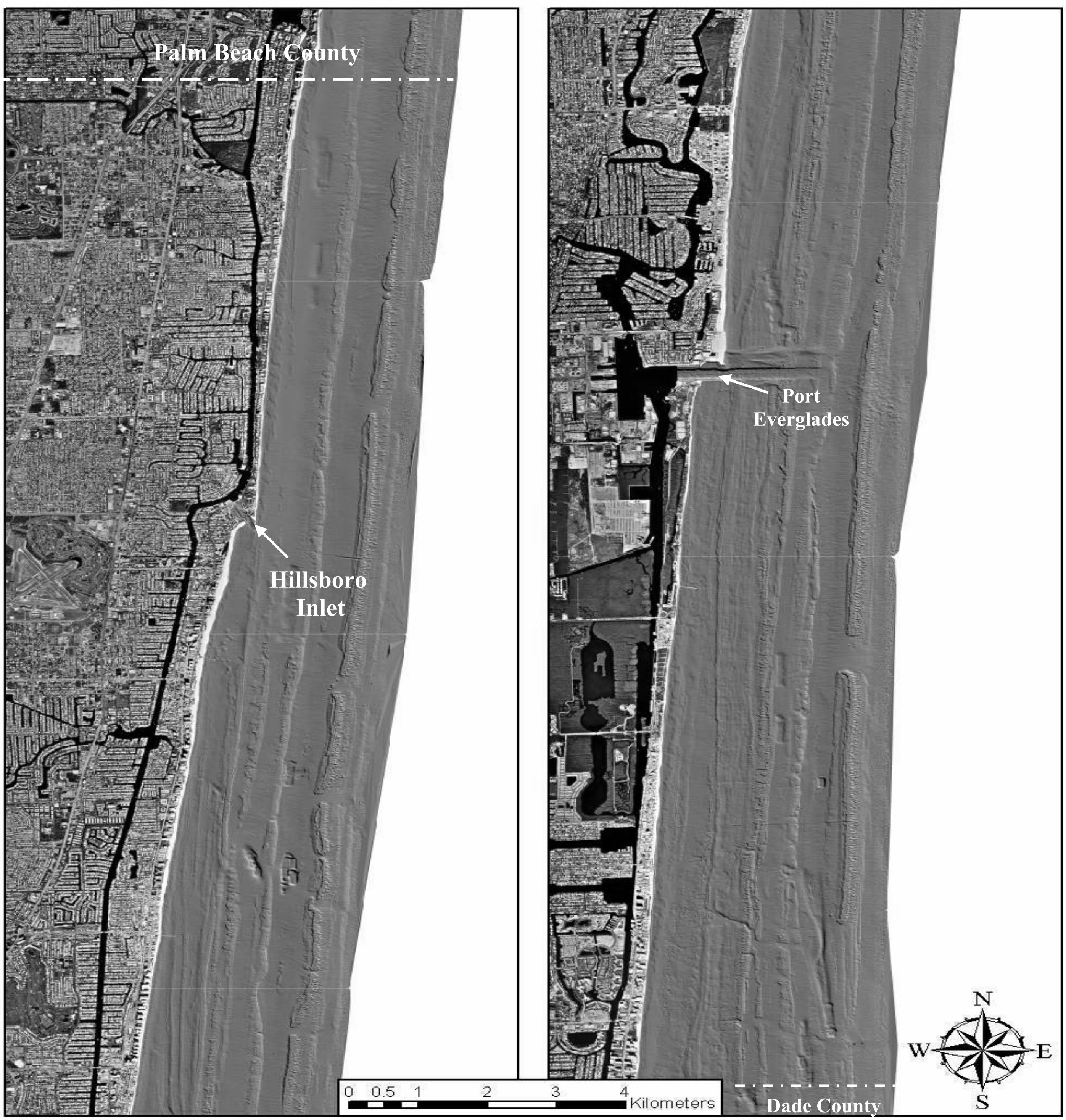


Figure 3. Laser Airborne Depth Sounding map of study area. Note: Port Everglades and Hillsboro Inlet are labeled.

## 2.2. Census Technique

### 2.2.1. Census Site Determination

Transect latitudes were located by using a Magellan DGPS (Magellan, San Dimas, CA). Laser Airborne Depth Sounding (LADS) maps were utilized to find the general topography at count site longitudes, which were then confirmed by using a Furuno FE-400 Echo sounder and depth plotter (Furuno Electric Co., LTD., Nishinomiya, Japan). The depth plotter was used to find bottom topography profiles, which made it possible to easily locate reef edges and crests. The eastern and western edges of the reefs were characterized by a reef-sand interface. The crest was characterized as the shallowest point of each reef; if no definite shallow point was available at a count site, a midpoint was selected and used for the crest. Once count sites were determined, "diver down" flags attached to buoys were deployed. With some exceptions in the North, where the inshore reef disappeared (Transects 76-81), each transect had three reef tracts, each of which included a western edge, eastern edge, and crest, totaling nine count site locations per transect.

### 2.2.2. Equipment

Each dive team was equipped with a 7.5-m line with a weight at one end and a clip on the other, an aluminum clipboard with waterproof data sheets attached, a pencil, a waterproof watch, fiberglass measuring tape for measuring rugosity, and a 1-m "T-stick" made from PVC pipe with a 30cm ruler attached to the end to aid in measuring fish lengths (Figures 4, 5, & 6). An underwater camera [Mavica MVC FD 81 camera (Sony Corp., Park Ridge, NJ) with an Ikelight housing (Ikelight Underwater Systems, Indianapolis, IN)] was used to aid in documentation of bottom cover, reef profiles, etc.

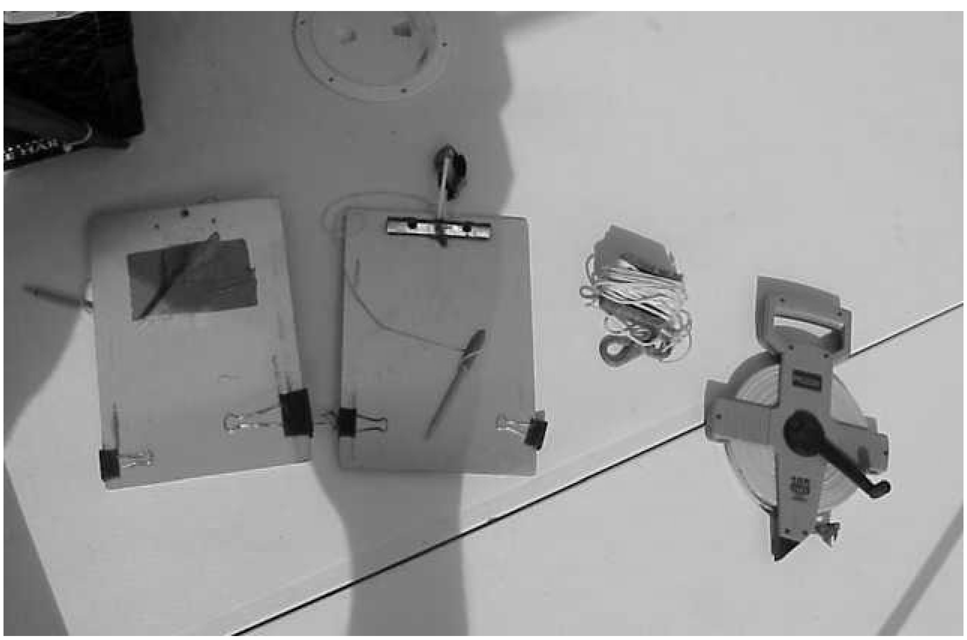

Figure 4. Examples of clipboard, 7.5m line, and measuring tape used in point counts.

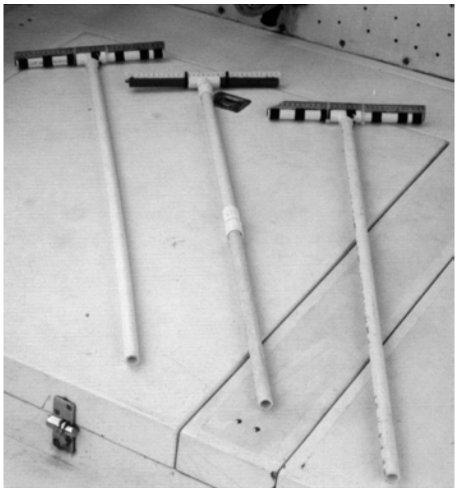

Figure 5. T-sticks used as aids in estimating fish length. Rulers were attached to the ends for reference.

Date

Sample site
Counter
Buddy
Depth(ft)
Elevation(ft)
Notes:

Ship
Start Time
End Time
Complexity(m)
Rating(1-10)

| | % |
|---|---|
| SAND | |
| RUBBLE | |
| TURF | |
| CORAL | |
| STAGHORN | |
| GORGONIAN | |
| FIRE CORAL | |
| ALGAE | |
| SPONGE | |
| TIRE | |

| Species | N | Avg | Min | Max | Species | N | Avg | Min | Max |
|---|---|---|---|---|---|---|---|---|---|

Figure 6. Example of data sheet used for recording point count data.

### 2.2.3. Underwater Operations

Tropical reef fishes are appropriate for visual observation due to their distinctive coloration and the water clarity of their underwater habitat (Dennis & Bright 1988). Although it has been suggested that destructive techniques (i.e. rotenone utilization) are the preferred method for providing relatively complete quantitative and qualitative samples (Ackerman et al. 2002), doing so in such a large sample area would be impractical and ecologically detrimental. Therefore, sampling was accomplished using a non-destructive underwater stationary visual census technique, known as the Bohnsack-Bannerot point count method (Bohnsack & Bannerot 1986). Two divers (one trained fish counter and one safety diver) were deployed at a census site with the equipment mentioned earlier (Section 2.2.2). Once on the bottom, the divers would swim the "diver down" flag weight to the specific edge or crest (if buoy deployment was not accurate) using their compasses to swim directly east or west (in order to stay on the transect) from where the buoy was deployed. The safety diver attached the 7.5m line to the dive buoy weight, and swam it out in a straight line from that point in a direction that the fish counter subjectively decided was the most topographically complex profile. The safety diver would then anchor that end on the bottom by placing the lead weight attached to it in a clear area, to avoid harm to benthic organisms. This line served as the radius of an

imaginary cylinder, which extended from the sea floor to the surface (Figure 7). Next, the safety diver swam out the fiberglass measuring tape, to be used later to determine rugosity, directly over the 7.5m line. Once the tape was laid out, the safety diver would remain outside the imaginary cylinder but within visual contact while the fish counter completed the census. The fish counter recorded site data including date and time, dive buddy, sample site number, complexity rating (1-10), depth, and elevation (Figure 8). Elevation was determined by estimating the difference between the highest and lowest point in the imaginary cylinder. The counter also estimated and recorded percent bottom coverage from a list of 10 substrate types (sand, rubble, turf, coral, staghorn coral, gorgonians, fire coral, algae, sponge, and tire) with all percentages summing up to 100%. This process took approximately three to five minutes; sufficient time for resident fish to become accustomed to the divers and equipment.

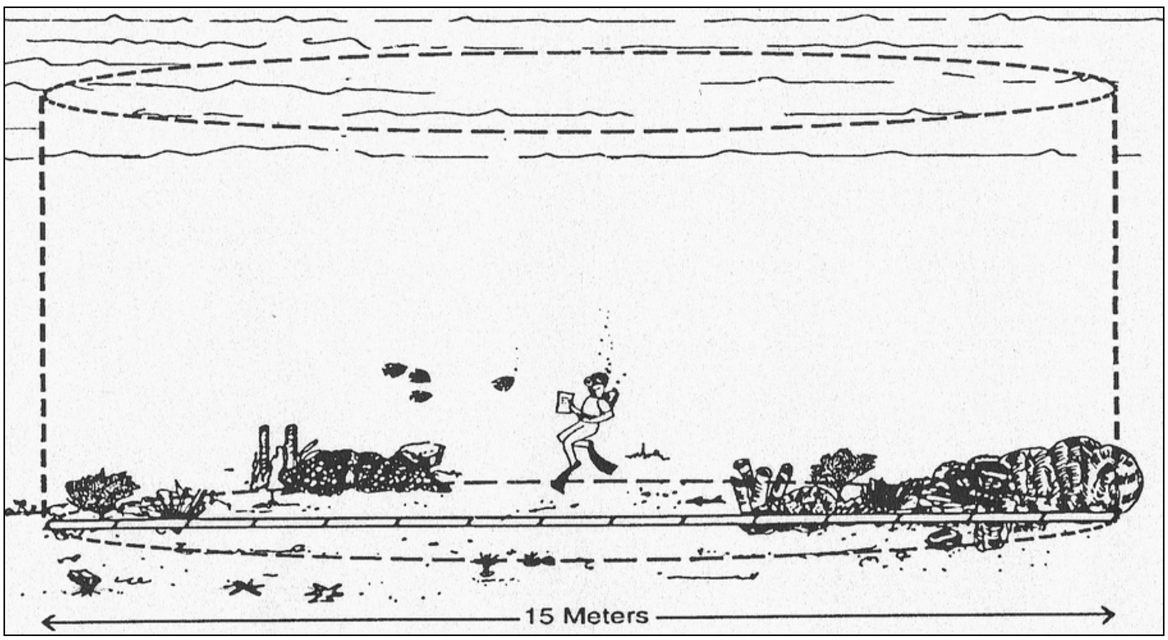


Figure 7. Diagram of point count method. The diver stands in the middle of a 15m diameter imaginary cylinder and records all fishes on the substrate and in the water column (from Rogers et al., 1994).

| | |
|---|---|
| Date ____________ | |
| Sample site ____________ | Ship ____________ |
| Counter ____________ | Start Time ____________ |
| Buddy ____________ | End Time ____________ |
| Depth(ft) ____________ | Complexity(m)____________ |
| Elevation(ft) ____________ | Rating(1-10)____________ |
| Notes: | |

Figure 8. Example of data the diver recorded prior to counting fishes.

### 2.2.4. Point Count Procedure

After recording all environmental data, the diver would begin the visual census. For the first five minutes, the fish counter remained in the center of the imaginary cylinder, scanned the entire cylinder, and recorded all species observed. After the five-minute species listing, the counter then recorded the abundance, minimum and maximum size (total length), and average length for each species recorded during the first five-minute period. If additional species entered the cylinder after the first five minutes, only species names were recorded for presence/absence data, (which was not used in analyses in this study). Once this was completed, in order to gain a measure of site complexity, the diver swam the length of the 7.5-m line while forcing the measuring tape to closely follow the contours of the reef. The difference between 7.5m and the tape length served as a gross index of complexity, termed rugosity from this point on. These data were recorded, and the safety diver was signaled that the count was complete. The equipment was collected and the divers made a slow ascent with a three-minute safety stop at 5 m for dives deeper than 15 m. Dive teams were alternated in order to maximize bottom times and surface intervals for safety purposes. When three teams (six divers) were available and weather permitted, two teams of divers were deployed simultaneously to maximize the counts per dive day.

## 2.3. Data Analysis

Collected data were entered into a Reef Fish Visual Census (RVC) (Weinberger 1998) data entry system and directly converted into Microsoft Excel (Microsoft Corp., Redmond, WA). Once entered into these programs, the data were tabulated and analyzed using Statistica (Stat Soft Inc., Tulsa, OK) and Plymouth Routines in Multivariate Ecological Research (PRIMER) (PRIMER-E, Ltd., Plymouth, UK). Microsoft Excel was used for general regressions, such as rugosity, depth, and elevation versus abundance and species richness data. Statistica was used to determine differences among the three reef tracts as well as among edges for abundance, species richness, biomass, depth, and rugosity. Total length estimates allowed for post-census calculation of biomass using length-weight equations published by Bohnsack & Harper (1988). Abundance and species richness data were not normally distributed and had high heteroscedasticity. Therefore, a parametric ANOVA was used on transformed $\log_{10}(x+1)$ data and if significant, a post-hoc Student-Newman-Keuls (SNK) test was used to find significant differences among means. However, for ease in interpretation, even when using transformed data for statistical analyses, means and standard errors of raw data were used for graphic descriptions of results. In addition, the Bray-Curtis dissimilarity indices with multidimensional scaling (MDS) ordination on fourth root-transformed data were used to examine potential differences in fish assemblage structure among sites and locations (Field et al. 1982). A p value $<0.05$ in both ANOVA and SNK was accepted as a significant difference (those tests which were not significant are not graphically displayed). SIMPER analysis in PRIMER was used to detect those species that most contributed to the differences noted in the MDS plots.

# 3.0. RESULTS

## 3.1. Broward County Reef Tract Description

### 3.1.1. Inshore Reef Tract

The inshore reef tract, ranging in depth from 1.8m to 9.1m, was generally located approximately 0.5 nm offshore. This varied, however, especially in the northern areas, where it even was absent, from Transects 76-88 (Figure 9). The western edge of the inshore reef tended to be in 2.7-5.5m and had low complexity. The crest ranged in depth from about 2.4-6.1m, and the eastern edge depth was between 1.8-9.1m. For analysis north and south of Port Everglades, 20 transects were used; for analysis of those north and south of Hillsboro Inlet fifteen transects were compared, as there were only 15 transects located north of Hillsboro Inlet. The inshore crest was significantly ($p<0.05$, ANOVA) deeper south of Port Everglades than north of the Port (Figure 10), with a mean depth of 5.3m south of the Port versus 4.4m north of the Port. South of Port Everglades, the inshore reef was characterized by hardbottom substrate, with little or no coral growth. Once north of Port Everglades, the inshore reef had slightly more coral but remained one of the least complex areas. The opposite was true at Hillsboro Inlet. The inshore crest at Hillsboro Inlet was significantly ($p<0.05$, ANOVA) deeper north of the Inlet than south (Figure 11), with a mean depth of 4.0m north of the Inlet versus 3.4m south of the Inlet. The inshore east edge was significantly ($p<0.05$, ANOVA) deeper north of the Inlet than south of the Inlet (Figure 12), with a mean depth of 5.8m north of the Inlet versus 4.3m south of the Inlet. The inshore reef was the least complex of the three, with a mean rugosity of 8.9m (range: 7.6-12.5m). These data support the Moyer et al. (2003) study, which involved an evaluation of the bottom cover of the reef tracts of Broward County and reported similar findings concerning bottom cover.


Figure 9. Laser Airborne Depth Sounding displaying the missing inshore reef.
Note: Inshore (I), Middle (M), and Offshore (O) reefs south of Hillsboro Inlet.

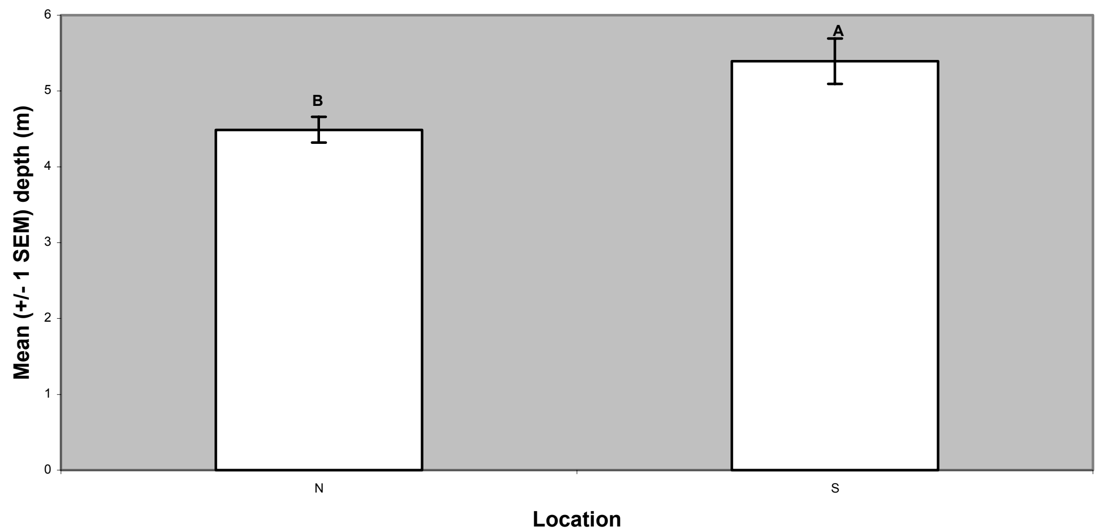


Figure 10. Mean (+/- 1 SEM) depth per inshore reef crest north and south of Port Everglades. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

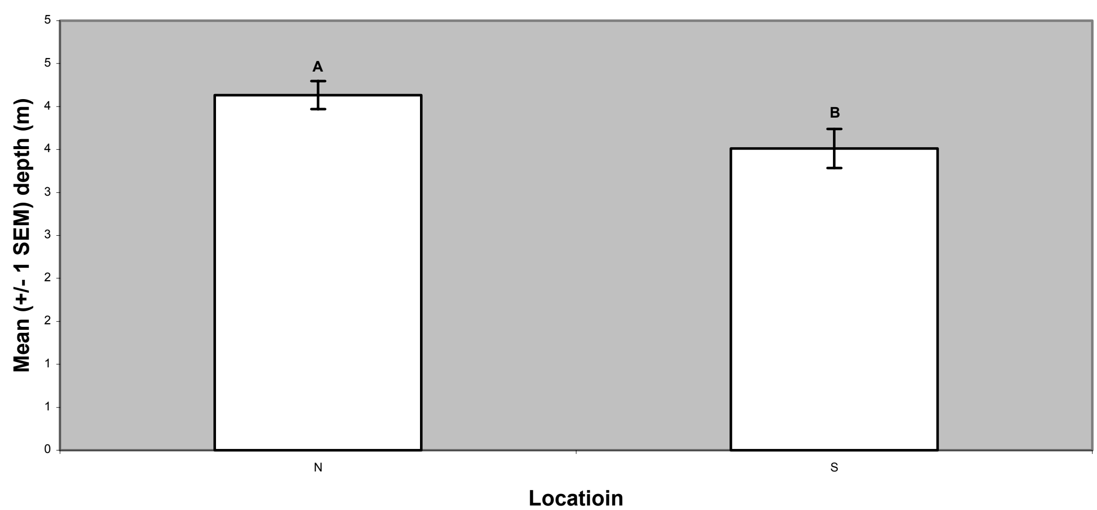


Figure 11. Mean (+/- 1 SEM) depth per inshore reef crest north and south of Hillsboro Inlet. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

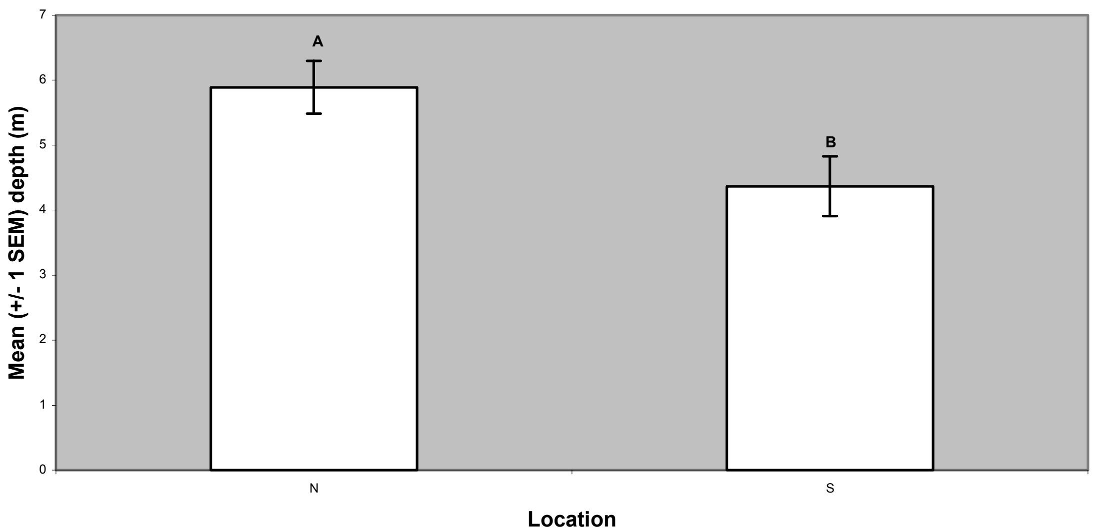


Figure 12. Mean (+/- 1 SEM) depth per inshore reef east edge north and south of Hillsboro Inlet. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

## 3.1.2. Middle Reef Tract

The middle reef tract had the most substantial north/south change in depth, ranging from 1.8 to 22.1m. Around Port Everglades, the crest of the middle reef was significantly deeper south of the Port than north (p<0.05, ANOVA), with a respective mean depth of 10.7m versus 5.7m (Figure 13). Likewise, the middle reef west edge was significantly deeper south (mean depth = 9.5m) than north of the Port (mean depth = 7.5m) (p<0.05, ANOVA) (Figure 14). However, the middle east edge was significantly deeper north (mean depth = 19.5m) than south of the Port (mean depth = 16.9m) (p<0.05, ANOVA). From transects 42-68, the depth of the crest and western edge of the middle reef ranged from 1.8-5.0m. However, from transects 69-95, the middle reef crest and western edge depth ranged from 12.0-18.2m. The eastern edge was much more consistent, at an average depth of 22.0m. At Hillsboro Inlet, both the middle west and the middle crests were significantly (p<0.05, ANOVA) deeper north of the Inlet than south (Figures 16 & 17). The middle crest had a mean depth of 8.9m north of the Inlet, and 3.5m south of the Inlet. The middle west edge had a mean depth of 10.6m north of the Inlet and 6.4m south of the Inlet.

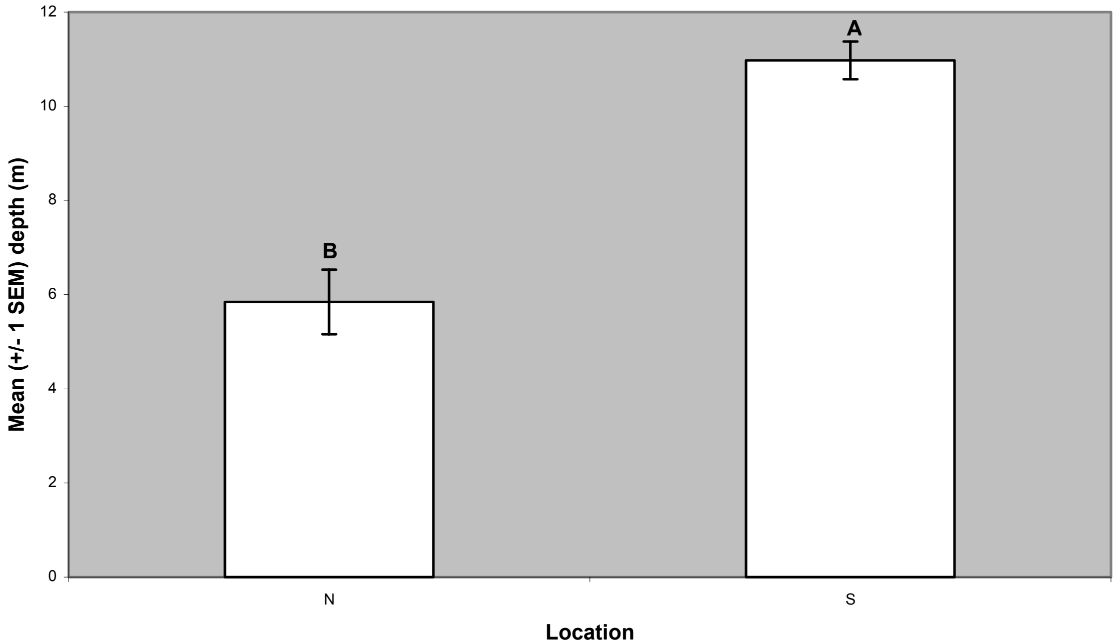


Figure 13. Mean (+/- 1 SEM) depth per middle reef crest north and south of Port Everglades. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

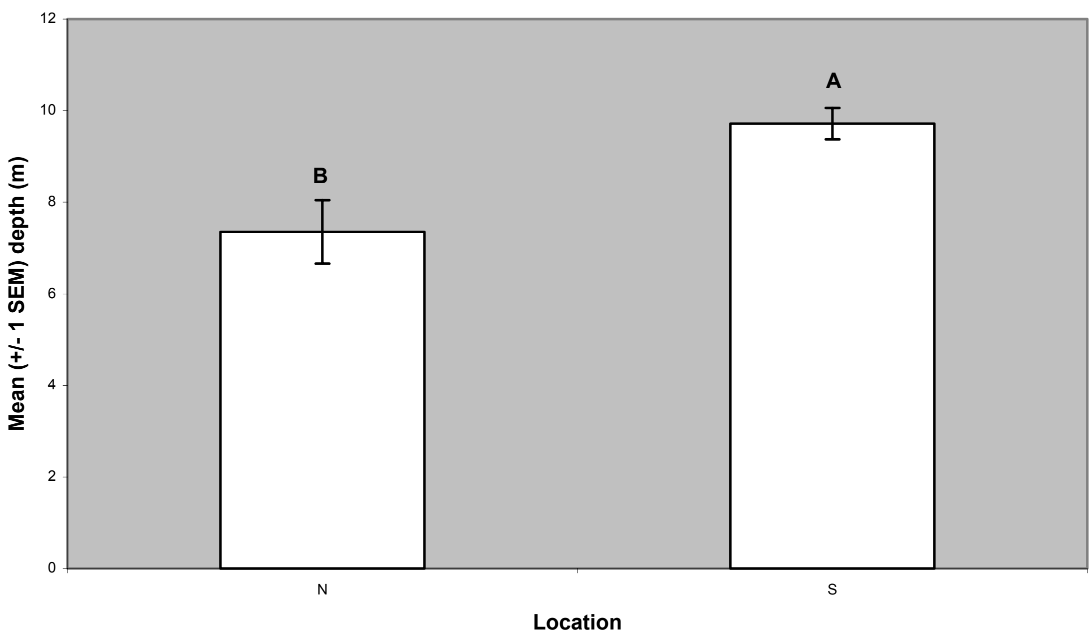


Figure 14. Mean (+/- 1 SEM) depth per middle reef west edge north and south of Port Everglades. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

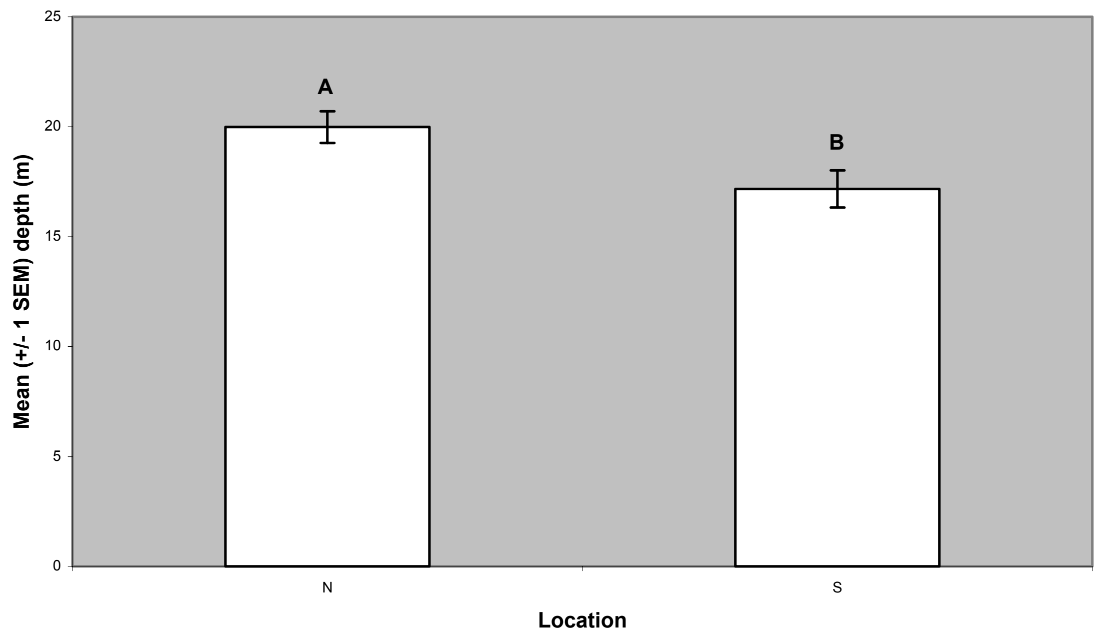


Figure 15. Mean (+/- 1 SEM) depth per middle reef east edge north and south of Port Everglades. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

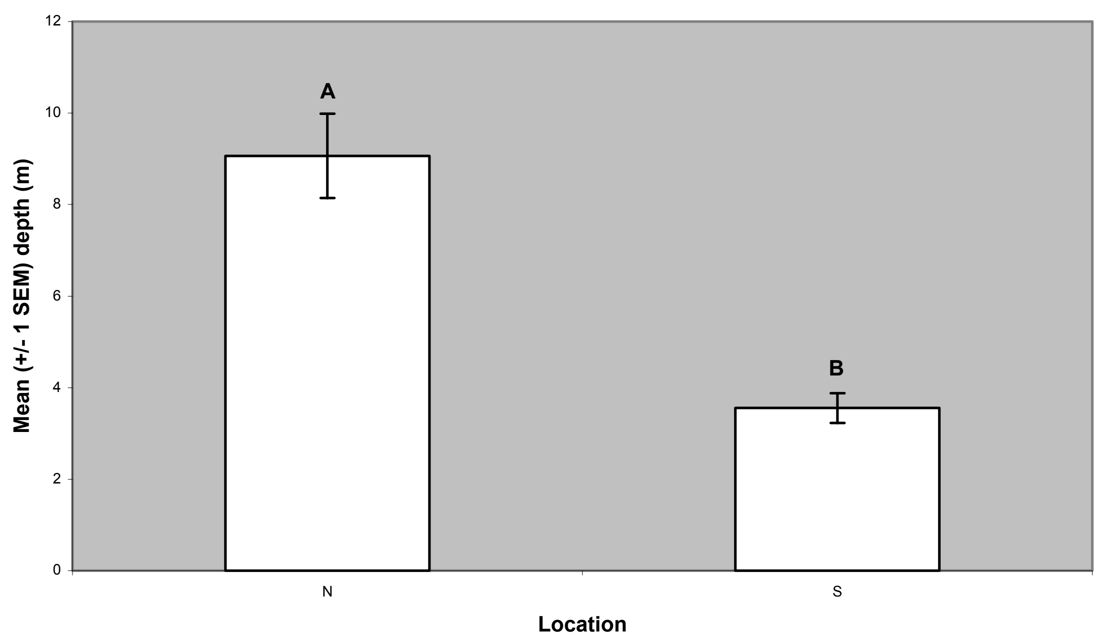


Figure 16. Mean (+/- 1 SEM) depth per middle reef crest north and south of Hillsboro Inlet. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

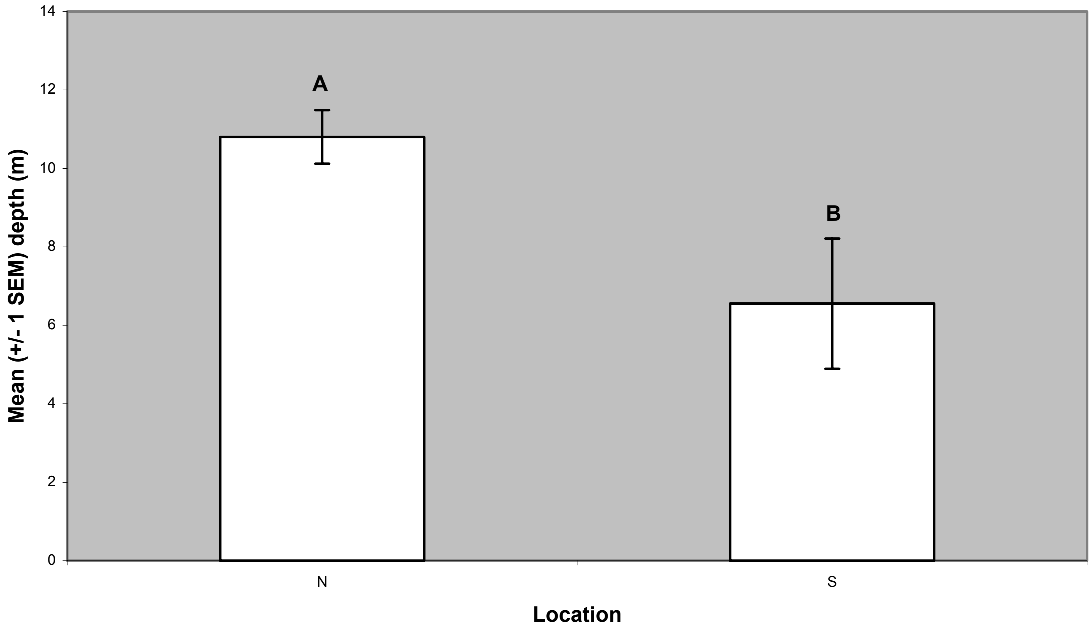


Figure 17. Mean (+/- 1 SEM) depth per middle reef west edge north and south of Hillsboro Inlet. Different letters (A, B) above each location indicate significantly different means (p<0.05, ANOVA).

The western edge of the middle reef became much more complex toward the north, with a mean rugosity of 8.7m (range: 7.6-12.2m). The crest of the middle reef tended to be low in complexity (mean rugosity of 8.5m), usually composed of a platform-type substrate, with much algae and little coral or sponge growth south of Hillsboro Inlet. North of the Inlet, there was greater density of gorgonians on the crest. The eastern edge was more complex, with a mean rugosity of 8.8m, and appeared to have a more steep change in elevation than the western edge. The middle reef was located much closer to shore north of transect 76 (about 0.5nm), which was where the inshore reef was missing, than south of transect 76 (about 1nm).

## 3.1.3. Offshore Reef Tract

The offshore reef tract ranged in depth from 12.1-32.4+ m. The western edge of the offshore reef depth did not vary much; it was usually found at a depth of approximately 24.0m. However, the sites on this edge were significantly (p<0.05, ANOVA) deeper north of Port Everglades than south of the Port (Figure 18); eastern edge and crest sites did not differ in depth (p>0.05, ANOVA). It was composed of mostly hardbottom with some live coral and sponge cover. The western edge of the offshore reef had less complexity (mean rugosity of 8.8m) in comparison to the crest and eastern edge, which is a characteristic different from the other two reef tracts. The offshore crest was low in complexity with a mean rugosity of 8.7m (range: 7.5–15.0m). The farther north

one traveled, the more gorgonians were found on the offshore crest. The eastern edge of the offshore reef had the highest complexity, with a mean rugosity of 9.7m (range: 7.8-15.0m). This edge was characterized by a well-defined reef border with coral patches and some relict spur and groove formations. The offshore east edge ranged in depth from 24.6m to 33+ m in some spots. Due to diving-safety limitations, the deepest eastern edge count sites were restricted to 30m.

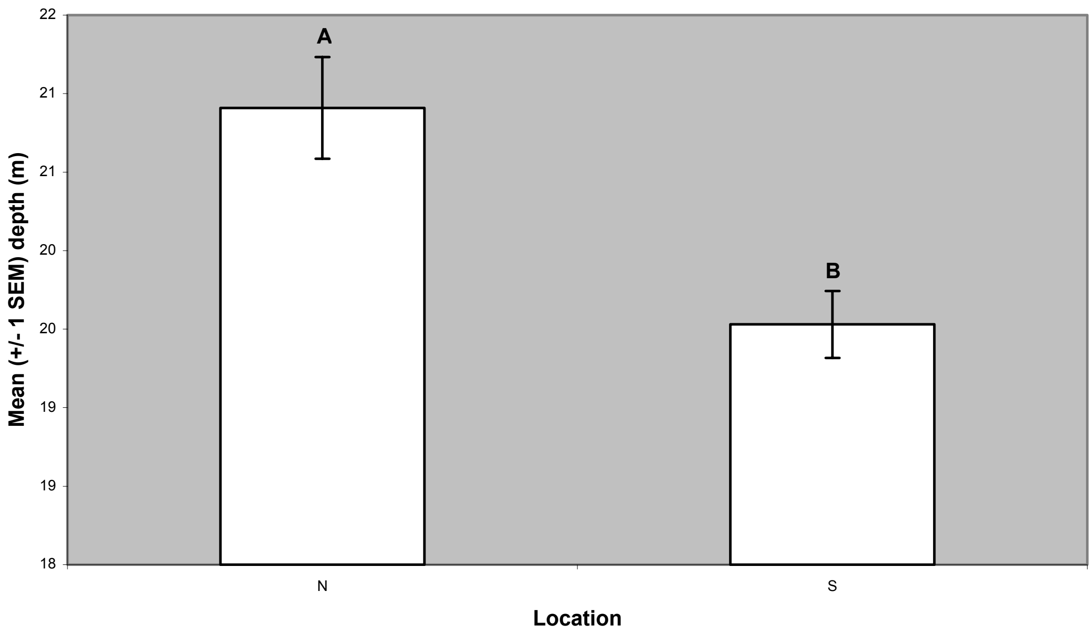


Figure 18. Mean (+/- 1 SEM) depth per offshore reef west edge north and south of Port Everglades. Different letters (A, B) above each location indicate significantly different means ($p<0.05$, ANOVA).

In general, the middle reef had the lowest mean rugosity, 8.7m, followed by the inshore reef with a mean rugosity of 8.9m, and the offshore reef had the highest mean rugosity, 9.1m ($p<0.05$, ANOVA, SNK) (Figure 19). However, mean data can be misleading as within each reef tract much variation occurred in rugosity as well as in depth and bottom cover. This was especially true concerning areas directly north and south of Port Everglades and Hillsboro Inlet.

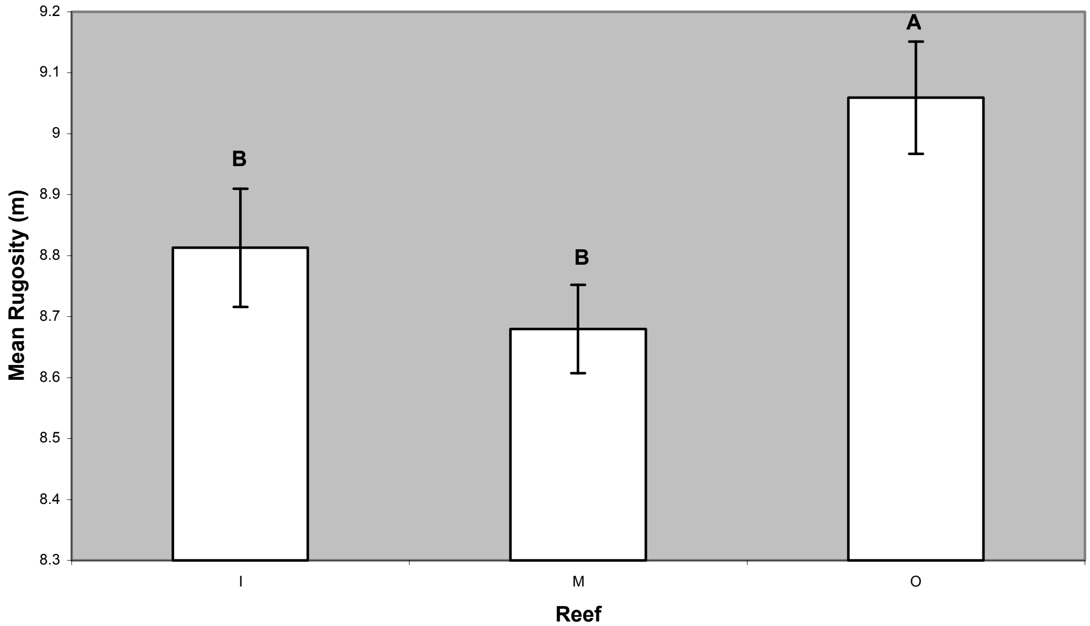


Figure 19. Graph of the mean rugosity (m) of each reef tract. Different letters (A, B) indicate significantly different reefs (p<0.05, ANOVA, SNK).

## 3.2. Fish Assemblage Structures

### 3.2.1. Totals for Each Reef Tract

Between August 1998 and November 2002, 667 study sites were sampled. A total of 86,463 fish of 211 species (52 families) was recorded; 144 species were found on the inshore reef, 170 on the middle reef, and 173 on the offshore reef. Twenty-two species were found on all three reef tracts, 11 were recorded exclusively on the inshore reef tract, 8 on the middle, and 18 on the offshore tract (Table 1).

There was significantly greater species richness and fish abundance on the offshore reef tract than on the middle tract, that in turn, had greater richness and abundance than the inshore reef tract (p<0.05; ANOVA, SNK) (Figures 20 & 21). Although the MDS plot of Bray-Curtis dissimilarity indices did not show a tight grouping of the inshore and middle reef sites, the offshore reef clustered tightly (p<0.01, ANOSIM) (Figure 22). Biomass results were similar. The offshore reef had significantly higher biomass than the middle reef, which had significantly higher biomass than the inshore reef (p<0.05, ANOVA, SNK) (Figure 23). For biomass analysis, three counts that skewed the inshore data were removed for more characteristic comparisons. These included 34 *Megalops atlanticus* (average 145cm TL), one *Ginglymostoma cirratum* (150cm TL), and one *Sphyraena barracuda* (130cm TL). Likewise, three additional counts skewed the offshore data, which included 20 *S. barracuda* which averaged 90cm TL, and one *Manta birostris* (300cm TL).

Significant differences ($p<0.05$, ANOVA, SNK) in species richness, abundance, and biomass were also found among the edges and crests of the reefs. There appears to be a gradient with higher numbers of fish as one moves offshore. Mean species richness and abundance on all three offshore edges/crest and the middle east edge were significantly different from all of the other edges ($p<0.05$, ANOVA, SNK). The middle crest, middle west, inshore east, and inshore crest all had significantly higher ($p<0.05$, ANOVA, SNK) species richness and abundance from the inshore west edge (Figures 24 & 25). Like species richness and abundance, for biomass the offshore edges and crest and the middle east edge grouped together, and the inshore west grouped with the inshore crest ($p<0.05$, ANOVA, SNK) (Figure 26).

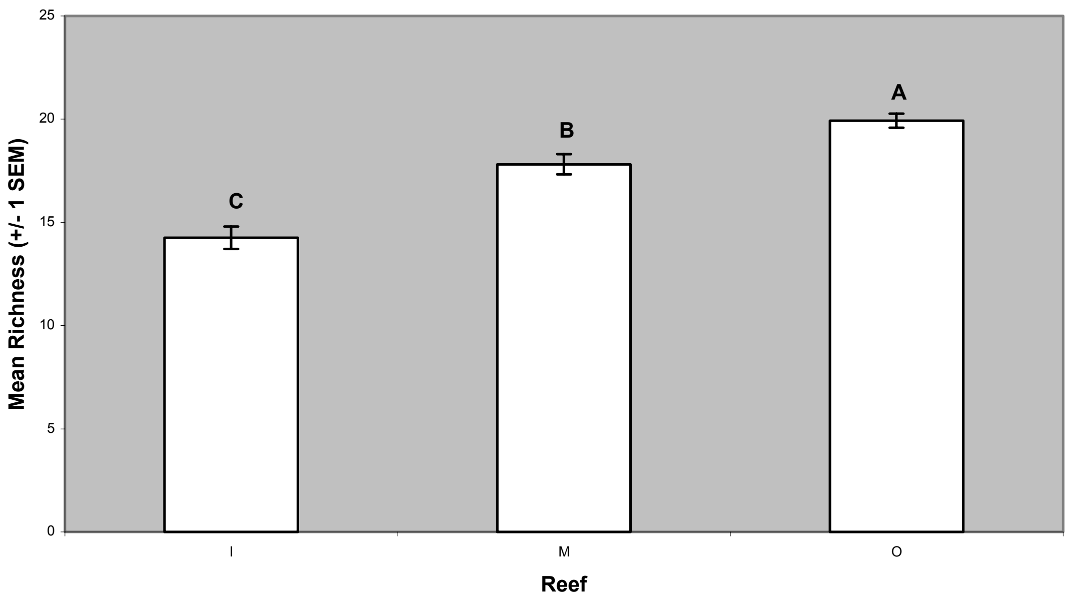


Figure 20. Mean (+/- 1 SEM) species richness for each reef tract. Different letters (A,B,C) indicate significantly different reefs ($p<0.05$, ANOVA, SNK).

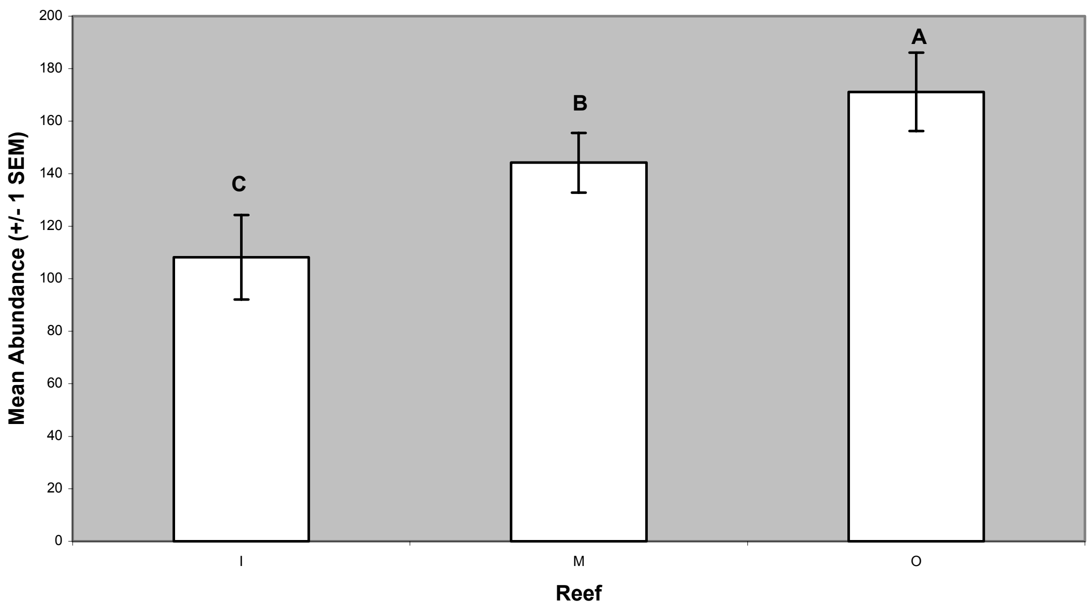


Figure 21. Mean (+/- 1 SEM) abundance for each reef tract. Different letters (A,B,C) indicate significantly different reefs (p<0.05, ANOVA, SNK).

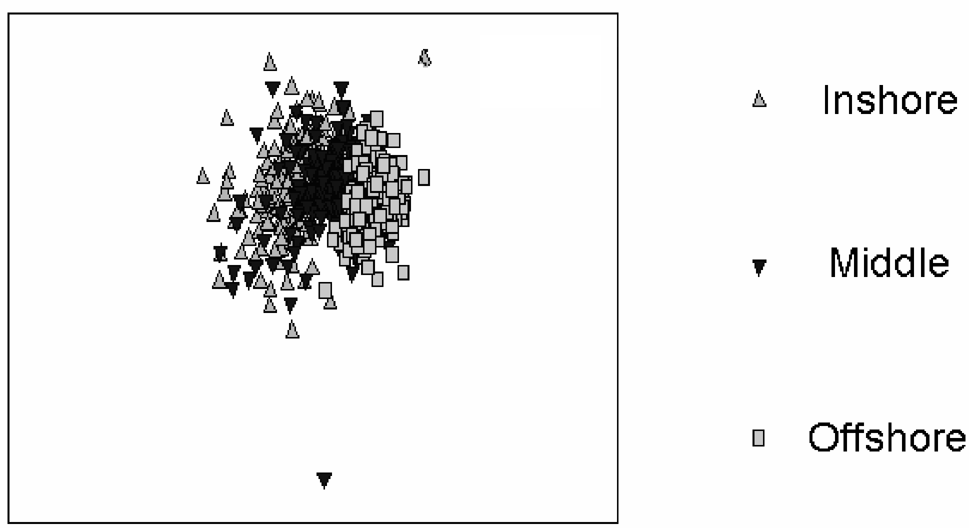


Figure 22. MDS plot of Bray-Curtis dissimilarity indices by reef tract.

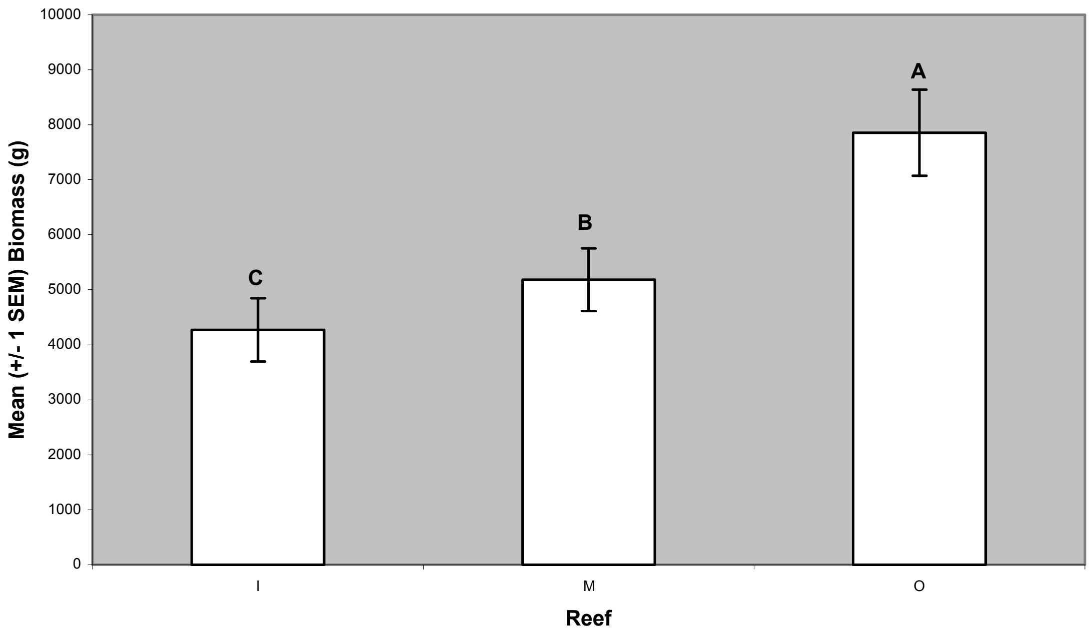


Figure 23. Mean biomass (+/- 1 SEM) per reef tract. Different letters (A,B,C) indicate significantly different means (p<0.05, ANOVA, SNK).

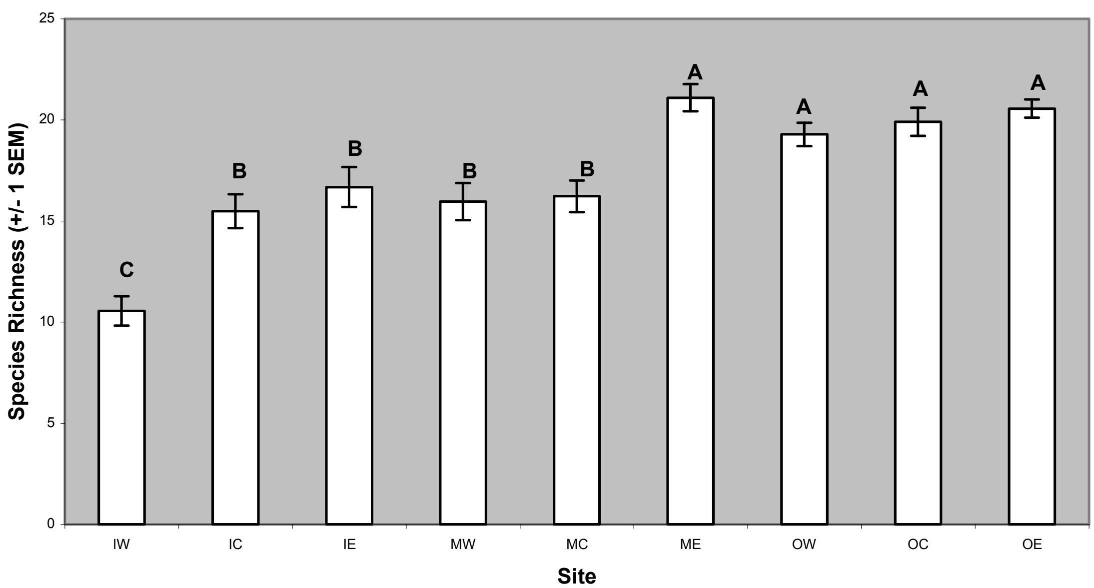


Figure 24. Mean (+/- 1 SEM) species richness per site of each reef tract. Different letters (A,B,C) indicate significantly different means (p<0.05, ANOVA, SNK). (IW=Inshore West, IC=Inshore Crest, IE=Inshore East, MW=Middle West, MC=Middle Crest, ME=Middle East, OW=Offshore West, OC=Offshore Crest, OE=Offshore East)

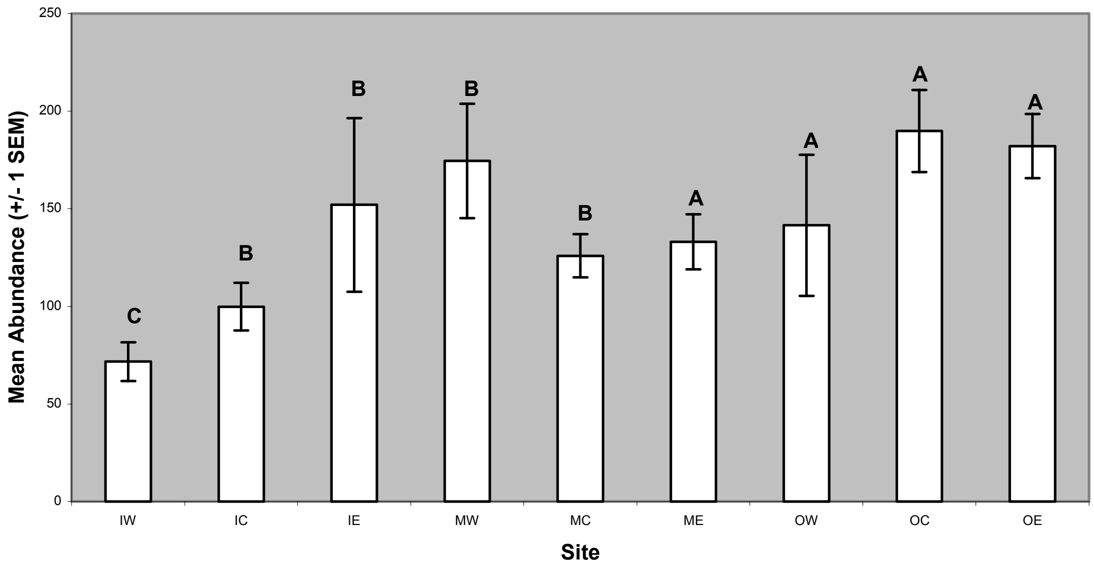


Figure 25. Mean (+/- 1 SEM) abundance per site of each reef tract. Different letters (A,B,C) indicate significantly different means (p<0.05, ANOVA, SNK). (IW=Inshore West, IC=Inshore Crest, IE=Inshore East, MW=Middle West, MC=Middle Crest, ME=Middle East, OW=Offshore West, OC=Offshore Crest, OE=Offshore East).

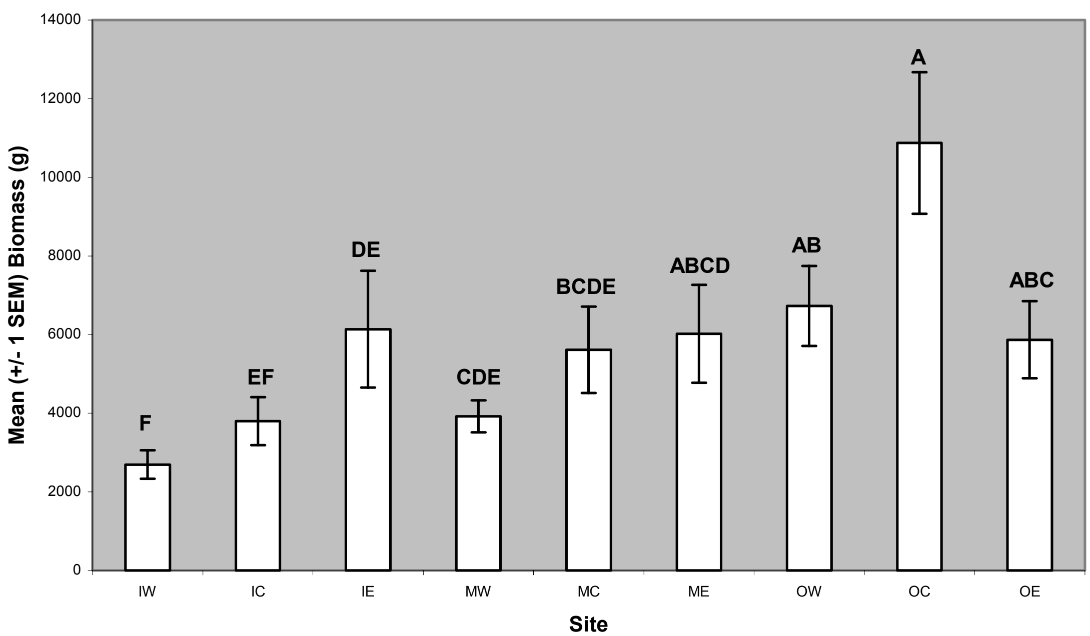


Figure 26. Mean biomass (+/- 1 SEM) per site of each reef tract. Different letters (A,B,C) indicate significantly different means (p<0.05, ANOVA, SNK). (IW=Inshore West, IC=Inshore Crest, IE=Inshore East, MW=Middle West, MC=Middle Crest, ME=Middle East, OW=Offshore West, OC=Offshore Crest, OE=Offshore East)

Fish assemblage structure was further analyzed using SIMPER analysis to show dissimilarity among reef tracts. SIMPER analysis allows a detailed breakdown of the top ten percent of the species that contributed to the differences among reefs or edges. For analyses, only those species contributing 3% or more to the difference between sites were used. The middle and offshore reefs had the lowest average dissimilarity, 66.75% (SIMPER) (Table 2). The species most important in separating the two reefs were: *Halichoeres bivitattus, Halichoeres garnoti*, and *Stegastes partitus*. The middle reef had a higher mean abundance of *H. bivitattus*, but a lower mean abundance of *H. garnoti* and *S. partitus*. The inshore and middle reefs had a slightly higher average dissimilarity of 73.62% (SIMPER) (Table 3). The species most important in separating these two reefs were, in descending order: *S. partitus, Thalassoma bifasciatum*, juvenile haemulids, and *Sparisoma aurofrenatum*. The middle reef had a higher mean abundance of *S. partitus, T. bifasciatum*, *and S. aurofrenatum,* but lower juvenile haemulid abundance than the inshore reef. Also, *Holocanthus tricolor* and *Chromis cyanea* were found on the middle reef, but not on the inshore reef. The largest difference was between the inshore and offshore reefs, with an average dissimilarity of 80.86% (SIMPER) (Table 4). The main species contributing to the difference in this case were *S. partitus, H. garnoti, H. bivitattus,* and *T. bifasciatum*. The offshore reef had a higher mean abundance of *S. partitus, H. garnoti*, and *T. bifasciatum*, and lower *H. bivitattus* than the inshore reef. It should also be noted that *H. tricolor, C. cyanea, Chromis insolata, Aluterus scriptus* and *Malacanthus plumieri* were found on the offshore reef but not the inshore reef and *Diplodus argenti* was found on the inshore reef but not on the offshore reef.

### 3.2.2. Abundance and Species Richness North and South of Port Everglades

Because the two Inlets along the coast of Broward County (Port Everglades and Hillsboro Inlet) provide a substantial outflow of freshwater and anthropogenic effluent onto the reef tracts, transects north and south of the Inlets were examined to see if there were differences in fish assemblages. To evaluate location north and south of Port Everglades, 20 transects directly south and twenty transects north of Port Everglades were used. Sites located along transects north had significantly higher species richness and abundance ($p<0.05$, ANOVA) than those south of the Port (Figures 27 & 28). Individual reef tracts did not differ significantly north or south of Port Everglades, but when evaluated, there were differences among edges. The inshore west edge displayed significant clustering ($p<0.01$, ANOSIM) when comparing south versus north of the Port (Figure 29), as did the middle east edge (Figure 30) and the offshore east edge (Figure 31). A similar separation was not noted among other reef tract edges north and south of Port Everglades.

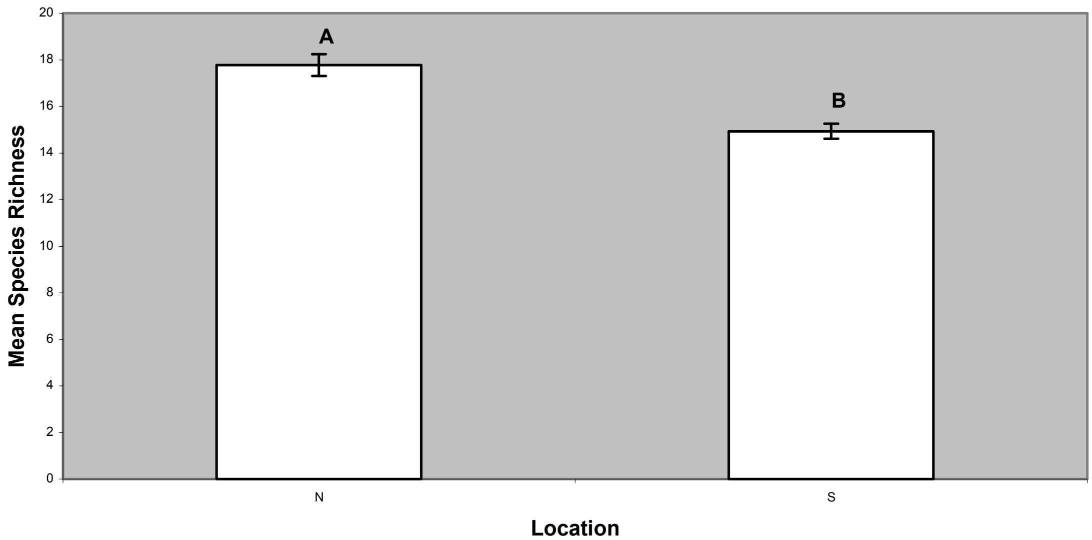


Figure 27. Mean (+/- 1 SEM) species richness in 20 transects north and south of Port Everglades for all reef tracts combined. Different letters (A,B) above each location indicate significantly different means ($p<0.05$, ANOVA).

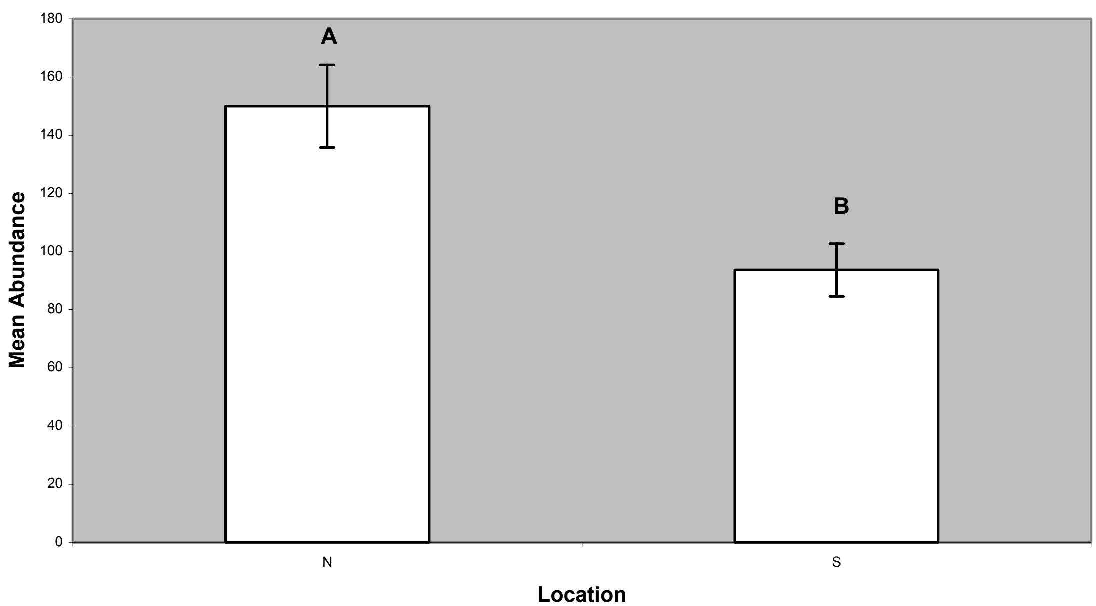


Figure 28. Mean (+/- 1 SEM) abundance north and south of Port Everglades for all reef tracts combined. Different letters (A,B) above each location indicate significantly different means ($p<0.05$, ANOVA).

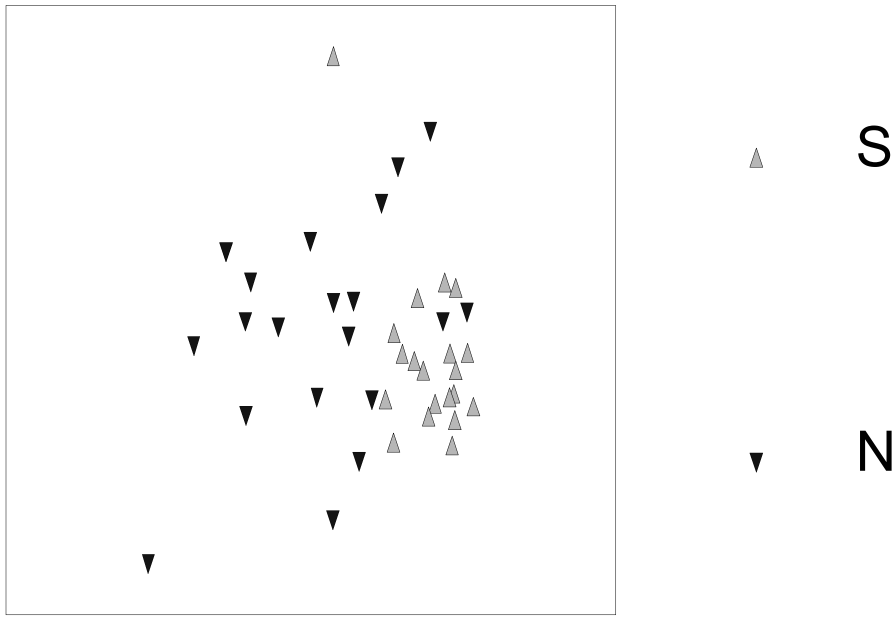


Figure 29. MDS plot of the Bray-Curtis dissimilarity indices of the inshore reef west edge north and south of Port Everglades ($p<0.01$, ANOSIM).

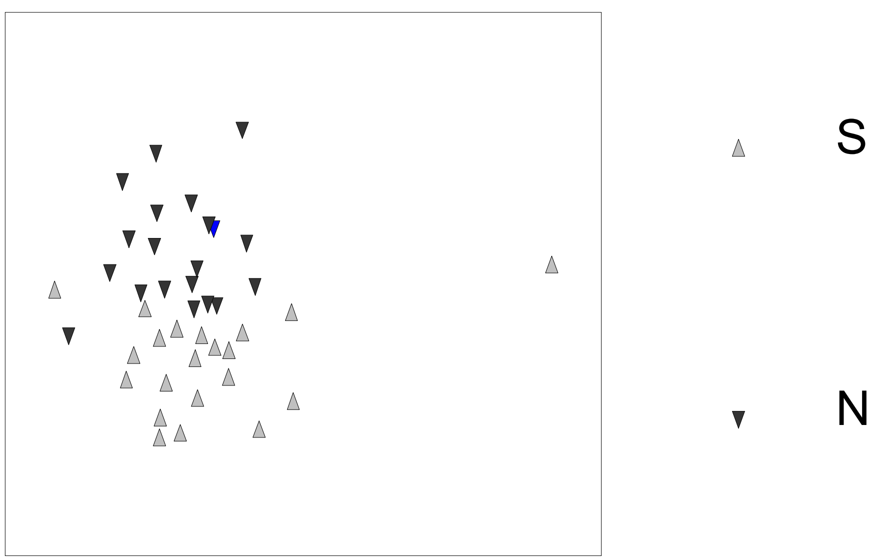


Figure 30. MDS plot of Bray-Curtis dissimilarity indices of the middle reef east edge north and south of Port Everglades ($p<0.01$, ANOSIM).

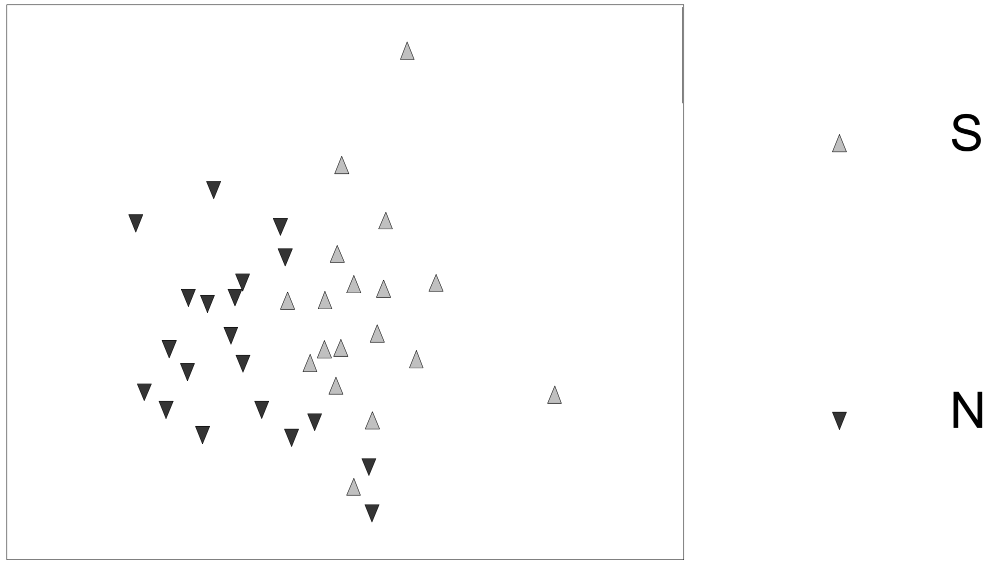


Figure 31. MDS plot of the Bray-Curtis dissimilarity indices of the offshore reef east edge north and south of Port Everglades ($p<0.01$, ANOSIM).

### 3.2.3. Fish Assemblages Relating to Port Everglades

Although ANOVA analyses indicated differences between reefs north and south of Port Everglades, an MDS plot did not show significant clustering. However, once broken down by reef edge, the MDS plots of the offshore east, middle east and inshore west edges did show clustering. The north and south offshore east groups had an average dissimilarity of 74.26% (SIMPER) (Table 5). The species most important to the difference between north and south were: *Coryphopterus personatus, S. partitus, T. bifasciatum, H. garnoti, C. insolata, Clepticus parra, Serranus tortugarum*, and *Chromis scotti*. North count sites had higher mean abundances of all of these listed species. *C. scotti,* and *Sparisoma atomarium* were found exclusively on the north count site locations while *Ioglossus calliurus* was found exclusively on the south count site locations. The next site that displayed significant clustering was the middle reef east edge. The north and south count site locations had an average dissimilarity of 74.26% (SIMPER) (Table 6). The main species responsible for this difference were: *T. bifasciatum, C. personatus, S. partitus, H. garnoti, S. tortugarum*, *Harengula jaguana, Acanthurus bahianus,* and *S. aurofrenatum*. The north sites had higher mean abundance of *T. bifasciatum, C. personatus, S. partitus, H. garnoti,* and *S. tortugarum*. The south sites had higher mean abundance of *Harengula jaguana, A. bahianus,* and *S. aurofrenatum. Crysopterum roseus, Epinephelus morio,* and *Anisotremus virginicus* were not found at all on the south sites. *H. jaguana* was not found on the north sites. The last site that showed significant clustering was the inshore west edge. The north and south count site locations had an average dissimilarity of 85.63%, which is the highest dissimilarity value for all of the

sites in this section (Table 7). The species most important to the dissimilarity in this case were juvenile haemulids, *Haemulon flavolineatum, A. bahianus, T. bifasciatum, H. bivitattus*, and *Haemulon plumieri*. In this case, the south sites had higher mean abundance values for all the listed species except juvenile haemulids. Species found exclusively on the south sites were *Scarus taenopterus, Stegastes planifrons*, and *C. personatus,* and *S. tortugarum*. *Pempheris schomburgki* was exclusively found on the north sites.

### 3.2.4. Abundance and Species Richness North and South of Hillsboro Inlet

At Hillsboro Inlet, 15 transects directly north and south of the Inlet for comparison were used, rather than 20 like at Port Everglades. Sites north of Hillsboro Inlet also had significantly higher species richness and abundance than those south of the Inlet (Figures 32 & 33). However, contrary to the Port, the middle reef showed significant clustering on an MDS plot north and south of the Inlet (p<0.01, ANOSIM) (Figure 34), and significant differences in abundance were also found by parametric analysis of abundance (p<0.05, ANOVA) (Figure 35). Differences were also determined by edge in relation to the Inlet. The inshore crest showed significant clustering (p<0.01, ANOSIM) (Figure 36) and had significantly higher mean abundances north of the Inlet (p<0.05, ANOVA) (Figure 37), as did the middle crest (Figures 38 & 39), and middle west edge (Figures 40 & 41). North and south comparisons of other reef tract edges did not differ (p>0.05, ANOVA).

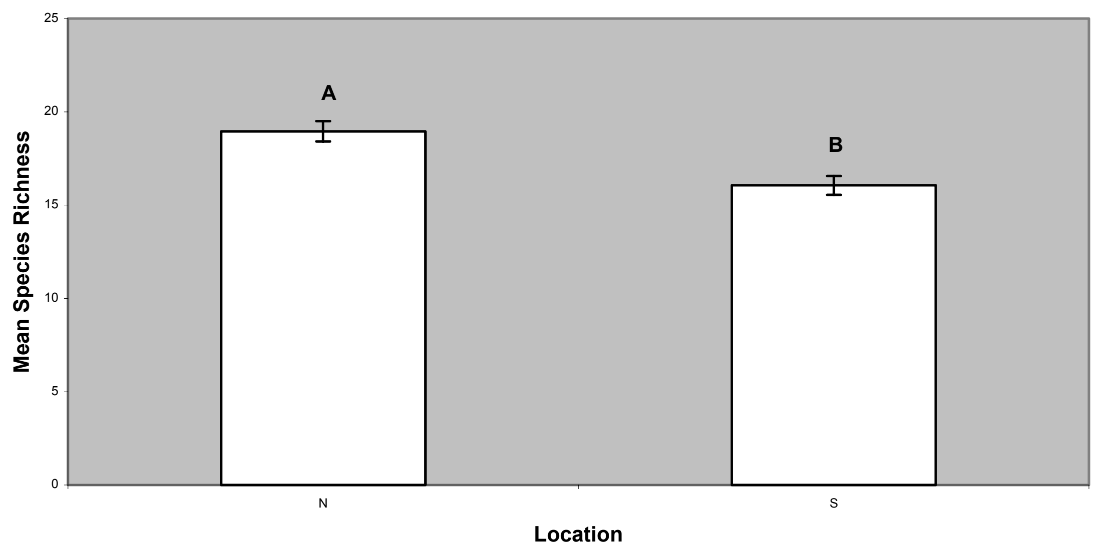


Figure 32. Mean (+/- 1 SEM) species richness for 15 transects north and south of Hillsboro Inlet. Different letters (A,B) above each location indicate significantly different means (p<0.05, ANOVA).

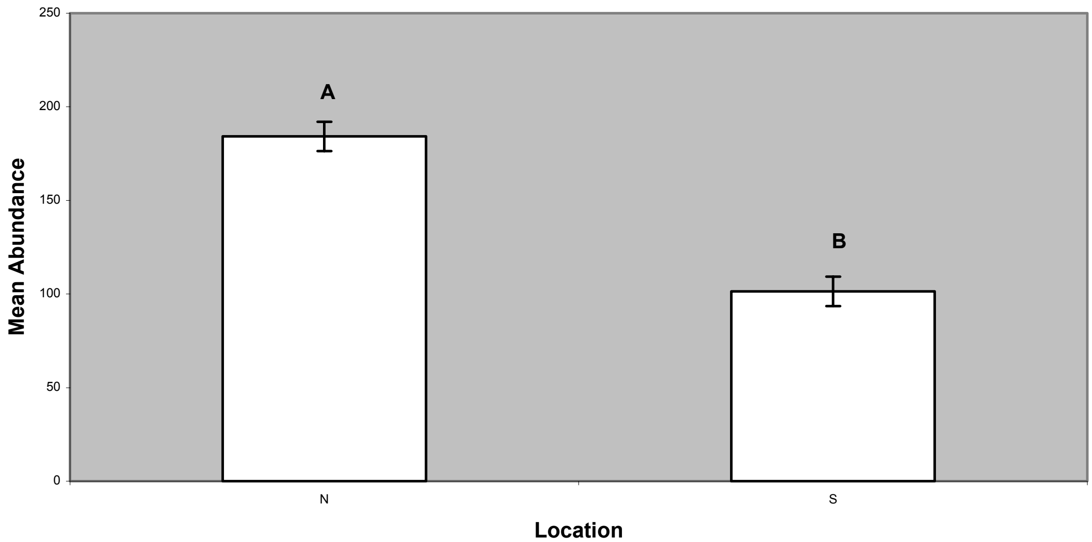


Figure 33. Mean (+/- 1 SEM) abundance for 15 transects north and south of Hillsboro Inlet. Different letters (A,B) above each location indicate significantly different means (p<0.05, ANOVA).

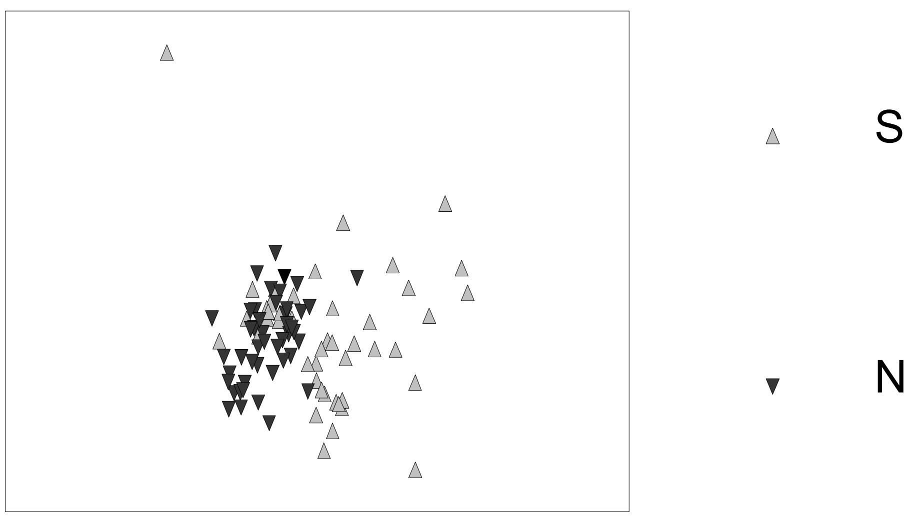


Figure 34. MDS plot of the Bray-Curtis dissimilarity indices of the middle reef north and south of Hillsboro Inlet (p<0.01, ANOSIM).

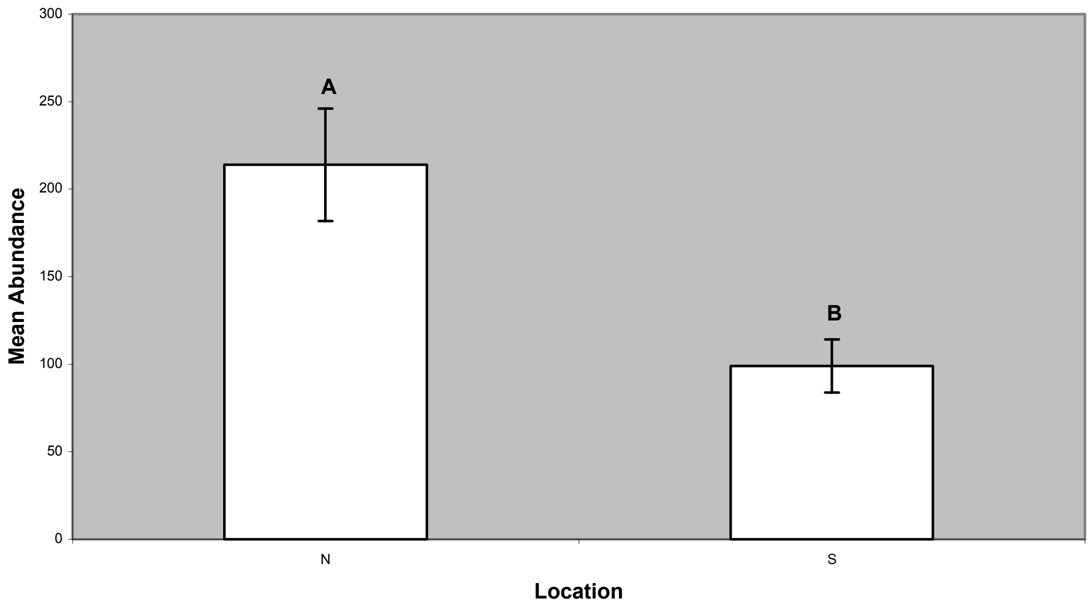


Figure 35. Mean (+/- 1 SEM) abundance of the middle reef north and south of Hillsboro Inlet. Different letters (A,B) above each location indicate significantly different means (p<0.05, ANOVA).

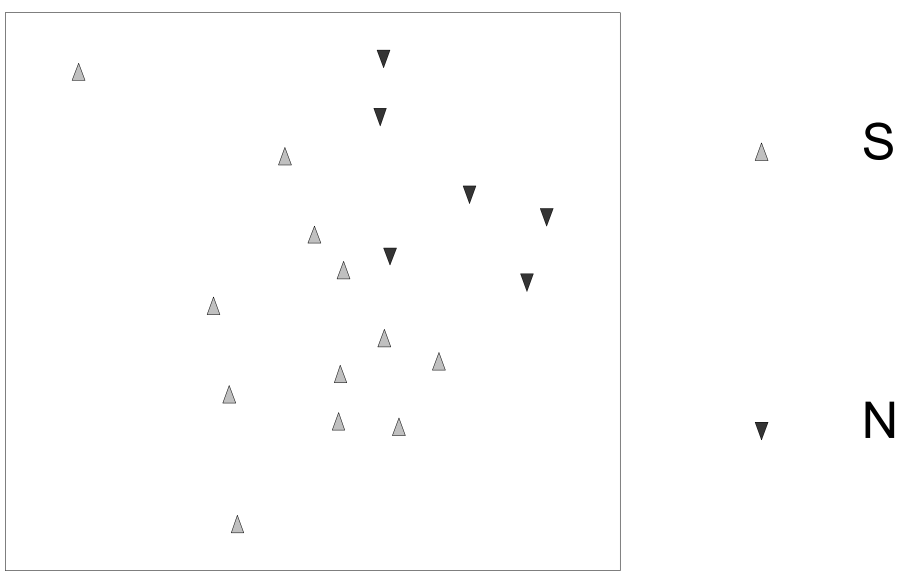


Figure 36. MDS plot of the Bray-Curtis dissimilarity indices of the inshore reef crest north and south of Hillsboro Inlet (p<0.01, ANOSIM).

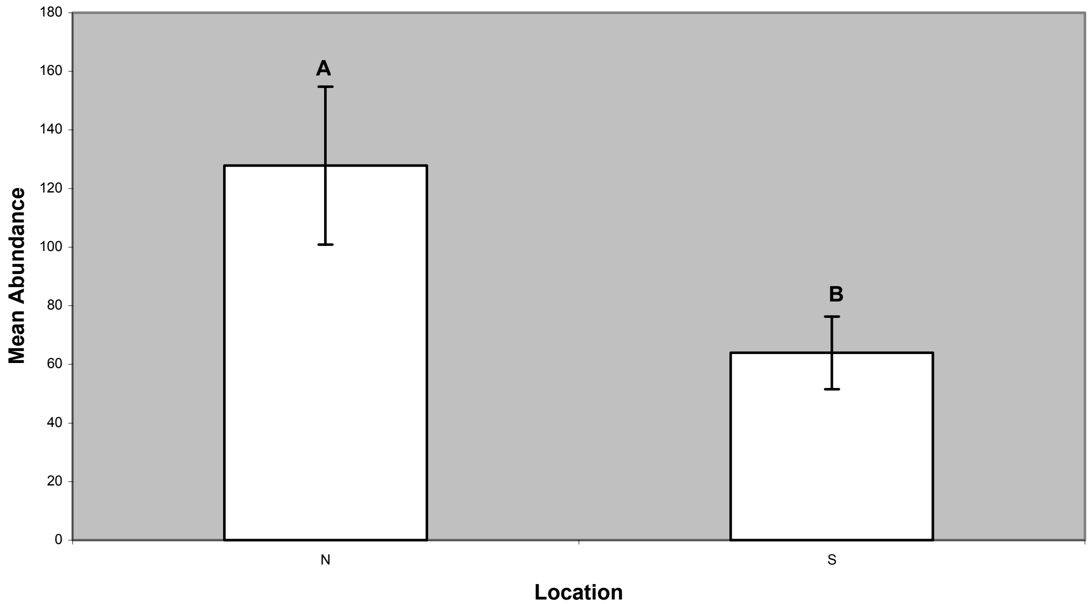


Figure 37. Mean (+/- 1 SEM) abundance of the inshore reef crest for 15 transects north and south of Hillsboro Inlet. Different letters (A,B) above each location indicate significantly different means (p<0.05, ANOVA).

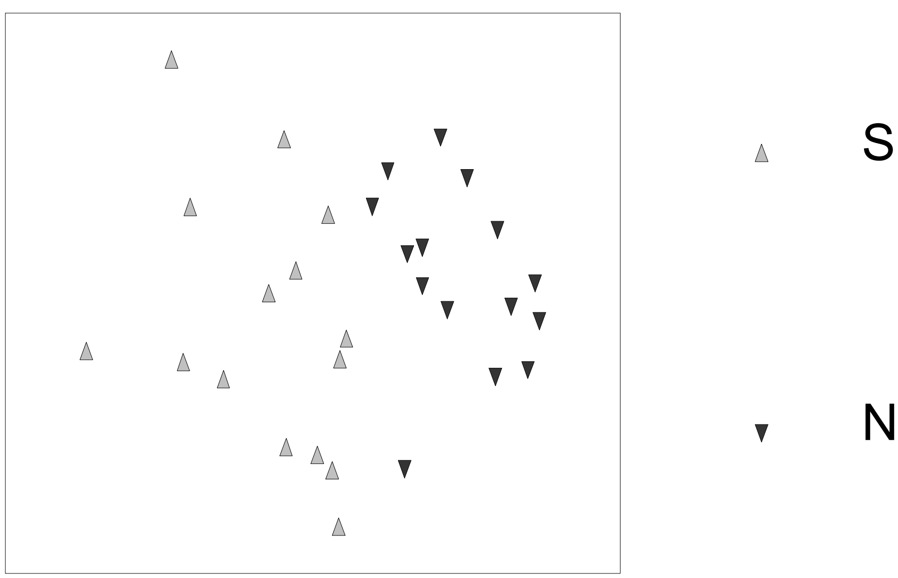


Figure 38. MDS plot of the Bray-Curtis dissimilarity indices of the middle reef crest north and south of Hillsboro Inlet (p<0.05, ANOSIM).

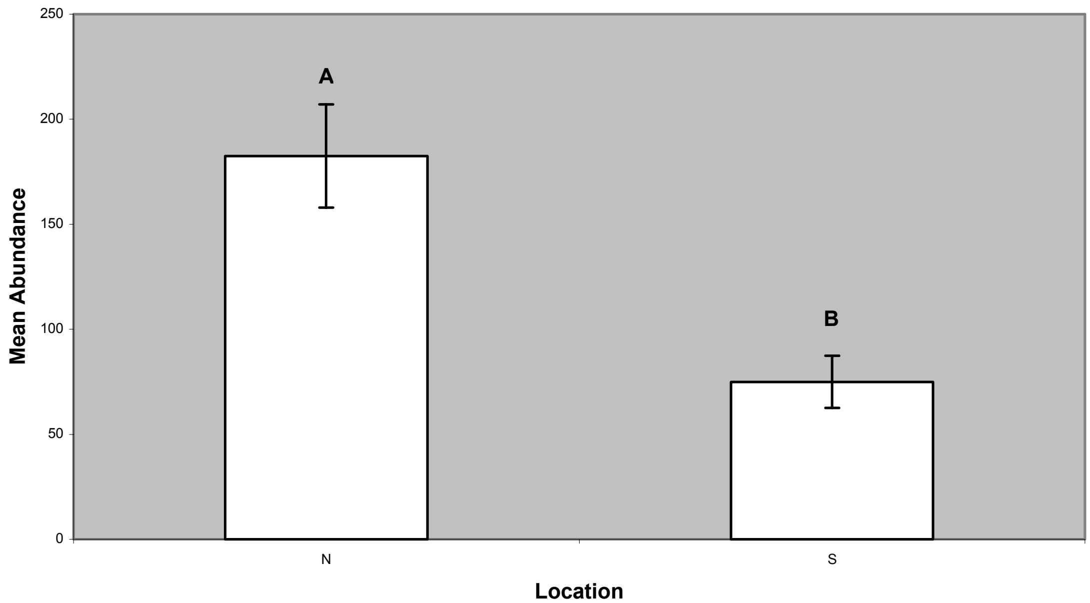


Figure 39. Mean (+/- 1 SEM) abundance of the middle reef crest for 15 transects north and south of Hillsboro Inlet. Different letters (A,B) above each location indicate significantly different means (p<0.05, ANOVA).

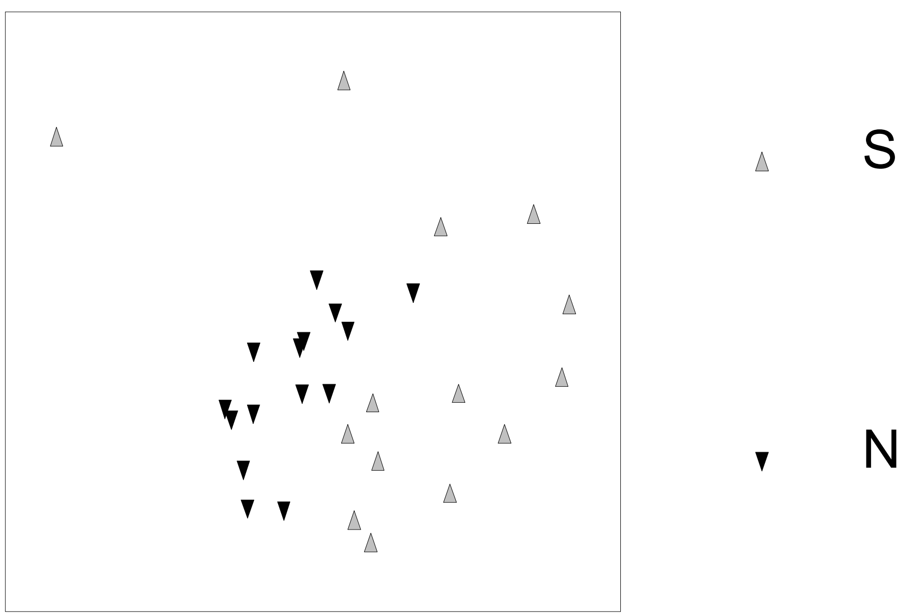


Figure 40. MDS plot of the Bray-Curtis dissimilarity indices of the Middle West Edge north and south of Hillsboro Inlet (p<0.05, ANOSIM).

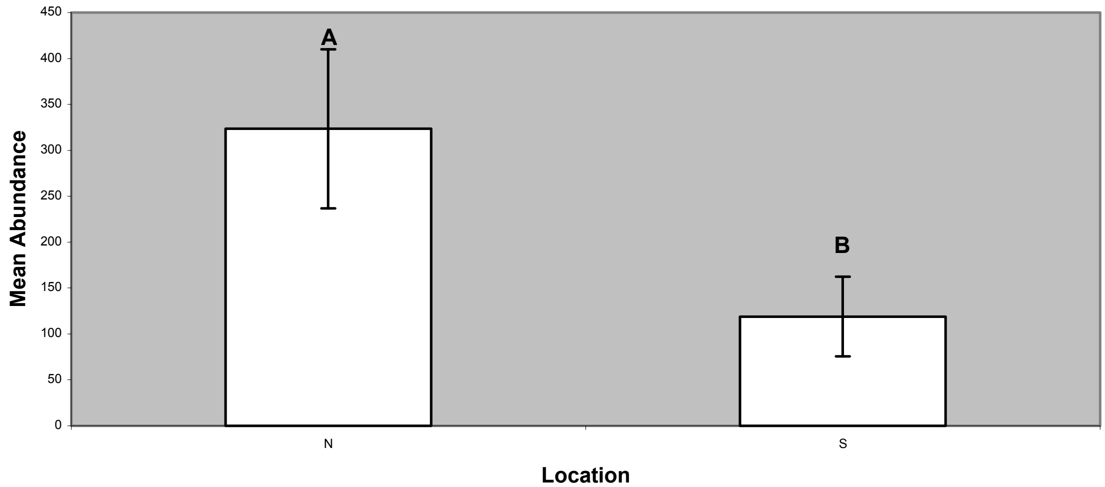


Figure 41. Mean (+/- 1 SEM) abundance of the middle reef west edge north and south of Hillsboro Inlet. Different letters (A,B) above each location indicate significantly different means ($p<0.05$, ANOVA).

### 3.2.5. Fish Assemblages Around Hillsboro Inlet

At Hillsboro Inlet, significant differences ($p<0.05$, ANOVA) were found between north and south site locations in species richness and abundance. The MDS plot of total reefs north and south of the Inlet showed significant clustering. The north and south groups had an average dissimilarity of 79.33% (Table 8). The species or species group (i.e. juvenile haemulids) most important to the difference between north and south groups were: *S. partitus, T. bifasciatum,* juvenile haemulids, *H. garnoti, C. personatus, A. bahianus, H. bivitattus,* and *C. parra*. The north count site locations had higher mean abundance of all listed species except *H. bivitattus*. Unlike the sites north and south of Port Everglades, the middle reef displayed significant clustering in an MDS plot. The middle reefs north and south of the Inlet had an average dissimilarity of 79.36% (Table 9). The species most important to the difference between north and south reefs were: juvenile haemulids, *S. partitus, T. bifasciatum, C. personatus, H. garnoti, H. bivitattus,* and *A. bahianus*. Once again, the north middle reef had higher mean abundance for all of the listed species, except *H. bivitattus* and *A. bahianus*. Also, *C. parra* and *Chromis multilineatum* were found exclusively on the north middle reef. Only *Kyphosus sectatrix* was found exclusively on the south middle reef.

The north and south differences were also found among reef edges. The middle west edge showed significant clustering when comparing north and south of the inlet. The average dissimilarity of these count site locations was high, with a value of 88.95% (Table 10). Species contributing to this difference were juvenile haemulids, *S. partitus, T. bifasciatum, C. personatus, H. garnoti*, and *A. bahianus*. For all listed species, the north sites had higher mean abundance. Also, the north had five species that were not observed on the south sites: *C. personatus, C. parra, S. atomarium, Opistognathus*

*aurifrons, and Chromis multilineata*. The middle crest also showed significant clustering, with an average dissimilarity of 79.78% (Table 11). The top species responsible for this difference were: *S. partitus, T. bifasciatum, H. bivitattus, H. flavolineatum, C. multilineata, C. parra, H. garnoti, S. aurolineatum, Haemulon aurolineatum, K. sectatrix,* and *A. bahianus*. The north had higher mean abundance of all listed species, with the exception of *H. bivitattus, K. sectatrix,* and *A. bahianus*. It should also be noted that the north had six species that were not observed on the southern sites: *C. multilineata, C. parra, H. aurolineatum,* juvenile haemulids*, C. personatus,* and *Serranus tigrinus*. Species found exclusively on the south sites were *K. sectatrix, D. argenti*, and *Haemulon chrysopterum*. Finally, the inshore crest showed significant clustering south versus north of the inlet, with an average dissimilarity of 81.40% (Table 12). The most important species in this difference were *Caranx crysos, T. bifasciatum, H. bivitattus, A. bahianus, Abudefduf saxatilis,* juvenile haemulids, *Haemulon sciurius*, and *K. sectatrix*. The north had higher mean abundance than the south for all species listed, except for *H. bivitattus*. Those species found exclusively on the north reef sites were *C. crysos,* juvenile haemulids, *Lutjanus griseus, H. aurolineatum, Selar crumenophthalmus*, and *H. chrysopterum*. Only *Halichoeres maculatus* was found exclusively on the south sites.

## 3.2.6. Total Fish Abundance and Species Richness North to South

Since, in both comparisons around the inlets, there were higher abundance and species richness to the north, we ran a simple regression of all site locations total from south to north. Surprisingly, species richness did not show a trend from south to north ($R^2$=0.0087) (Figure 42), but abundance displayed a slight positive regression ($R^2$=0.0215) (Figure 43).

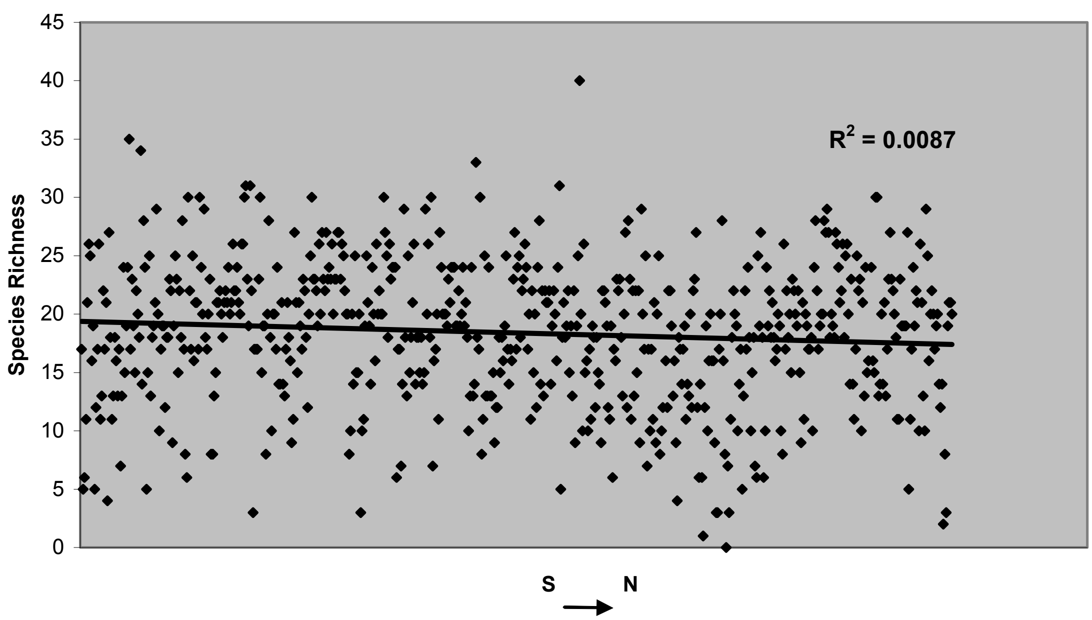


Figure 42. South to north regression of species richness for Broward County.

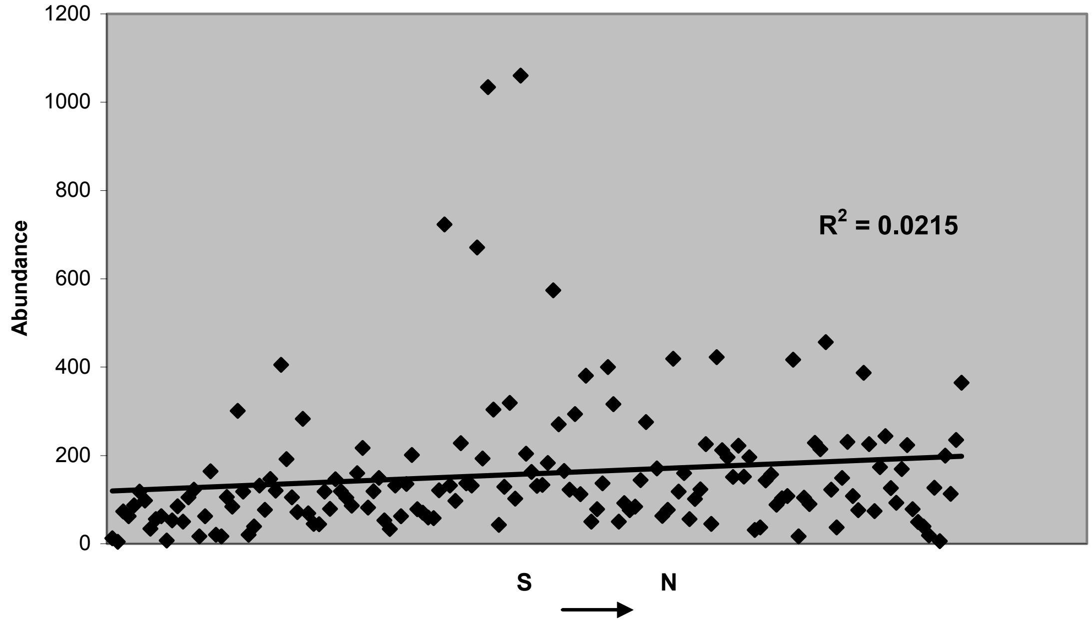


Figure 43. South to north regression of abundance for Broward County.

### 3.2.7. Environmental Factors

The influence of specific environmental variables on species richness and abundance was examined using regression analysis. Both species richness and abundance displayed weak positive relationships against rugosity ($R^2$=0.1521 and 0.1382, respectively) (Figures 44 & 45). Abundance, however, displayed an interesting upper limit with rugosity, around 485 and 490, with only 15 counts exceeding this number regardless of the amount of rugosity. Coral cover had no relationship with species richness ($p>0.05$), but had a slight positive relationship with abundance ($R^2$=0.029) (Figure 46). Species richness had a positive relationship with depth ($R^2$=0.2023), and abundance had a weaker positive relationship ($R^2$=0.0151) (Figures 47 & 48), but again abundance appeared to top out around 500 individuals per count with only 9 counts exceeding this number. The strongest regressions found were between elevation and species richness and abundance. Species richness had an $R^2$ value of 0.268 against elevation, and abundance had an $R^2$ value of 0.0698 (Figures 49 & 50).

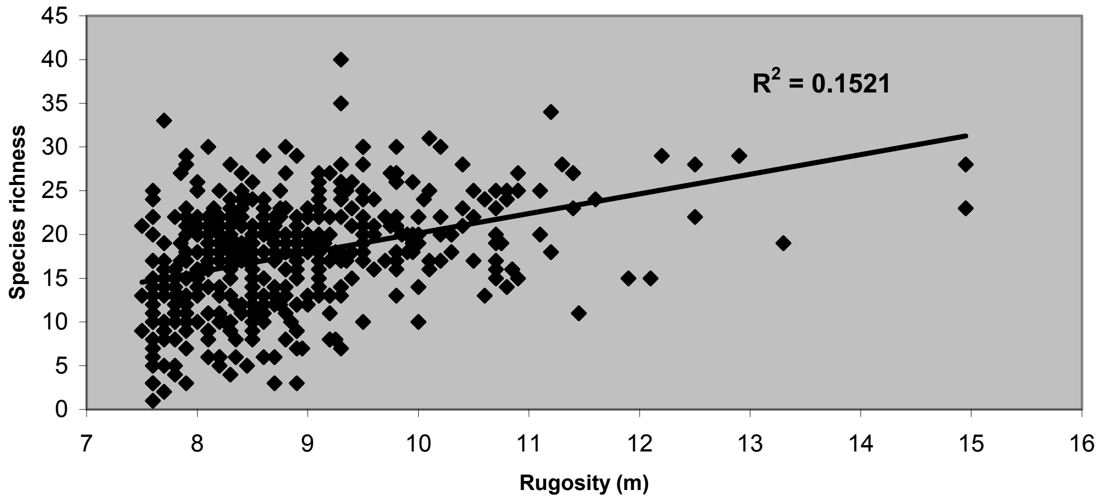


Figure 44. Regression of species richness on rugosity.

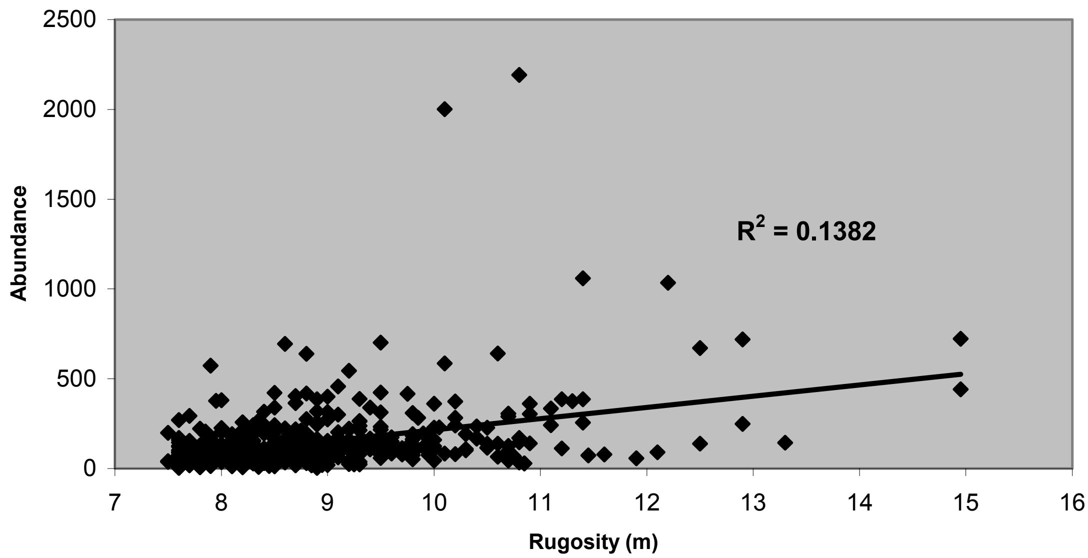


Figure 45. Regression of abundance on rugosity.

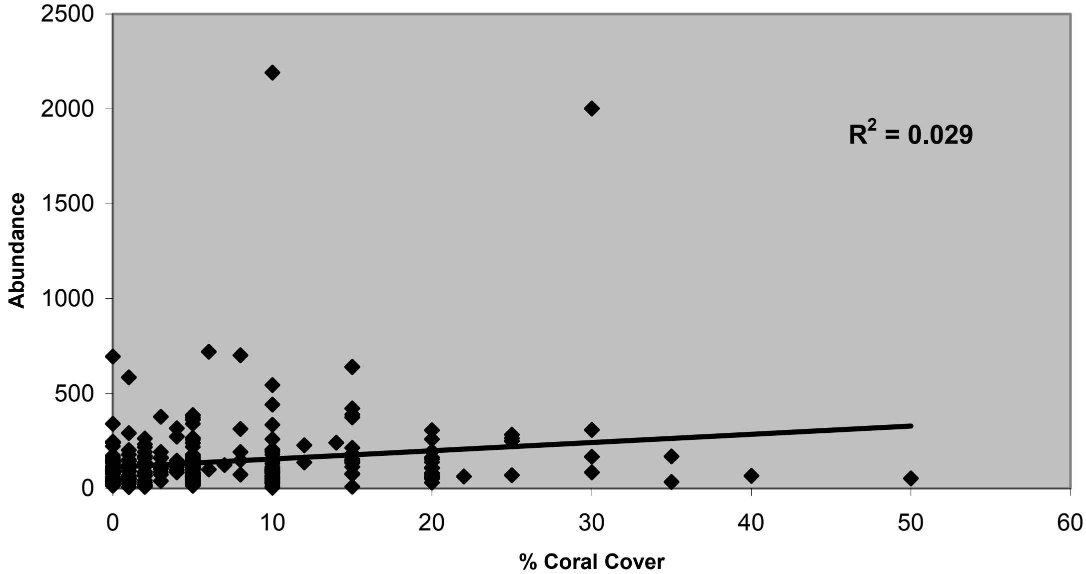


Figure 46. Regression of abundance on coral cover.

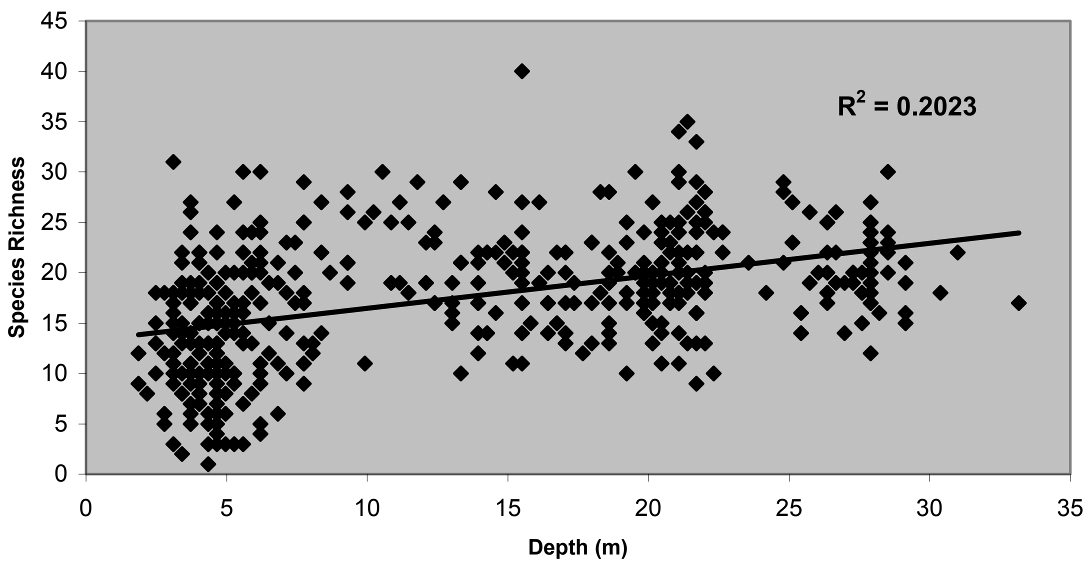


Figure 47. Regression of species richness on depth.

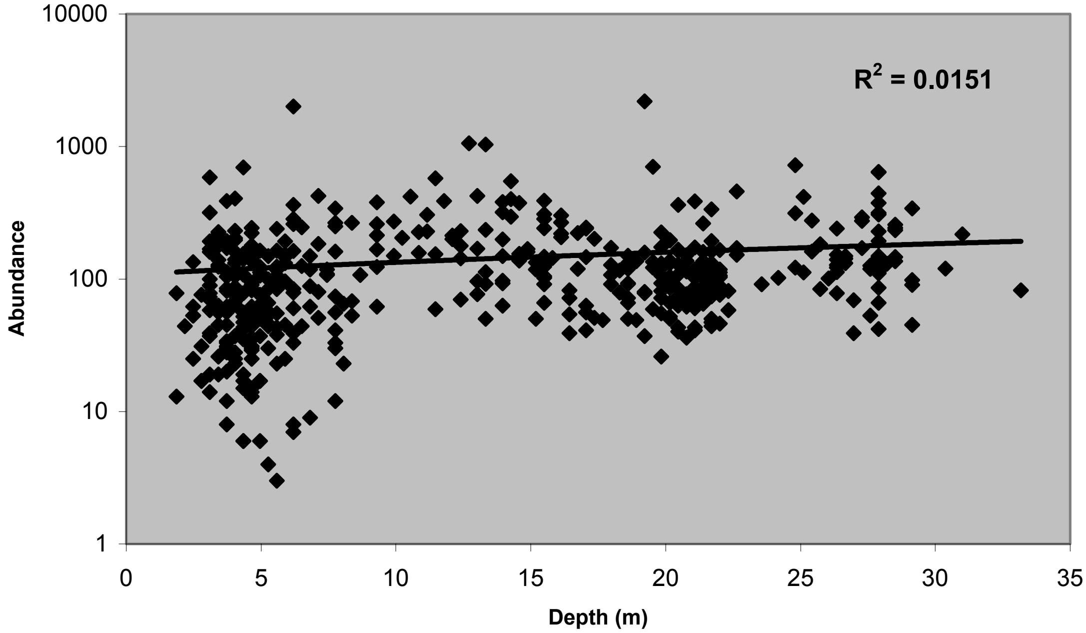


Figure 48. Regression of abundance on depth.

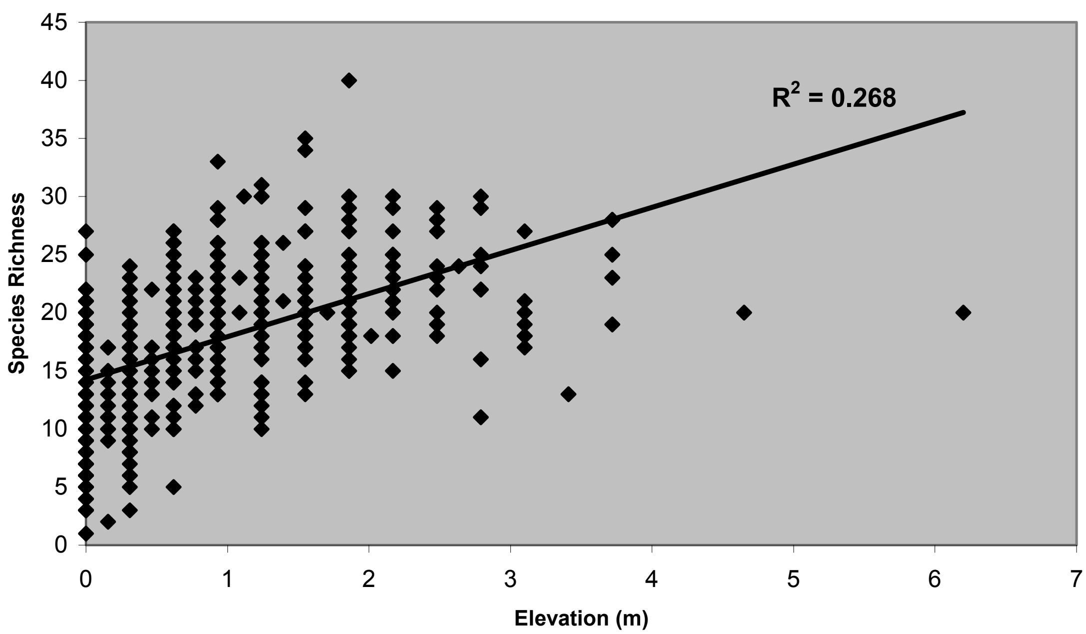


Figure 49. Regression of species richness on elevation.

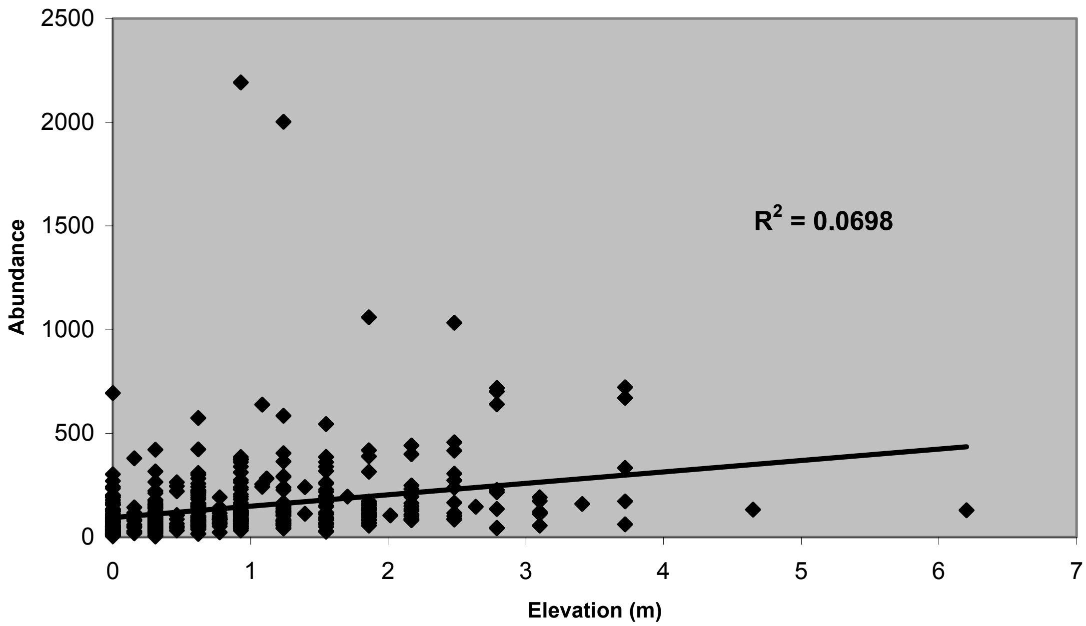


Figure 50. Regression of abundance on elevation.

### 3.2.8. Juvenile Haemulidae

Juvenile haemulid data were examined due to their noticeable abundance on the reefs. For ease in comparison, only those fish ≤ 5cm were analyzed. The inshore reef had 6,795 total fish ≤5cm, of which 4830 were juvenile haemulids, the middle reef had 9,041 total fish ≤5cm, of which 3735 were juvenile haemulids, and the offshore reef had 8,924 total fish ≤5cm, of which 2140 were juvenile haemulids. Data for juvenile haemulids on the offshore reef were heavily skewed due to a one-time count of 2000 (which occurred in April); that data point was removed for a more representative analysis. The offshore reef tract had significantly fewer ($p<0.05$, ANOVA, SNK) juvenile haemulids than the middle or offshore reef tracts (Figure 51). When all three reef tracts were grouped together, Haemulidae ≤ 5cm dominated the fishes, comprising 72% of the total fishes ≤ 5cm (Figure 52). Also, there was an inverse relationship between juvenile haemulids and *S. partitus* (Figure 53).

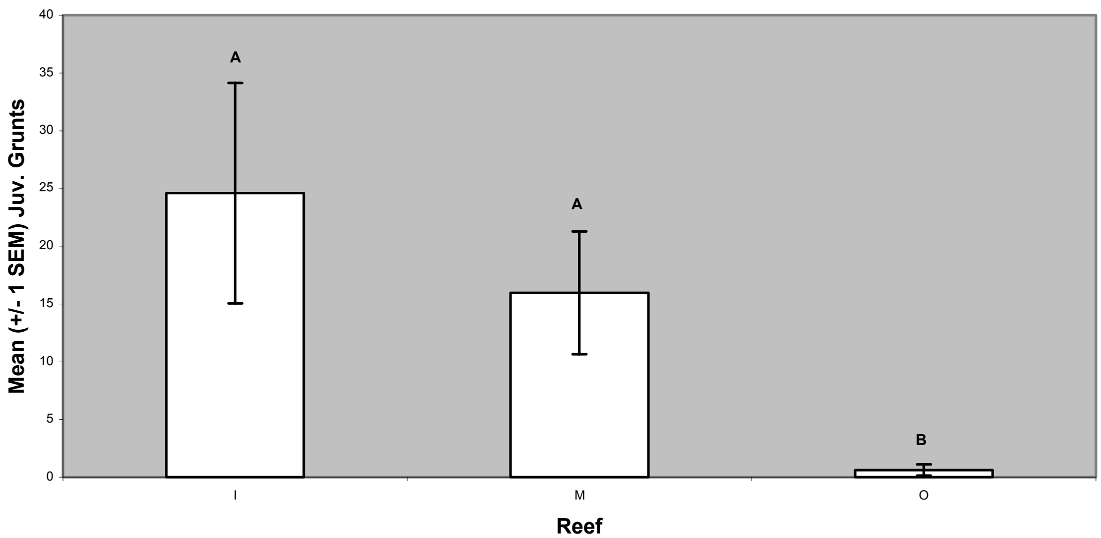


Figure 51. Mean (+/- 1 SEM) juvenile haemulids (<5cm) by reef. Different letters (A, B) indicate significantly different means.

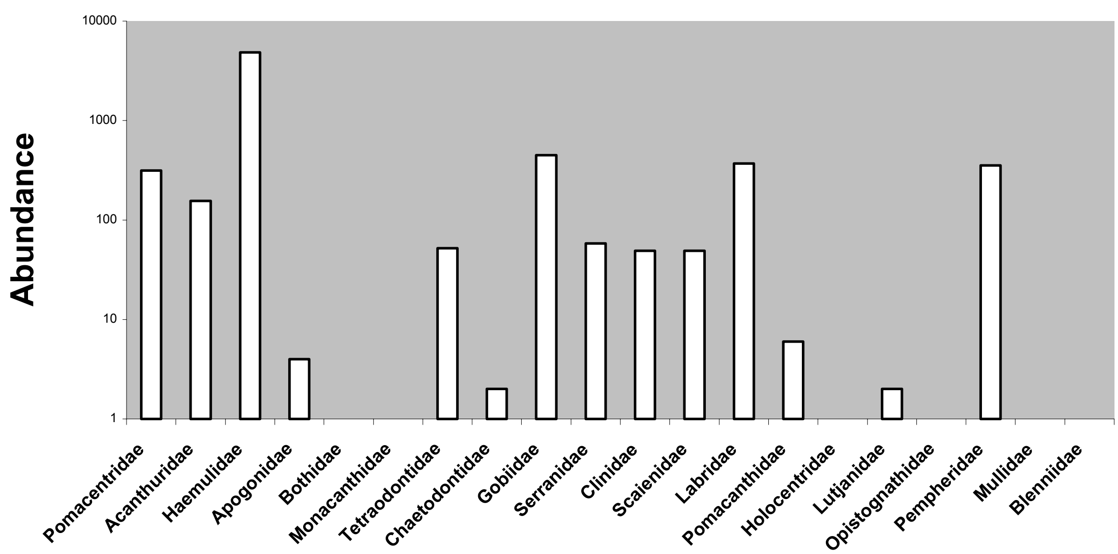


Figure 52. Total juvenile fishes (≤ 5cm) for all reef tracts combined by family (n=24,760).

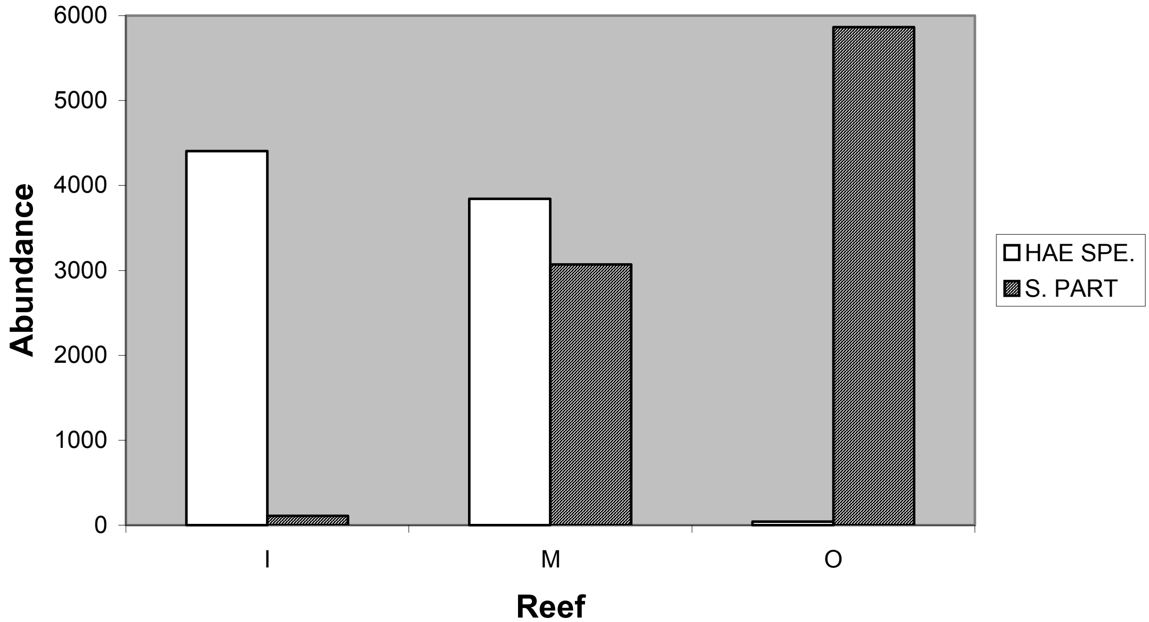


Figure 53. Total abundance of juvenile haemulids and *S. partitus* by reef.

## 3.2.9. Serranidae

Groupers were also evaluated separately due to their recreational and commercial importance. We counted 383 groupers on the three reefs: 87 on the inshore reef, 158 on the middle reef, and 148 on the offshore reef. *Cephalopolis cruentatus* and *Epinephelus morio* were the most common groupers observed. Ten to twenty cm was the most abundant size class for *E. cruentatus* (Figure 54), and 20- 30cm was the most abundant size class for *E. morio* (Figure 55). Four out of the eight grouper species observed have legal catch size limits in Florida (50.8cm), *E. morio, Mycteroperca interstitialis, M. phenax, and M. venenosa* (http://marinefisheries.org/Regulations/1-03englishregulations chart.pdf). Of the 242 fish within this group, only 2 were legal size (Table 13). One legal sized grouper was found on the inshore reef, and the other on the middle reef. When total groupers were plotted against depth, there was, however, a slight positive relationship between groupers and water depth ($R^2$=0.0225) (Figure 56). When total groupers were plotted against elevation, a slightly stronger relationship was found ($R^2$= 0.0432) (Figure 57).

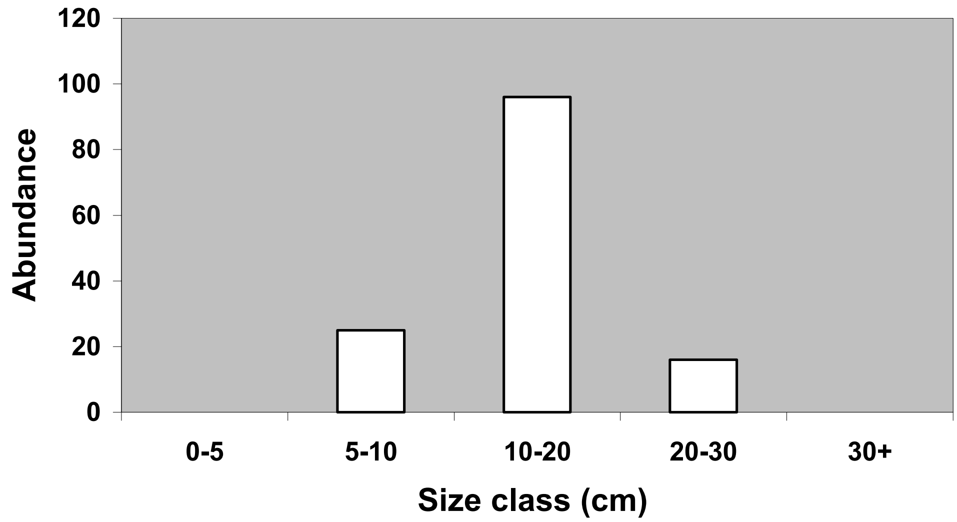


Figure 54. Size distribution (cm) of *Cepalopholis cruentatus* (n=127).

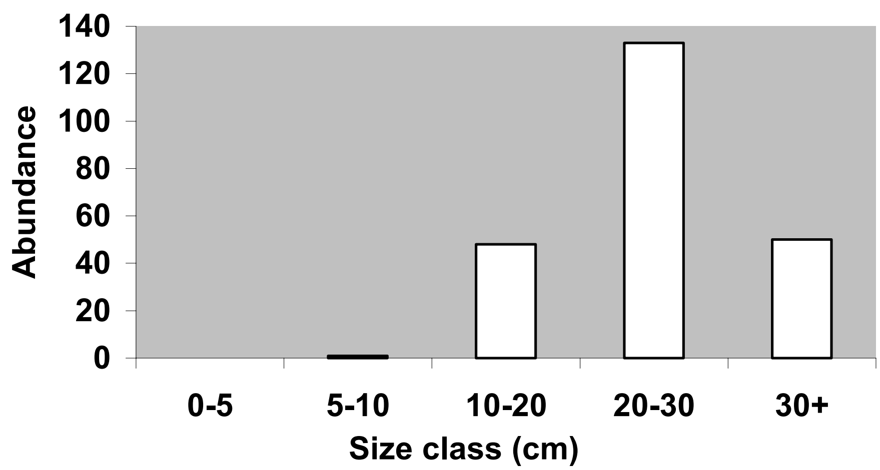


Figure 55. Size distribution (cm) of *Epinephelus morio* (n=232).

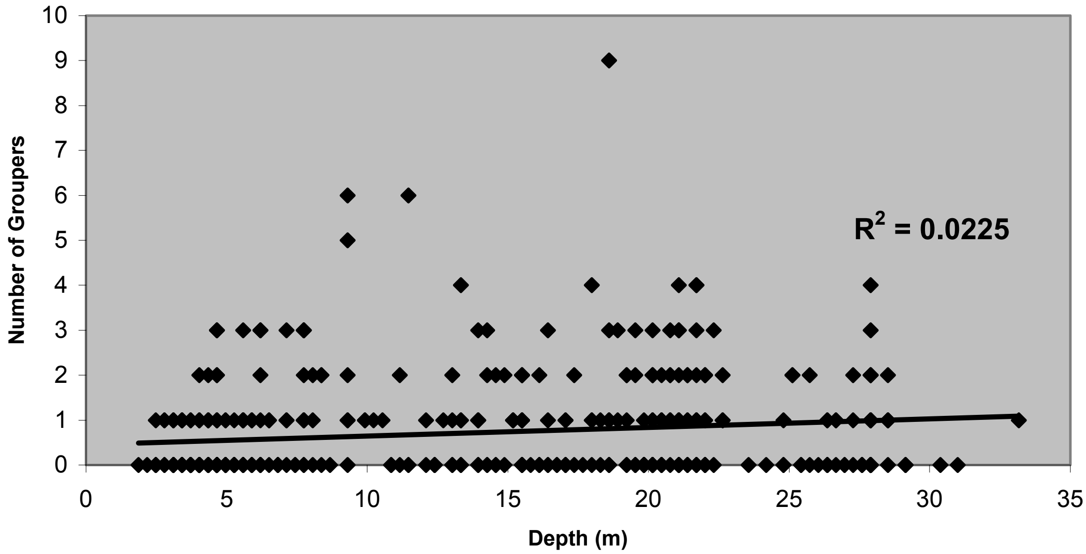


Figure 56. Regression of grouper abundance on depth.

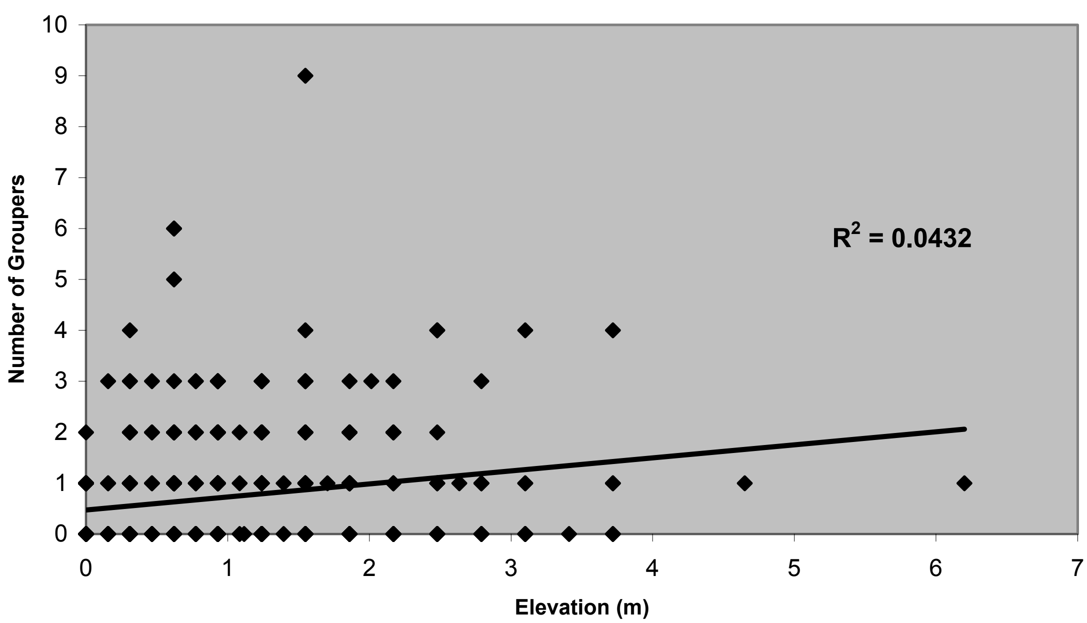


Figure 57. Regression of grouper abundance on elevation.

## 3.2.10. Lutjanidae

Snappers are another commercially and recreationally important family in southern Florida. A total of 718 snappers was counted on the three reefs: 294 on the inshore reef, 256 on the middle reef, and 168 on the offshore reef. There was no significant difference in total snappers between the reefs. The most abundant snapper species were *Ocyrus chrysurus* and *Lutjanus griseus*. The most abundant size class for *O. chrysurus* (Figure 58) and *L. griseus* (Figure 59) was 10-20 cm. Of the 718 snappers counted, 219 were of legal size, which ranges from 20.3- 40.6cm depending on the species (Table 14). The most abundant legal size snapper species were *L. griseus* and *Lutjanus synagris.* Eighty-one of the legal-sized snappers were found on the inshore reef, 27 on the middle reef, and 90 on the offshore reef. No relationship was found between snapper abundance and depth (R=0.0057, p>0.05), but a slightly positive regression was found between snappers and elevation ($R^2$= 0.0117) (Figures 56 & 57).

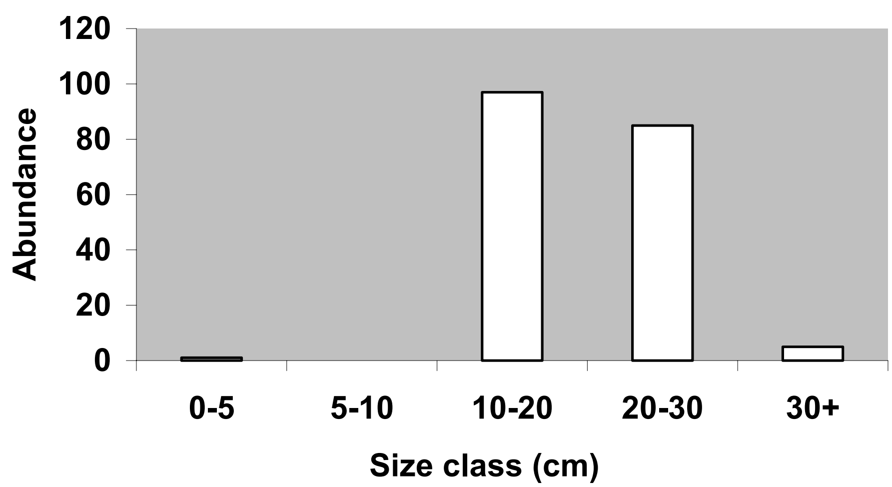


Figure 58. Size distribution (cm) of *Ocyrus chrysurus* (n=312).

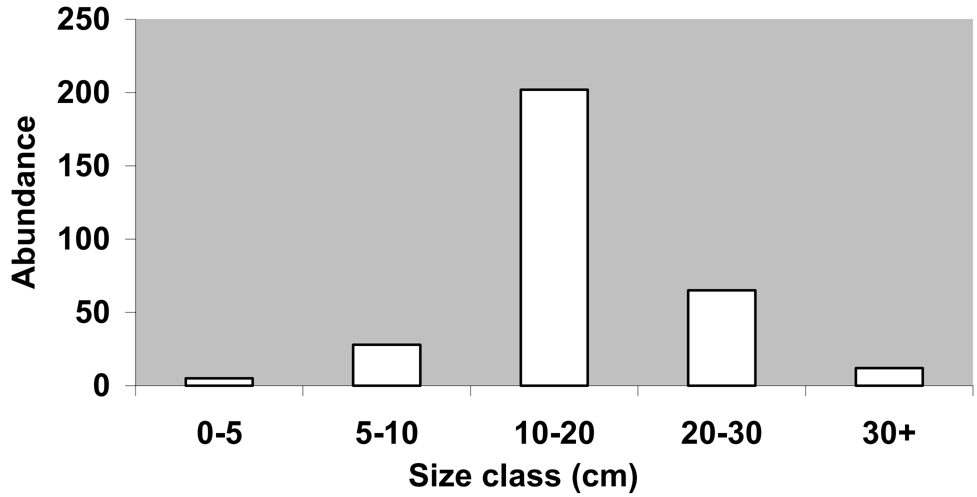


Figure 59. Size distribution (cm) of *Lutjanus griseus* (n=188).

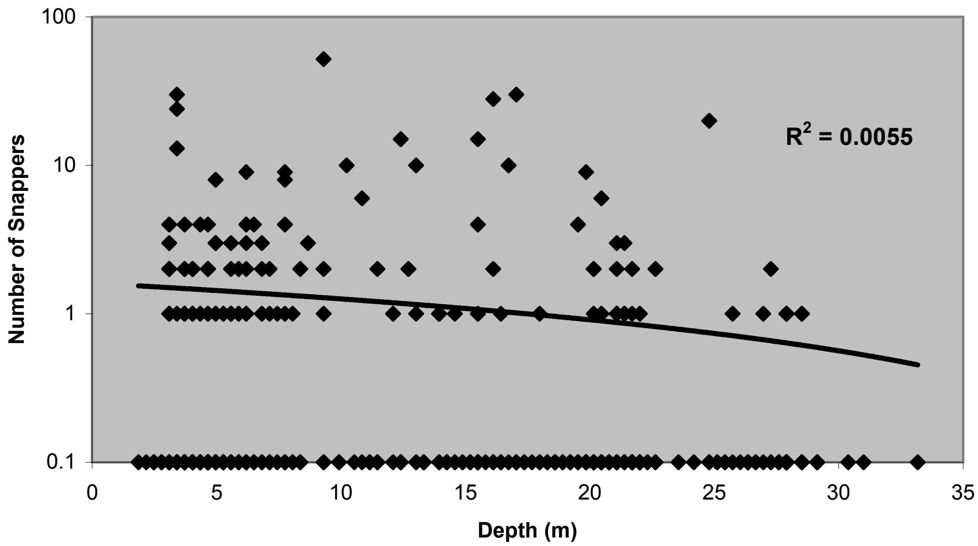


Figure 60. Regression of snapper abundance on depth.

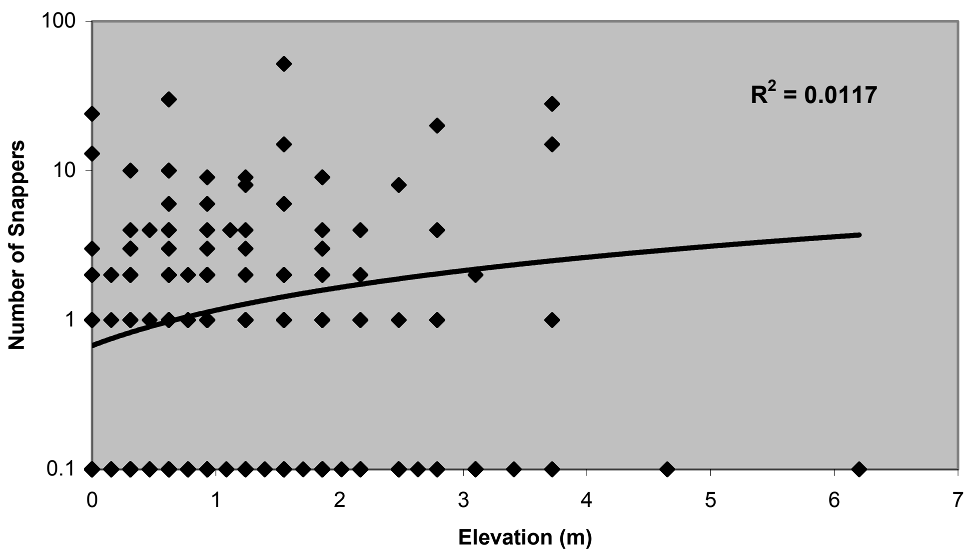


Figure 61. Regression of snapper abundance on elevation.

# 4.0. DISCUSSION

## 4.1. Broward County's Fish Assemblage Structure

Significant differences were found among the three reef tracts. The most prominent difference was among the inshore, middle and offshore reefs, in terms of fish abundance and species richness (Figures 20 & 21). This compares to a study by Newman and Williams (1996) on the Great Barrier Reef, Australia, in which he reported significant differences in community structure among inshore, midshelf, and offshore reefs. However, his inshore, middle and offshore reefs were slightly deeper, 10-15m for the inshore reef and 15-40m for the middle and offshore reefs. Microhabitat differences within the tracts may be important determinants in structuring the different coral reef fish assemblages (Syms 1998, Connell & Kingsford 1998, Sluka et al. 2001, Alevizon et al. 1985). Habitat structure influences fish assemblages by providing: refuge against predators and fishing pressure (e.g. trawling), protection from light exposure or extreme temperatures, food, and mating and nesting sites (Garcia Charton & Ruzafa 1998). Assuming equal recruit availability, a species may be present at one location but not in another due to the presence or absence of specific habitat (Thompson et al. 1990). However, habitat contribution to structuring ecological communities has been underreported because of the complexity of separating the effects of habitat from other influences in the environment (Friedlander & Parrish 1998, Garcia Charton & Ruzafa 1998, Hayes et al. 1996, Caley & St. John 1996). Deciding mechanisms in reef fish assemblage structure could be physical, biological, or both (Garcia Charton & Ruzafa 1998). Therefore, a series of *post hoc* tests on all the recorded variables was performed to see if any habitat/fish assemblage relationships would stand out.

The three reef tracts are located in sequentially deeper water offshore and both species richness and abundance increased with depth (Figures 47 & 48). Regression analysis led to the conclusion that depth may be a strong contributing factor to the differences. This conclusion is also supported by the relationship between the deeper reefs and their higher species richness and fish abundance found north of the two inlets compared to reefs to the south. Numerous studies have linked increases in species richness and abundance with increasing depth (McCormick 1994, Friedlander & Parrish 1998, Miclat et al. 1981, Dennis & Bright 1988, Anderson et al. 1981). It is also clear that most marine fishes tend to have depth preferences, or ranges in which they are usually found (Robins et al. 1986, Froese 1997, Humann 2002, Garcia Charton & Ruzafa 1998). Differences by depth were also illustrated by the SIMPER analyses of the differences between reefs. Although the middle and offshore reefs had the lowest average dissimilarity, the species contributing the most to the differences between them (SIMPER) may be linked to depth preferences. For example, *H. bivitattus* (contributing 3.35% to the difference) is more commonly found in shallower waters, while *H. garnoti* (contributing 3.01% to the difference) and *S. partitus* (contributing 3.00% to the difference) are fishes more commonly found at deeper sites (Humann, 2002). The inshore and middle reefs had the next lowest average dissimilarity, and *S. partitus* (contributing 4.39% to the difference) and *T. bifasciatum* (contributing 3.85% to the difference) had higher mean abundances on the middle reef, which is deeper. Juvenile haemulids (contributing 3.18% to the difference), had the opposite pattern which, in this

study (Figure 51) as in others, had higher mean abundances on the inshore reef (Baron et al. 2002, Jordan et al. in press), and are primarily found in shallow inshore hardbottom habitats (Lindeman & Snyder 1999).

Another reason for the differences among reef tract assemblages could be differences in preferred food availability. Different bottom cover characteristics of the three reef tracts were described earlier. Food sources differ on each reef tract. Presumably, these different food resources would attract different fish assemblages, based on their feeding habits (Friedlander & Parrish 1998). For example, *T. bifasciatum* was most abundant on the offshore reef and this could be due to higher plankton abundance in that area. Wolanski and Hamner (1988) suggested that reefs interact with tidal- and wind-generated current systems to produce hydrological features, concentrating planktonic organisms and retaining nutrients and other food sources close to reef areas. The offshore reef is possibly acting as a hydrologic feature, concentrating planktonic food sources. *S. partitus*, which feeds mostly on algae and plankton (Thompson et al.1990), and therefore would be expected to display a relationship with algal cover and plankton found on the offshore reef tract (Figure 53). Curiously, chaetodontids, which are known to consume coral polyps (Thompson et al. 1990), had a negative relationship with live coral cover. Likewise, pomacanthids, which are known to depend on sponges as a primary food source (Thompson et al.1990), did not increase in frequency with sponge cover. However, it is important to note that, unlike fish identification and counting, census takers did not receive extensive training or validation in bottom cover estimation and therefore the percent bottom cover estimates varied widely between individuals and this variation provides ample room for Type II statistical errors.

Habitat complexity is another aspect that is closely related to bottom cover. We calculated gross rugosity as a measure of habitat complexity. Grigg (1994) stated that habitat complexity is a major factor controlling abundance of reef fishes, and several studies have found that as complexity increases, species richness and abundance increase as well (Friedlander & Parrish 1998, Garcia Charton & Ruzafa 1998, Miclat et al. 1981, Caley & St. John 1996). The offshore reef had significantly higher ($p<0.05$, ANOVA, SNK) rugosity than the other two reefs. The inshore reef had the next highest rugosity, but was not significantly different from the middle reef. Although this rugosity pattern does not exactly follow the species richness and abundance characteristics of the reef tracts, it could nonetheless be a factor influencing the differences among fish assemblages on the three reef tracts. The offshore reef had the highest abundance and species richness of the three reef tracts, and the highest rugosity. There were slight positive relationships between rugosity and species richness and abundance on the three reefs.

Elevation is another factor that may play a role in the structure of reef fish assemblages. Elevation provided the strongest relationship of any of the environmental variables with species richness and abundance (Figures 49 & 50). Rapid changes in elevation are often associated with ledges in Broward County. These ledges can serve as a predation refuge. Shade, which is created by ledges, is an important factor in predation avoidance. Prey located in shady areas have an advantage by being able to see an approaching predator more easily than the predator can see them. Therefore, the prey can avoid the predator more readily as a result of hovering within the shade from the ledge (Helfman, et al., 1997).

## 4.2. Port Everglades and Hillsboro Inlet

There were significant differences between some edge sites north and south of both Port Everglades and Hillsboro Inlet. The reasons for these differences are difficult to determine. As mentioned earlier, fish have depth preferences (Humann, 2002) and there were statistical differences in depth between sites north and south of the Inlets. Also, statistical differences in species richness and abundance were found north and south of the two Inlets. Therefore, depth preferences may account for the statistical differences found. Another difference that may contribute to the different fish assemblages north and south of Port Everglades and Hillsboro Inlet is bottom cover. On the inshore reef, coral cover increased to the north. Also, the middle reef had much more gorgonian abundance north of Hillsboro Inlet. According to Marszalek (1981), gorgonians are the most tolerant of the reef macrofauna to sediment loading and dredged induced turbidity. These conditions occur in and around Hillsboro Inlet, which has been dredged repeatedly since 1964 (http://bcs.dep.state.fl.us/bchmngmt/hillsbor.pdf). The change in bottom cover could influence the fish assemblage structure, either due to a change in food or refuge availability. However, according to Syms (1998), coral reef fish assemblages may be more resistant to disturbance than many studies suggest, so a more detailed investigation into this specific issue is recommended. Another possible reason for the differences found north and south of the Inlets could be effluent. Warm water, freshwater, treated sewage, and nutrients are discharged daily from Port Everglades into the surrounding ocean, which has a prevailing north bound current offshore running parallel to the Broward County coastline. This current could be a reason for the higher numbers of fishes found on the north of each Inlet. The prevailing current could be bringing food in the effluent supporting the slightly higher abundance to the north. This hypothesis is supported by Grigg (1994), who found that the discharge of primary or secondary treated sewage effluent into the ocean causes no apparent negative environmental impact to coral reef ecosystems.

## 4.3. Juvenile Haemulidae

Juvenile haemulids are an important group due to their high abundance in the Broward County reef fish assemblage. Juvenile haemulids comprised 72% of the total fishes ≤5cm and are an important forage base for piscivores (Lindeman, 1986). Significantly more juvenile haemulids occurred on the inshore and middle reefs than on the offshore reef. Jordan et al. (in press) and Baron et al. (2002) also found juvenile haemulids in large numbers nearshore. This pattern could be due to recruitment preferences and/or refuge availability. Broward County has been hypothesized to be refuge-limited for juvenile haemulids (Gilliam 1999). Also, an interesting inverse relationship occurred between *S. partitus* and juvenile haemulids which could be a result of species-specific depth preferences, or perhaps competitive exclusion, since both are planktivores (Thompson 1990; Humann 2002).

## 4.4. Serranidae

The middle reef had significantly more groupers than the inshore and offshore reef tracts. This result differs from a study that found a significant inshore to offshore pattern in grouper density in the Florida Keys (Sluka et al. 2001). The inshore reef in the Keys differed in habitat characteristics from this study in that it was more of a patch reef formation whereas the Broward Co. inshore reef tended to be more of a continuous tract. Sluka et al. (2001) also found that *E. morio* and *M. bonaci* were most abundant on inshore reefs, whereas, our results indicate the highest abundance of red grouper on the middle reef. Our results do, however, correspond to the Sluka et al. (2001) study and a study by Thompson et al. (1990), in that the graysby, *Cephalopholis cruentatus,* was most numerous on the offshore reef. Our most significant finding regarding Serranidae is the very low numbers of legal size groupers. In four years of point counts, only 2 out of 242 observed groupers were within legal size limits. This pattern was most likely due to fishing pressure, which is heavy on the Broward County reef tracts. Interestingly, recruitment does not appear to be the problem, since we found a relatively high number of immature groupers. These were predominantly *E. morio* and *C. cruentatus*; the first is a commercially and recreationally important fish; the second is of minor importance to fisheries (http://www.fishbase.org). The lack of legal sized *E. morio* could be an indication of fishing pressure and should be addressed in management plans. Black grouper, *M. bonaci,* and goliath grouper, *M. itajara,* were not recorded in any counts although they have been previously recorded from our area (http://www.flmnh.ufl.edu/scripts/dbs/fish_pub_proc.asp) and are still seen on rare occasion (authors unpublished data). The absence of legal size groupers is also important due to the possible effects of their absence on the remaining fish assemblage. Piscivory appears to play a critical role in the formation of fish assemblage structure in terms of species richness and species-specific abundance (Hixon, 1991). Therefore, it is imperative to gain understanding of the importance of these larger predatory fish and their role in structuring reef fish assemblages.

## 4.5. Lutjanidae

Snappers were another commercially important family analyzed. Newman and Williams (1996) found that snapper density was lowest inshore and increased offshore on the Great Barrier Reef. Our findings were the exact opposite. The inshore reef had the highest snapper abundance, followed by the middle, and then the offshore reef. Newman and Williams (1996) also found that snapper species increased in size with depth and distance from shore . Our study found no relationship with snapper abundance and depth, but it did find that snapper size tended to increase moving offshore. This could be due to the fact that live coral are important to lutjanids (Connell & Kingsford 1998), and that there was more live coral cover on the offshore reef than the other two reefs. More detailed analysis of the actual bottom cover composition would be necessary to make strong conclusions concerning this issue. The lack of legal size snappers is an issue similar to that of the groupers, and needs further study. Their absence could have prominent effects on the assemblage structure of reef fish.

# 5.0. CONCLUSION

This study reports on a four-year census of the reef associated fishes off Broward County. The results provide baseline data necessary for resource management and the determination of natural and anthropogenic impact to the local populations of fishes. In addition, this study can serve as an excellent starting point for more detailed studies of the relationships among fishes within an assemblage and provides a basis for designing experimental studies on the dynamics of coral reef fish assemblages. Such studies should focus on relationships at a population level, or even an individual level, in search of mechanistic explanations that may be extrapolated to the community level (Garcia Charton & Rufaza 1998). Of immediate management concern are the extremely low numbers of legal-sized groupers and snappers found in Broward County. These low numbers are a concern for recreational fishing and potentially the entire fish assemblage.

# 6.0. ACKOWLEDGMENTS

This work was, in part, the Masters thesis research of Fleur Ferro and a major portion of the text herein was extracted from that document. James Bohnsack trained initial NSU personnel in point-count methodology. Douglas Harper provided essential aid in training NSU personnel in data acquisition and in data transport between differing software programs. J. Bohnsack and D. Harper also provided editorial assistance. Fish censusing was done by Paul Arena, Lance Jordan, Fleur Ferro (nee Harttung), Dan Fahy, Brian Walker, Brian Buskirk, Pat Quinn, Amy Hall, and Richard Spieler. A number of graduate students from NSU Oceanographic Center served as dive-partners. Partial financial support for this research was provided in part from NOAA Grants NA7870A0380 and NA060A0390 to the National Coral Reef Institute (NCRI) and from the NOAA Coral Reef Conservation Program by NOAA/NMFS Grant # 40GENF200249. This is NCRI publication #71.

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**Table 1. Master species list.**
(Alphabetized by common name, family, and species within family).

| Common Name | Scientific Name | Inshore | Middle | Offshore |
|---|---|---|---|---|
| **ANGELFISHES** | **POMACANTHIDAE** | | | |
| Blue Angelfish | *Holocanthus bermudensis* | X | X | X |
| Cherubfish | *Centropyge argi* | | X | X |
| French Angelfish | *Pomacanthus paru* | X | X | X |
| Gray Angelfish | *Pomacanthus arcuatus* | X | X | X |
| Queen Angelfish | *Holocanthus cilaris* | X | X | X |
| Rock Beauty | *Holcanthus tricolor* | | X | X |
| **BARRACUDAS** | **SPHYRAENIDAE** | | | |
| Great Barracuda | *Sphyraena barracuda* | X | X | X |
| **BIGEYES** | **PRIACANTHIDAE** | | | |
| Glasseye Snapper | *Priacanthus cruentatus* | | X | X |
| **BONNETMOUTHS** | **INERMIIDAE** | | | |
| Boga | *Inermia vittata* | | | X |
| **BOXFISHES** | **OSTRACIIDAE** | | | |
| Honeycomb cowfish | *Acanthostracion polygonius* | | X | X |
| Scrawled cowfish | *Acanthostracion quadricornis* | X | X | X |
| Smooth trunkfish | *Lactophrys triqueter* | X | X | X |
| Spotted Trunkfish | *Lactophrys bicaudalis* | | | X |
| Trunkfish | *Lactophrys trigonus* | | | X |
| **BUTTERFLYFISHES** | **CHAETODONTIDAE** | | | |
| Banded Butterflyfish | *Chaetodon striatus* | | X | X |
| Foureye Butterflyfish | *Chaetodon capistratus* | X | X | X |
| Longsnout Butterflyfish | *Chaetodon aculeatus* | | | X |
| Reef Butterflyfish | *Chaetodon sedentarius* | X | X | X |
| Spotfin Butterflyfish | *Chaetodon ocellatus* | X | X | X |
| **CARDINALFISHES** | **APOGONIDAE** | | | |
| Barred Cardinal Fish | *Apogon binotatus* | | | X |
| Flamefish | *Apogon maculatus* | | X | X |
| Twospot Cardinalfish | *Apogon pseudomaculatus* | X | | |
| **COBIAS** | **RACHYICENTRIDAE** | | | |
| Cobia | *Rachycentron canadum* | | | X |
| **COMBTOOTH BLENNIES** | **BLENNIDAE** | | | |
| Barred Blenny | *Hypleurochilus bermudensis* | | X | |
| Redlip Blenny | *Ophioblennius atlanticus* | X | X | |
| Seaweed Blenny | *Parablennius marmoreus* | X | X | X |
| **CONGER EELS** | **CONGRIDAE** | | | |
| Garden Eel | *Heteroconger halis* | | | X |
| **CORNETFISH** | **FISTULARIIDAE** | | | |
| Bluespotted Cornetfish | *Fistularia tabacaria* | X | X | X |
| **DAMSELFISHES** | **POMACENTRIDAE** | | | |
| Beaugregory | *Stegastes leucostictus* | X | X | X |
| Bicolor Damselfish | *Stegastes partitus* | X | X | X |
| Blue Chromis | *Chromis cyanis* | | X | X |
| Brown Chromis | *Chromis multilineatus* | X | X | X |

**Table 1 (cont.). Master species list.**
(Alphabetized by common name, family, and species within family).

| Common Name | Scientific Name | Inshore | Middle | Offshore |
|---|---|---|---|---|
| Cocoa Damslefish | *Stegastes variabilis* | X | X | X |
| Damselfish species | *Stegastes spp.* | X | | |
| Dusky Damselfish | *Stegastes adustus* | X | X | X |
| Longfin Damselfish | *Stegastes diencaeus* | X | X | |
| Purple Reeffish | *Chromis scotti* | X | X | X |
| Sergeant Major | *Abudefduf saxatilis* | X | X | X |
| Sunshinefish | *Chromis insolatus* | | X | X |
| Threespot Damselfish | *Stegastes planifrons* | X | X | X |
| Yellowtail Damselfish | *Microspathadon chrysurus* | X | X | X |
| Yellowtail Reeffish | *Chromis enchrysurus* | | X | X |
| **DRUMS** | **SCIAENIDAE** | | | |
| Highhat | *Pareques acuminatus* | X | X | X |
| Jacknife | *Pareques lanceolatus* | X | X | X |
| Reef Croaker | *Odontoscion dentex* | | X | |
| Spotted Drum | *Equetus punctatus* | | | X |
| **FILEFISHES** | **MONACANTHIDAE** | | | |
| Fringed Filefish | *Monacanthus ciliatus* | | | X |
| Orange Filefish | *Aluterus schoepfi* | X | X | X |
| Orangespotted Filefish | *Cantherhines pullus* | X | X | X |
| Planehead Filefish | *Stephanolepis hispidus* | X | X | X |
| Scrawled Filefish | *Aluterus scriptus* | | X | X |
| Slender Filefish | *Monacanthus tuckeri* | | X | X |
| Whitespotted Filefish | *Cantherhines macrocerus* | X | X | X |
| **FLYINGFISH** | **EXOCOETIDAE** | | | |
| Ballyhoo | *Hemiramphus brasiliensis* | | X | |
| **GOATFISHES** | **MULLIDAE** | | | |
| Spotted Goatfish | *Pseudopeneus maculatus* | X | X | X |
| Yellow Goatfish | *Mulloidichthys martinicus* | X | X | X |
| **GOBIES** | **GOBIIDAE** | | | |
| Blue Goby | *Ioglossus calliurus* | X | X | X |
| Bridled Goby | *Coryphopterus glaucofraenum* | X | X | X |
| Colon Goby | *Coryphopterus dicrus* | X | | |
| Dash Goby | *Gobiosoma saepepallens* | X | X | X |
| Goby Species | Goby Species | | | X |
| Goldspot Goby | *Gnatholepis thompsoni* | X | X | X |
| Hovering Goby | *Ioglossus helenae* | X | X | X |
| Masked/Glass Goby | *Coryphopterus hyalinus/personatus* | X | X | X |
| Neon Goby | *Gobiosoma oceanops* | X | X | X |
| Pallid Goby | *Coryphopterus eidolon* | | X | |
| Seminole Goby | *Microgobius carri* | X | X | |
| Tiger Goby | *Gobiosoma macrodon* | X | | |
| **GRUNTS** | **HAEMULIDAE** | | | |
| Black Margate | *Anisotremus surinamensis* | X | X | X |
| Bluestripe Grunt | *Haemulon sciurus* | X | X | X |

**Table 1 (cont.). Master species list.**
(Alphabetized by common name, family, and species within family

| Common Name | Scientific Name | Inshore | Middle | Offshore |
|---|---|---|---|---|
| Caesar Grunt | *Haemulon carbonarium* | X | | X |
| Cottonwick | *Haemulon melanurum* | X | X | X |
| French Grunt | *Haemulon flavolineatum* | X | X | X |
| Juvenile Grunts | *Haemulon spp.* | X | X | X |
| Porkfish | *Anisotremus virginicus* | X | X | X |
| Sailors Choice | *Haemulon parra* | X | X | X |
| Smallmouth Grunt | *Haemulon chrysargyreum* | X | X | X |
| Spanish Grunt | *Haemulon macrostomum* | X | X | X |
| Striped Grunt | *Haemulon striatum* | X | X | X |
| Tomtates | *Haemulon aurolineatum* | X | X | X |
| White Grunt | *Haemulon plumieri* | X | X | X |
| **GUITARFISHES** | **RHINOBATIDAE** | | | |
| Atlantic Guitarfish | *Rhinobatos lentiginosus* | X | X | X |
| **HERRINGS** | **CLUPEIDAE** | | | |
| Scaled Sardine | *Harengula jaguana* | | X | X |
| **JACKS** | **CARANGIDAE** | | | |
| Almaco Jack | *Seriola rivoliana* | X | | |
| Bar Jack | *Caranx ruber* | X | X | X |
| Bigeye Scad | *Selar crumenophthalmus* | X | X | X |
| Blue Runner | *Caranx crysos* | X | X | X |
| Horse-eye Jack | *Caranx latus* | | | X |
| Leatherjacket | *Oligoplites saurus* | | X | |
| Mackerel Scad | *Decapterus macarellus* | | X | X |
| Round Scad | *Decapterus punctatus* | X | X | |
| Yellow Jack | *Caranx bartholomaei* | X | X | X |
| **JAWFISHES** | **OPISTOGNATHIDAE** | | | |
| Banded Jawfish | *Opistognathus macrognathus* | X | | |
| Dusky Jawfish | *Opistognathus whitehursti* | X | X | |
| Yellowhead Jawfish | *Opistognathus aurifrons* | X | X | X |
| **LABROSOMIDS** | **LABRISOMIDAE** | | | |
| Marbled Blenny | *Paraclinus marmoratus* | X | X | X |
| Rosy Blenny | *Malacoctenus macropus* | X | X | X |
| Saddled Blenny | *Malacoctenus triangulatus* | X | X | |
| **LEATHERJACKETS** | **BALISTIDAE** | | | |
| Gray Triggerfish | *Balistes capriscus* | X | X | X |
| Ocean Triggerfish | *Canthidermis sufflamen* | | | X |
| Queen Triggerfish | *Balistes vetula* | X | X | X |
| **LEFTEYE FLOUNDERS** | **BOTHIDAE** | | | |
| Flounder species | *Bothus sp.* | X | X | |
| **LIZARDFISHES** | **SYNODONTIDAE** | | | |
| Sand Diver | *Synodus intermedius* | X | | X |
| **MACKERELS** | **SCOMBRIDAE** | | | |
| Cero | *Scomberomorous regalis* | X | X | X |
| King Mackerel | *Scomberomorous cavalla* | | X | |

**Table 1 (cont.). Master species list.**
(Alphabetized by common name, family, and species within family

| Common Name | Scientific Name | Inshore | Middle | Offshore |
|---|---|---|---|---|
| Spanish Mackerel | *Scomberomorous maculatus* | | X | X |
| **MANTA** | **MOBULIDAE** | | | |
| Manta | *Manta birostris* | | | X |
| **MOJARRAS** | **GERREIDAE** | | | |
| Slender Mojarra | *Eucinostomus jonesi* | X | | |
| Yellowfin Mojarra | Gerres cinereus | X | X | |
| **MORAY EELS** | **MURAENIDAE** | | | |
| Goldentail Moray | *Muraena miliaris* | | X | X |
| Green Moray | *Gymnothorax funebris* | | | X |
| Purplemouth Moray | *Gymnothorax vicinus* | X | X | |
| Spotted Moray | *Gymnothorax moringa* | | X | X |
| **NURSE SHARKS** | **ORECTOLOBIDAE** | | | |
| Nurse Shark | *Ginglymostoma cirratum* | X | X | X |
| **PARROTFISHES** | **SCARIDAE** | | | |
| Blue Parrotfish | *Scarus coeruleus* | | X | X |
| Bluelip Parrotfish | *Cryptotomus roseus* | X | X | X |
| Bucktooth Parrotfish | *Sparisoma radians* | X | X | X |
| Greenblotch Parrotfish | *Sparisoma atomarium* | X | X | X |
| Midnight Parrotfish | *Scarus coelestinus* | X | | |
| Parrotfish | *Scaridae spp.* | X | X | X |
| Princess Parrotfish | *Scarus taeniopterus* | X | X | X |
| Queen Parrotfish | *Scarus vetula* | X | X | X |
| Rainbow Parrotfish | *Scarus guacamaia* | X | X | X |
| Redband Parrotfish | *Sparisoma aurofrenatum* | X | X | X |
| Redfin Parrotfish | *Sparisoma rubripinne* | X | X | X |
| Redtail Parrotfish | *Sparisoma chrysopterum* | X | X | X |
| Stoplight Parrotfish | *Sparisoma virride* | X | X | X |
| Striped Parrotfish | *Scarus croicensis* | X | X | X |
| **PORGIES** | **SPARIDAE** | | | |
| Calamus Species | Calamus spp. | X | X | X |
| Jolthead Porgy | *Calamus bajonado* | | X | X |
| Knobbed Porgy | *Calamus nodosus* | | | X |
| Littlehead Porgy | *Calamus proridens* | | X | X |
| Saucereye Porgy | *Calamus calamus* | X | X | X |
| Sheepshead Porgy | *Calamus penna* | X | X | X |
| Silver Porgy | *Diplodus argenteus* | X | X | |
| Spottail Pinfish | *Diplodus holbrooki* | X | X | X |
| **PUFFERS** | **TETRAODONTIDAE** | | | |
| Bandtail Pufferfish | *Sphoeroides spengleri* | X | X | X |
| Checkered Pufferfish | *Sphoeroides testudineus* | | X | X |
| Sharpnose Pufferfish | *Canthigaster rostrata* | X | X | X |
| **REMORAS** | **ECHENEIDIDAE** | | | |
| Remora | *Remora remora* | | | X |
| Sharksucker | *Echeneis naucrates* | X | X | X |

**Table 1 (cont.). Master species list.**
(Alphabetized by common name, family, and species within family

| Common Name | Scientific Name | Inshore | Middle | Offshore |
|---|---|---|---|---|
| **ROUND STINGRAYS** | **UROLOPHIDAE** | | | |
| Yellow Stingray | *Urobatis jamaicensis* | X | X | X |
| **SEA BASSES** | **SERRANIDAE** | | | |
| Bank Sea Bass | *Centropristis ocyurus* | X | | X |
| Barred Hamlet | *Hypoplectrus puella* | X | X | X |
| Black Grouper | *Mycteroperca bonaci* | | X | X |
| Black Hamlet | *Hypoplectrus nigricans* | | | X |
| Blue Hamlet | *Hypoplectrus gemma* | X | X | X |
| Butter Hamlet | *Hypoplectrus unicolor* | X | X | X |
| Chalk Bass | *Serranus tortugarum* | X | X | X |
| Coney | *Epinephelus fulvus* | | | X |
| Gag | *Mycteroperca microlepis* | | X | X |
| Graysby | *Cephalopholis cruentatus* | X | X | X |
| Hamlet Juvenile | *Hypoplectrus spp.* | X | X | X |
| Harlequin Bass | *Serranus tigrinus* | X | X | X |
| Lantern Bass | *Serranus baldwini* | X | X | X |
| Orangeback Bass | *Serranus annularis* | | X | X |
| Red Grouper | *Epinephelus morio* | X | X | X |
| Red Hind | *Epinephelus guttatus* | X | X | X |
| Rock Hind | *Epinephelus adscensionis* | | | X |
| Sand Perch | *Diplectum formosum* | X | X | X |
| Scamp | *Mycteroperca phenax* | X | X | X |
| Shy Hamlet | *Hypoplectrus guttavarius* | | X | X |
| Tattler Bass | *Serranus phoebe* | | | X |
| Tobaccofish | *Serranus tabacarius* | X | X | X |
| Yellowfin Grouper | *Mycteroperca venenosa* | X | | |
| Yellowmouth Grouper | *Mycteroperca interstitialis* | | X | |
| **SEA CHUBS** | **KYPHOSIDAE** | | | |
| Bermuda Chub | *Kyphosus sectatrix* | X | X | X |
| **SNAKE EELS** | **OPHICHTHIDAE** | | | |
| Sharptail Eel | *Myrichthys breviceps* | X | | |
| **SNAPPERS** | **LUTJANIDAE** | | | |
| Dog Snapper | *Lutjanus jocu* | | X | |
| Gray Snapper | *Lutjanus griseus* | X | X | X |
| Lane Snapper | *Lutjanus synagris* | X | X | |
| Mahogany Snapper | *Lutjanus mahogoni* | X | X | X |
| Mutton Snapper | *Lutjanus analis* | X | X | X |
| Schoolmaster | *Lutjanus apodus* | X | X | X |
| Yellowtail Snapper | *Ocyurus chrysurus* | X | X | X |
| **SOAPFISHES** | **GRAMMISTIDAE** | | | |
| Greater Soapfish | *Rypticus saponaceus* | | X | X |
| **SPADEFISHES** | **EPHIPPIDAE** | | | |
| Spadefish | *Chaetodipterus faber* | X | X | X |
| **SPINY PUFFERS** | **DIODONTIDAE** | | | |

**Table 1 (cont.). Master species list.**
(Alphabetized by common name, family, and species within family

| Common Name | Scientific Name | Inshore | Middle | Offshore |
|---|---|---|---|---|
| Balloonfish | *Diodon holocanthus* | X | X | X |
| PorcupineFish | *Diodon hystrix* | X | X | X |
| Striped Burrfish | *Chilomycterus schoepfi* | | | X |
| Web Burrfish | *Chilomycterus antillarum* | | X | |
| **SQUIRRELFISH** | **HOLOCENTRIDAE** | | | |
| Blackbar Soldierfish | *Myripristis jacobus* | X | | X |
| Dusky Squirrelfish | *Sargocentron vexillarium* | | | X |
| Longspine Squirrelfish | *Holocentrus rufus* | | X | X |
| Squirrelfish | *Holocentrus adscensionis* | X | X | X |
| **STINGRAY** | **DASYATIDAE** | | | |
| Southern stingray | *Dasyatis americana* | | X | X |
| **SURGEONFISHES** | **ACANTHURIDAE** | | | |
| Blue tang | *Acanthurus coeruleus* | X | X | X |
| Doctorfish | *Acanthurus chirurgus* | X | X | X |
| Ocean Surgeonfish | *Acanthurus bahianus* | X | X | X |
| **SWEEPERS** | **PEMPHERIDAE** | | | |
| Glassy Sweeper | *Pempheris schomburgki* | X | X | X |
| **TARPONS** | **MEGALOPIDAE** | | | |
| Tarpon | *Megalops atlanticus* | X | | |
| **TILEFISHES** | **MALACANTHIDAE** | | | |
| Sand Tilefish | *Malacanthus plumieri* | | X | X |
| **TRUMPETFISH** | **AULOSTOMIDAE** | | | |
| Trumpetfish | *Aulostomus maculatus* | X | X | X |
| **TUBE BLENNYS** | **CHAENOPSIDAE** | | | |
| Roughhead Blenny | *Acanthemblemaria aspera* | X | X | X |
| Sailfin Blenny | *Emblemaria pandionis* | X | X | X |
| Spinyhead Blenny | *Acanthemblemaria spinosa* | | X | |
| **WRASSES** | **LABRIDAE** | | | |
| Blackear Wrasse | *Halichoeres poeyi* | X | X | |
| Bluehead Wrasse | *Thalassoma bifasciatum* | X | X | X |
| Clown Wrasse | *Halichoeres maculipinna* | X | X | X |
| Creole Wrasse | *Clepticus parra* | X | X | X |
| Green Razorfish | *Xyrichthys splendens* | X | X | X |
| Hogfish | *Lachnolaimus maximus* | X | X | X |
| Puddingwife | *Halichoeres radiatus* | X | X | X |
| Rainbow Wrasse | *Halichoeres pictus* | X | X | X |
| Rosy Razorfish | *Xyrichthys martinicensis* | X | X | X |
| Slippery Dick | *Halichoeres bivittatus* | X | X | X |
| Spanish Hogfish | *Bodianus rufus* | X | X | X |
| Spotfin Hogfish | *Bodianus pulchellus* | | X | X |
| Yellowcheek Wrasse | *Halichoeres cyanocephalus* | | X | X |
| Yellowhead Wrasse | *Halichoeres garnoti* | X | X | X |
| | **TOTAL SPECIES PER TRACT** | **144** | **170** | **173** |
| | **TOTAL FAMILIES** | **52** | | |
| | **TOTAL SPECIES** | **211** | | |
| | **TOTAL FISH** | **86463** | | |

**Table 2. Middle reef versus offshore reef, SIMPER analysis.**

Average Dissimilarity= 66.75%

| | Group M | Group O | | | | |
|---|---|---|---|---|---|---|
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| HAL BIVI | 5.3 | 0.95 | 2.23 | 1.35 | 3.35 | 3.35 |
| HAL GARN | 4.03 | 9.5 | 2.01 | 1.16 | 3.01 | 6.36 |
| POM PART | 12.95 | 25.51 | 2.01 | 1.04 | 3 | 9.36 |
| THA BIFA | 19.55 | 19.72 | 1.88 | 1.04 | 2.82 | 12.18 |
| ACA BAHI | 6.62 | 4.09 | 1.69 | 1.1 | 2.53 | 14.71 |
| SER TABA | 0.99 | 2.26 | 1.64 | 1.15 | 2.45 | 17.16 |
| CHA SEDE | 0.84 | 2.12 | 1.58 | 1.13 | 2.37 | 19.53 |
| ACA CHIR | 2.04 | 2.38 | 1.56 | 0.99 | 2.34 | 21.87 |
| SCA TAEN | 0.92 | 2.58 | 1.55 | 1.06 | 2.33 | 24.2 |
| SPA AURO | 4.23 | 5.39 | 1.54 | 1 | 2.31 | 26.51 |
| CAN ROST | 1.25 | 2.06 | 1.5 | 1.14 | 2.25 | 28.76 |
| SER TIGR | 0.95 | 1.36 | 1.41 | 1.1 | 2.12 | 30.88 |
| COR PERS | 12.72 | 12.25 | 1.41 | 0.63 | 2.11 | 32.99 |
| HAE PLUM | 2.46 | 1.25 | 1.3 | 0.89 | 1.94 | 34.93 |
| PSE MACU | 0.82 | 1.08 | 1.19 | 0.92 | 1.78 | 36.72 |
| SCA CROI | 1.09 | 1.45 | 1.16 | 0.81 | 1.74 | 38.46 |
| BAL CAPR | 1.12 | 0.72 | 1.14 | 0.83 | 1.71 | 40.17 |
| POM VARI | 1.67 | 0.32 | 1.09 | 0.82 | 1.63 | 41.8 |
| HYP UNIC | 0.45 | 0.71 | 1.09 | 0.93 | 1.63 | 43.42 |
| ACA COER | 0.74 | 0.78 | 1.08 | 0.88 | 1.62 | 45.04 |
| HOL TRIC | 0.22 | 0.78 | 1.06 | 0.89 | 1.59 | 46.63 |
| SPA VIRI | 0.62 | 1.13 | 1.02 | 0.82 | 1.53 | 48.17 |
| HAE FLAV | 4.11 | 1.06 | 0.96 | 0.61 | 1.43 | 49.6 |
| HAL MACU | 2 | 0.06 | 0.94 | 0.63 | 1.41 | 51.01 |
| CHR CYAN | 0.28 | 3.14 | 0.93 | 0.64 | 1.39 | 52.41 |
| CHA OCEL | 0.21 | 0.73 | 0.89 | 0.72 | 1.34 | 53.75 |
| HOL ADSC | 0.49 | 0.47 | 0.87 | 0.76 | 1.3 | 55.04 |
| COR GLAU | 1.18 | 0.55 | 0.85 | 0.65 | 1.28 | 56.32 |
| CLE PARR | 2.8 | 7.27 | 0.82 | 0.49 | 1.23 | 57.55 |
| SER TORT | 1.45 | 1.33 | 0.82 | 0.53 | 1.23 | 58.78 |
| POM ARCU | 0.37 | 0.41 | 0.81 | 0.71 | 1.22 | 60 |
| ANI VIRG | 0.68 | 0.81 | 0.8 | 0.67 | 1.2 | 61.21 |
| EPI MORI | 0.43 | 0.21 | 0.78 | 0.73 | 1.17 | 62.37 |
| SPA ATOM | 0.74 | 0.79 | 0.77 | 0.59 | 1.15 | 63.52 |
| HAE SCIU | 0.94 | 1.33 | 0.73 | 0.58 | 1.09 | 64.61 |
| OPI AURI | 0.57 | 0.56 | 0.71 | 0.55 | 1.07 | 65.68 |
| CAR RUBE | 0.76 | 1.09 | 0.71 | 0.55 | 1.06 | 66.73 |
| LAC MAXI | 0.3 | 0.34 | 0.7 | 0.66 | 1.05 | 67.79 |
| CHR SCOT | 0.29 | 2.09 | 0.64 | 0.51 | 0.96 | 68.75 |
| EPI CRUE | 0.18 | 0.32 | 0.64 | 0.65 | 0.96 | 69.71 |
| HAE SPE. | 16.22 | 8.76 | 0.62 | 0.31 | 0.93 | 70.64 |
| BOD RUFU | 0.31 | 0.31 | 0.62 | 0.62 | 0.93 | 71.57 |
| POM LEUC | 0.54 | 0.15 | 0.6 | 0.57 | 0.89 | 72.46 |

Table 2 (cont.). Middle reef versus offshore reef, SIMPER analysis.

| | Group M | Group O | | | | |
|---|---|---|---|---|---|---|
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| HOL BERM | 0.03 | 0.33 | 0.57 | 0.56 | 0.85 | 73.31 |
| CAL CALA | 0.19 | 0.33 | 0.56 | 0.54 | 0.85 | 74.15 |
| CHR INSO | 0.04 | 2.12 | 0.55 | 0.44 | 0.83 | 74.98 |
| CHA CAPI | 0.19 | 0.36 | 0.52 | 0.51 | 0.78 | 75.76 |
| IOG CALL | 0.41 | 0.42 | 0.52 | 0.44 | 0.77 | 76.53 |
| POM PARU | 0.27 | 0.25 | 0.5 | 0.53 | 0.75 | 77.28 |
| ABU SAXA | 1.14 | 0.06 | 0.5 | 0.44 | 0.75 | 78.04 |
| MON HISP | 0.15 | 0.16 | 0.44 | 0.48 | 0.66 | 78.7 |
| ALU SCRI | 0.04 | 0.27 | 0.43 | 0.47 | 0.65 | 79.34 |
| SPH SPEN | 0.09 | 0.19 | 0.43 | 0.48 | 0.65 | 79.99 |
| LUT ANAL | 0.14 | 0.13 | 0.42 | 0.48 | 0.62 | 80.61 |
| CRY ROSE | 0.62 | 0.6 | 0.4 | 0.36 | 0.6 | 81.21 |
| HOL CILI | 0.1 | 0.16 | 0.38 | 0.46 | 0.57 | 81.78 |
| HAE AURO | 3.06 | 1.17 | 0.38 | 0.33 | 0.57 | 82.35 |
| OCY CHRY | 0.42 | 0.3 | 0.36 | 0.39 | 0.54 | 82.89 |
| SER BALD | 0.12 | 0.12 | 0.35 | 0.41 | 0.53 | 83.42 |
| CHR MULT | 0.84 | 0.42 | 0.33 | 0.34 | 0.49 | 83.91 |
| GNA THOM | 0.22 | 0.12 | 0.31 | 0.37 | 0.47 | 84.38 |
| HAL CYAN | 0.12 | 0.19 | 0.31 | 0.37 | 0.47 | 84.84 |
| SPA CHRY | 0.19 | 0.13 | 0.3 | 0.37 | 0.45 | 85.29 |
| MAL PLUM | 0.05 | 0.13 | 0.3 | 0.38 | 0.45 | 85.74 |
| LAC TRIQ | 0.08 | 0.09 | 0.29 | 0.39 | 0.43 | 86.17 |
| KYP SECT | 0.75 | 0.39 | 0.28 | 0.28 | 0.42 | 86.59 |
| CAN PULL | 0.07 | 0.07 | 0.26 | 0.36 | 0.39 | 86.98 |
| LUT GRIS | 0.18 | 0.22 | 0.26 | 0.35 | 0.39 | 87.37 |
| AUL MACU | 0.07 | 0.11 | 0.25 | 0.37 | 0.38 | 87.75 |
| URO JAMA | 0.06 | 0.06 | 0.25 | 0.34 | 0.37 | 88.11 |
| SPA RUBR | 0.16 | 0.07 | 0.24 | 0.33 | 0.37 | 88.48 |
| GOB OCEA | 0.32 | 0.05 | 0.24 | 0.32 | 0.36 | 88.84 |
| SPA RADI | 0.11 | 0.24 | 0.24 | 0.29 | 0.36 | 89.2 |
| SPA SPE. | 0.27 | 0.21 | 0.23 | 0.27 | 0.35 | 89.54 |
| HYP GEMM | 0.1 | 0.07 | 0.22 | 0.34 | 0.32 | 89.87 |
| HEM SPLE | 0.19 | 0.01 | 0.21 | 0.26 | 0.32 | 90.19 |

**Table 3. Inshore reef versus middle reef, SIMPER analysis.**

| Average Dissimilarity= 73.62% | | | | | | |
|---|---|---|---|---|---|---|
| | Group I | Group M | | | | |
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| POM PART | 0.56 | 12.95 | 3.23 | 1.49 | 4.39 | 4.39 |
| THA BIFA | 7.31 | 19.55 | 2.83 | 1.11 | 3.85 | 8.24 |
| HAE SPE. | 22.35 | 16.22 | 2.34 | 0.65 | 3.18 | 11.41 |
| SPA AURO | 1.75 | 4.23 | 2.23 | 1.17 | 3.03 | 14.45 |
| HAL GARN | 0.19 | 4.03 | 2.12 | 1.12 | 2.88 | 17.33 |
| HAE PLUM | 3.29 | 2.46 | 2.06 | 1.09 | 2.79 | 20.12 |
| ACA BAHI | 7.34 | 6.62 | 2 | 0.96 | 2.72 | 22.84 |
| ACA CHIR | 2.99 | 2.04 | 1.96 | 0.99 | 2.66 | 25.49 |
| HAL BIVI | 6.92 | 5.3 | 1.92 | 1.03 | 2.6 | 28.1 |
| HAE FLAV | 10.32 | 4.11 | 1.76 | 0.81 | 2.39 | 30.49 |
| POM VARI | 1.82 | 1.67 | 1.75 | 1.02 | 2.38 | 32.87 |
| BAL CAPR | 0.76 | 1.12 | 1.54 | 0.9 | 2.09 | 34.96 |
| HAL MACU | 1.26 | 2 | 1.52 | 0.81 | 2.07 | 37.03 |
| CAN ROST | 0.39 | 1.25 | 1.47 | 0.97 | 2 | 39.03 |
| COR GLAU | 1.37 | 1.18 | 1.29 | 0.75 | 1.75 | 40.78 |
| SCA CROI | 1.11 | 1.09 | 1.25 | 0.72 | 1.69 | 42.47 |
| SPA VIRI | 0.59 | 0.62 | 1.18 | 0.83 | 1.6 | 44.07 |
| SER TIGR | 0.06 | 0.95 | 1.12 | 0.76 | 1.52 | 45.59 |
| PSE MACU | 0.51 | 0.82 | 1.12 | 0.73 | 1.52 | 47.11 |
| CHA SEDE | 0.06 | 0.84 | 1.11 | 0.75 | 1.51 | 48.62 |
| HAE SCIU | 1.06 | 0.94 | 1.11 | 0.7 | 1.5 | 50.12 |
| POM LEUC | 0.66 | 0.54 | 1.1 | 0.71 | 1.49 | 51.61 |
| ACA COER | 0.59 | 0.74 | 1.08 | 0.78 | 1.47 | 53.08 |
| EPI MORI | 0.38 | 0.43 | 1.07 | 0.76 | 1.46 | 54.54 |
| COR PERS | 0.63 | 12.72 | 1.07 | 0.49 | 1.45 | 55.99 |
| ANI VIRG | 1.15 | 0.68 | 1.03 | 0.7 | 1.4 | 57.39 |
| SER TABA | 0.01 | 0.99 | 1.02 | 0.65 | 1.38 | 58.78 |
| SCA TAEN | 0.73 | 0.92 | 1 | 0.64 | 1.36 | 60.13 |
| CAR RUBE | 0.53 | 0.76 | 0.87 | 0.56 | 1.18 | 61.31 |
| POM ARCU | 0.31 | 0.37 | 0.85 | 0.65 | 1.16 | 62.47 |
| ABU SAXA | 0.86 | 1.14 | 0.84 | 0.53 | 1.15 | 63.62 |
| HYP UNIC | 0.07 | 0.45 | 0.79 | 0.63 | 1.07 | 64.69 |
| HOL ADSC | 0.1 | 0.49 | 0.74 | 0.6 | 1.01 | 65.7 |
| EQU ACUM | 0.57 | 0.26 | 0.69 | 0.49 | 0.94 | 66.64 |
| GOB OCEA | 1.05 | 0.32 | 0.69 | 0.51 | 0.94 | 67.57 |
| HAE AURO | 2.91 | 3.06 | 0.62 | 0.38 | 0.85 | 68.42 |
| DIP ARGE | 0.49 | 0.32 | 0.61 | 0.4 | 0.83 | 69.25 |
| OCY CHRY | 0.23 | 0.42 | 0.58 | 0.47 | 0.79 | 70.04 |
| LAC MAXI | 0.1 | 0.3 | 0.58 | 0.52 | 0.79 | 70.83 |
| SPA ATOM | 0.19 | 0.74 | 0.58 | 0.45 | 0.79 | 71.62 |
| LUT GRIS | 0.39 | 0.18 | 0.55 | 0.49 | 0.75 | 72.36 |
| SER TORT | 0.13 | 1.45 | 0.55 | 0.37 | 0.74 | 73.11 |

Table 3 (cont.). Inshore reef versus middle reef, SIMPER analysis.

| | Group I | Group M | | | | |
|---|---|---|---|---|---|---|
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| POM FUSC | 0.49 | 0.11 | 0.54 | 0.44 | 0.74 | 73.85 |
| HEM SPLE | 0.23 | 0.19 | 0.54 | 0.38 | 0.74 | 74.58 |
| CAR CRYS | 2.21 | 0.54 | 0.54 | 0.32 | 0.73 | 75.31 |
| DIP FORM | 0.42 | 0.14 | 0.51 | 0.39 | 0.69 | 76 |
| IOG CALL | 0.12 | 0.41 | 0.49 | 0.37 | 0.66 | 76.66 |
| DIO HOLO | 0.17 | 0.1 | 0.48 | 0.43 | 0.65 | 77.31 |
| KYP SECT | 0.75 | 0.75 | 0.45 | 0.34 | 0.61 | 77.92 |
| OPI AURI | 0.01 | 0.57 | 0.45 | 0.39 | 0.61 | 78.53 |
| HAL RADI | 0.16 | 0.09 | 0.44 | 0.43 | 0.6 | 79.13 |
| LUT ANAL | 0.07 | 0.14 | 0.43 | 0.42 | 0.58 | 79.72 |
| POM PARU | 0.14 | 0.27 | 0.42 | 0.42 | 0.57 | 80.29 |
| CAL CALA | 0.08 | 0.19 | 0.4 | 0.4 | 0.54 | 80.83 |
| SPA RADI | 0.22 | 0.11 | 0.37 | 0.33 | 0.51 | 81.34 |
| BOD RUFU | 0.02 | 0.31 | 0.37 | 0.41 | 0.51 | 81.84 |
| SPA CHRY | 0.28 | 0.19 | 0.37 | 0.37 | 0.51 | 82.35 |
| URO JAMA | 0.08 | 0.06 | 0.36 | 0.35 | 0.49 | 82.84 |
| MAL MACR | 0.08 | 0.2 | 0.35 | 0.34 | 0.48 | 83.32 |
| MON HISP | 0.05 | 0.15 | 0.35 | 0.36 | 0.47 | 83.8 |
| HOL TRIC | 0 | 0.22 | 0.34 | 0.4 | 0.46 | 84.26 |
| PAR MARM | 0.08 | 0.07 | 0.34 | 0.34 | 0.46 | 84.72 |
| EMB PAND | 0.14 | 0.05 | 0.34 | 0.32 | 0.46 | 85.17 |
| GNA THOM | 0.07 | 0.22 | 0.33 | 0.35 | 0.45 | 85.62 |
| DIP HOLB | 0.25 | 0.03 | 0.31 | 0.35 | 0.43 | 86.04 |
| EPI CRUE | 0.02 | 0.18 | 0.31 | 0.4 | 0.42 | 86.46 |
| CAL PENN | 0.06 | 0.11 | 0.31 | 0.31 | 0.42 | 86.88 |
| CHA OCEL | 0.02 | 0.21 | 0.29 | 0.35 | 0.39 | 87.27 |
| LAC TRIQ | 0.05 | 0.08 | 0.28 | 0.34 | 0.38 | 87.65 |
| SPA SPE. | 0.14 | 0.27 | 0.27 | 0.26 | 0.37 | 88.02 |
| CLE PARR | 0.01 | 2.8 | 0.26 | 0.26 | 0.35 | 88.37 |
| SPA RUBR | 0.04 | 0.16 | 0.26 | 0.3 | 0.35 | 88.72 |
| CAN PULL | 0.05 | 0.07 | 0.26 | 0.32 | 0.35 | 89.07 |
| CHA CAPI | 0.02 | 0.19 | 0.26 | 0.31 | 0.35 | 89.42 |
| CRY ROSE | 0.01 | 0.62 | 0.25 | 0.26 | 0.34 | 89.76 |
| CHR CYAN | 0 | 0.28 | 0.25 | 0.32 | 0.34 | 90.1 |

**Table 4. Inshore reef versus offshore reef, SIMPER analysis.**

| Average Dissimilarity= 80.86% | | | | | | |
|---|---|---|---|---|---|---|
| | Group I | Group O | | | | |
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| POM PART | 0.56 | 25.51 | 4.27 | 2.19 | 5.28 | 5.28 |
| HAL GARN | 0.19 | 9.5 | 3.52 | 2.06 | 4.36 | 9.64 |
| HAL BIVI | 6.92 | 0.95 | 2.77 | 1.62 | 3.42 | 13.06 |
| THA BIFA | 7.31 | 19.72 | 2.57 | 1.17 | 3.18 | 16.24 |
| SPA AURO | 1.75 | 5.39 | 2.26 | 1.28 | 2.8 | 19.04 |
| CHA SEDE | 0.06 | 2.12 | 2.17 | 1.4 | 2.68 | 21.72 |
| SER TABA | 0.01 | 2.26 | 2.05 | 1.22 | 2.54 | 24.26 |
| CAN ROST | 0.39 | 2.06 | 2 | 1.34 | 2.47 | 26.73 |
| ACA BAHI | 7.34 | 4.09 | 1.99 | 1.16 | 2.47 | 29.2 |
| HAE PLUM | 3.29 | 1.25 | 1.87 | 1.14 | 2.32 | 31.52 |
| ACA CHIR | 2.99 | 2.38 | 1.84 | 1.05 | 2.28 | 33.8 |
| HAE SPE. | 22.35 | 8.76 | 1.84 | 0.61 | 2.28 | 36.08 |
| SCA TAEN | 0.73 | 2.58 | 1.74 | 1.04 | 2.15 | 38.23 |
| SER TIGR | 0.06 | 1.36 | 1.68 | 1.14 | 2.08 | 40.3 |
| POM VARI | 1.82 | 0.32 | 1.43 | 0.97 | 1.77 | 42.07 |
| SCA CROI | 1.11 | 1.45 | 1.29 | 0.8 | 1.6 | 43.67 |
| HAE FLAV | 10.32 | 1.06 | 1.29 | 0.7 | 1.6 | 45.27 |
| PSE MACU | 0.51 | 1.08 | 1.27 | 0.89 | 1.58 | 46.84 |
| BAL CAPR | 0.76 | 0.72 | 1.2 | 0.8 | 1.48 | 48.32 |
| HOL TRIC | 0 | 0.78 | 1.14 | 0.85 | 1.41 | 49.73 |
| ACA COER | 0.59 | 0.78 | 1.12 | 0.81 | 1.38 | 51.12 |
| SPA VIRI | 0.59 | 1.13 | 1.1 | 0.8 | 1.36 | 52.48 |
| COR GLAU | 1.37 | 0.55 | 1.1 | 0.72 | 1.36 | 53.83 |
| HYP UNIC | 0.07 | 0.71 | 1.08 | 0.83 | 1.34 | 55.17 |
| COR PERS | 0.63 | 12.25 | 1.03 | 0.48 | 1.28 | 56.45 |
| ANI VIRG | 1.15 | 0.81 | 1.02 | 0.76 | 1.27 | 57.71 |
| HAE SCIU | 1.06 | 1.33 | 0.98 | 0.69 | 1.21 | 58.92 |
| CHA OCEL | 0.02 | 0.73 | 0.92 | 0.67 | 1.14 | 60.06 |
| CHR CYAN | 0 | 3.14 | 0.92 | 0.57 | 1.14 | 61.2 |
| CAR RUBE | 0.53 | 1.09 | 0.91 | 0.64 | 1.13 | 62.33 |
| POM ARCU | 0.31 | 0.41 | 0.89 | 0.69 | 1.1 | 63.43 |
| EPI MORI | 0.38 | 0.21 | 0.84 | 0.68 | 1.04 | 64.48 |
| HAL MACU | 1.26 | 0.06 | 0.83 | 0.63 | 1.03 | 65.5 |
| POM LEUC | 0.66 | 0.15 | 0.82 | 0.63 | 1.01 | 66.51 |
| CLE PARR | 0.01 | 7.27 | 0.73 | 0.42 | 0.91 | 67.42 |
| SPA ATOM | 0.19 | 0.79 | 0.7 | 0.53 | 0.86 | 68.28 |
| HOL ADSC | 0.1 | 0.47 | 0.68 | 0.59 | 0.84 | 69.12 |
| HOL BERM | 0.05 | 0.33 | 0.63 | 0.55 | 0.78 | 69.9 |
| LAC MAXI | 0.1 | 0.34 | 0.63 | 0.56 | 0.78 | 70.68 |
| SER TORT | 0.13 | 1.33 | 0.62 | 0.41 | 0.76 | 71.44 |
| CHR SCOT | 0.01 | 2.09 | 0.61 | 0.45 | 0.75 | 72.2 |
| CAL CALA | 0.08 | 0.33 | 0.59 | 0.52 | 0.73 | 72.93 |
| EPI CRUE | 0.02 | 0.32 | 0.59 | 0.56 | 0.73 | 73.66 |

**Table 4 (cont). Inshore reef versus offshore reef, SIMPER analysis.**

| | Group I | Group O | | | | |
|---|---|---|---|---|---|---|
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| CHR INSO | 0 | 2.12 | 0.58 | 0.42 | 0.72 | 74.38 |
| POM PARU | 0.14 | 0.25 | 0.58 | 0.55 | 0.72 | 75.1 |
| OPI AURI | 0.01 | 0.56 | 0.52 | 0.4 | 0.65 | 75.75 |
| EQU ACUM | 0.57 | 0.02 | 0.51 | 0.46 | 0.64 | 76.39 |
| GOB OCEA | 1.05 | 0.05 | 0.51 | 0.46 | 0.63 | 77.02 |
| BOD RUFU | 0.02 | 0.31 | 0.49 | 0.49 | 0.61 | 77.63 |
| CAR CRYS | 2.21 | 0.08 | 0.46 | 0.32 | 0.57 | 78.19 |
| DIP ARGE | 0.49 | 0 | 0.45 | 0.37 | 0.56 | 78.75 |
| IOG CALL | 0.12 | 0.42 | 0.44 | 0.38 | 0.55 | 79.3 |
| OCY CHRY | 0.23 | 0.3 | 0.44 | 0.43 | 0.55 | 79.84 |
| ALU SCRI | 0 | 0.27 | 0.44 | 0.44 | 0.55 | 80.39 |
| HAE AURO | 2.91 | 1.17 | 0.44 | 0.33 | 0.54 | 80.93 |
| CHA CAPI | 0.02 | 0.36 | 0.44 | 0.42 | 0.54 | 81.48 |
| POM FUSC | 0.49 | 0.06 | 0.44 | 0.42 | 0.54 | 82.02 |
| SPH SPEN | 0.02 | 0.19 | 0.42 | 0.42 | 0.52 | 82.54 |
| ABU SAXA | 0.86 | 0.06 | 0.42 | 0.39 | 0.52 | 83.05 |
| MON HISP | 0.05 | 0.16 | 0.4 | 0.42 | 0.49 | 83.55 |
| HOL CILI | 0.06 | 0.16 | 0.38 | 0.43 | 0.48 | 84.02 |
| DIP FORM | 0.42 | 0.03 | 0.38 | 0.36 | 0.48 | 84.5 |
| LUT ANAL | 0.07 | 0.13 | 0.38 | 0.42 | 0.46 | 84.96 |
| KYP SECT | 0.75 | 0.39 | 0.36 | 0.36 | 0.45 | 85.41 |
| DIO HOLO | 0.17 | 0.03 | 0.36 | 0.4 | 0.45 | 85.86 |
| LUT GRIS | 0.39 | 0.22 | 0.36 | 0.4 | 0.45 | 86.31 |
| SPA RADI | 0.22 | 0.24 | 0.36 | 0.36 | 0.44 | 86.75 |
| SPA CHRY | 0.28 | 0.13 | 0.33 | 0.37 | 0.4 | 87.16 |
| URO JAMA | 0.08 | 0.06 | 0.32 | 0.37 | 0.4 | 87.55 |
| HEM SPLE | 0.23 | 0.01 | 0.32 | 0.33 | 0.4 | 87.95 |
| HAL RADI | 0.16 | 0.03 | 0.32 | 0.38 | 0.39 | 88.35 |
| DIP HOLB | 0.25 | 0.21 | 0.26 | 0.33 | 0.33 | 88.67 |
| MAL PLUM | 0 | 0.13 | 0.26 | 0.32 | 0.33 | 89 |
| CRY ROSE | 0.01 | 0.6 | 0.26 | 0.26 | 0.32 | 89.32 |
| LAC QUAD | 0.05 | 0.11 | 0.26 | 0.34 | 0.32 | 89.65 |
| EMB PAND | 0.14 | 0.06 | 0.26 | 0.3 | 0.32 | 89.97 |
| LAC TRIQ | 0.05 | 0.09 | 0.26 | 0.35 | 0.32 | 90.29 |

**Table 5. Offshore east north versus south of Port Everglades, SIMPER analysis.**

| Average Dissimilarity= 74.26% | | | | | | |
|---|---|---|---|---|---|---|
| | Group S | Group N | | | | |
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| COR PERS | 1.11 | 67.95 | 15.43 | 0.74 | 20.78 | 20.78 |
| POM PART | 13.28 | 33.05 | 9.75 | 1.3 | 13.13 | 33.91 |
| THA BIFA | 3.33 | 13.4 | 4.38 | 1.14 | 5.89 | 39.81 |
| HAL GARN | 2.39 | 13.55 | 4.31 | 1.07 | 5.81 | 45.61 |
| CHR INSO | 0.78 | 12.95 | 3.94 | 0.87 | 5.31 | 50.92 |
| CLE PARR | 0.17 | 16.85 | 3.88 | 0.56 | 5.23 | 56.15 |
| SER TORT | 2.61 | 4.4 | 3.14 | 0.62 | 4.22 | 60.38 |
| CHR SCOT | 0 | 8.95 | 2.95 | 0.62 | 3.97 | 64.35 |
| SPA AURO | 4.61 | 3.9 | 1.67 | 1.15 | 2.25 | 66.6 |
| SCA TAEN | 1.78 | 2.75 | 1.43 | 0.87 | 1.93 | 68.53 |
| CHR CYAN | 0.06 | 5.05 | 1.42 | 0.68 | 1.91 | 70.44 |
| ACA CHIR | 1.5 | 1.35 | 1.27 | 0.5 | 1.71 | 72.15 |
| ACA BAHI | 0.94 | 1.75 | 1.15 | 0.59 | 1.56 | 73.71 |
| HAE PLUM | 0.67 | 1.45 | 1.14 | 0.34 | 1.54 | 75.25 |
| SER TABA | 2.44 | 2.55 | 1.1 | 0.95 | 1.48 | 76.73 |
| SCA CROI | 0.72 | 1.7 | 1.06 | 0.57 | 1.43 | 78.16 |
| CAR RUBE | 0.72 | 0.9 | 0.9 | 0.38 | 1.21 | 79.37 |
| CHA SEDE | 2.28 | 2.3 | 0.89 | 0.78 | 1.2 | 80.57 |
| SER TIGR | 1.06 | 1.75 | 0.83 | 0.93 | 1.11 | 81.68 |
| CAN ROST | 2.11 | 2.2 | 0.78 | 1.18 | 1.05 | 82.73 |
| PSE MACU | 1.11 | 0.4 | 0.69 | 0.42 | 0.92 | 83.65 |
| HOL TRIC | 1.33 | 1.8 | 0.66 | 1.08 | 0.89 | 84.55 |
| SPH BARR | 0.33 | 0.7 | 0.66 | 0.29 | 0.88 | 85.43 |
| SPA ATOM | 0 | 0.95 | 0.54 | 0.33 | 0.73 | 86.16 |
| COR GLAU | 0.89 | 0.4 | 0.54 | 0.46 | 0.72 | 86.88 |
| HOL ADSC | 0.44 | 0.85 | 0.52 | 0.5 | 0.7 | 87.58 |
| CHA OCEL | 0.67 | 0.85 | 0.48 | 0.76 | 0.64 | 88.23 |
| IOG CALL | 0.94 | 0 | 0.47 | 0.34 | 0.64 | 88.86 |
| HYP UNIC | 1 | 1 | 0.46 | 1.02 | 0.62 | 89.49 |
| OPI AURI | 0.61 | 0.6 | 0.43 | 0.55 | 0.58 | 90.07 |

**Table 6. Middle east north versus south of Port Everglades, SIMPER analysis.**

| Average dissimilarity= 74.26% | | | | | | |
|---|---|---|---|---|---|---|
| | Group S | Group N | | | | |
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| THA BIFA | 5.05 | 17.1 | 7.66 | 1.16 | 10.32 | 10.32 |
| COR PERS | 5.52 | 17.7 | 7.33 | 0.49 | 9.87 | 20.19 |
| POM PART | 6.24 | 16.3 | 6.3 | 1.37 | 8.49 | 28.68 |
| HAL GARN | 2.05 | 12.6 | 5.16 | 1.04 | 6.96 | 35.63 |
| SER TORT | 4.76 | 6.35 | 5.01 | 0.75 | 6.75 | 42.38 |
| HAR JAGU | 47.62 | 0 | 4.01 | 0.22 | 5.41 | 47.79 |
| ACA BAHI | 6 | 4.35 | 3.72 | 0.91 | 5.02 | 52.81 |
| SPA AURO | 4.33 | 3.55 | 2.48 | 0.92 | 3.34 | 56.14 |
| CRY ROSE | 0 | 4.55 | 1.86 | 0.44 | 2.51 | 58.65 |
| HAL BIVI | 2.29 | 1.3 | 1.86 | 0.72 | 2.5 | 61.15 |
| SCA CROI | 1.19 | 2.15 | 1.78 | 0.55 | 2.4 | 63.56 |
| COR GLAU | 1.62 | 3.2 | 1.73 | 0.75 | 2.33 | 65.88 |
| ACA CHIR | 0.14 | 2.95 | 1.64 | 0.58 | 2.21 | 68.09 |
| BAL CAPR | 2.38 | 2.45 | 1.63 | 1.09 | 2.19 | 70.28 |
| OPI AURI | 1.9 | 1.7 | 1.52 | 0.64 | 2.05 | 72.33 |
| SER TABA | 2.19 | 1.95 | 1.39 | 1.02 | 1.87 | 74.2 |
| SER TIGR | 0.67 | 2.45 | 1.15 | 1.49 | 1.54 | 75.75 |
| IOG CALL | 1.95 | 0.45 | 1.13 | 0.46 | 1.52 | 77.27 |
| CAN ROST | 0.86 | 2.3 | 1 | 1.21 | 1.35 | 78.62 |
| EPI MORI | 0 | 1.7 | 0.93 | 1.28 | 1.26 | 79.87 |
| HAE PLUM | 1.29 | 0.6 | 0.9 | 0.64 | 1.22 | 81.09 |
| CHA SEDE | 1.24 | 2.1 | 0.86 | 0.86 | 1.16 | 82.25 |
| SPA SPE. | 1.19 | 0 | 0.73 | 0.26 | 0.99 | 83.24 |
| HYP UNIC | 1 | 0.65 | 0.7 | 0.85 | 0.94 | 84.18 |
| LAC MAXI | 0.1 | 1.45 | 0.69 | 0.65 | 0.93 | 85.11 |
| HOL ADSC | 0.86 | 0.5 | 0.61 | 0.87 | 0.82 | 85.93 |
| ANI VIRG | 0 | 0.9 | 0.58 | 0.45 | 0.79 | 86.72 |
| POM VARI | 0.19 | 0.9 | 0.57 | 0.62 | 0.77 | 87.48 |
| SPA VIRI | 0.48 | 0.55 | 0.5 | 0.56 | 0.67 | 88.15 |
| POM ARCU | 0.43 | 0.7 | 0.49 | 0.94 | 0.66 | 88.81 |
| HOL TRIC | 0.14 | 0.8 | 0.48 | 0.77 | 0.65 | 89.46 |
| SCA TAEN | 0.24 | 0.75 | 0.46 | 0.36 | 0.62 | 90.08 |

**Table 7. Inshore west north versus south of Port Everglades, SIMPER analysis.**

| Average dissimilarity= 85.63% | | | | | | |
|---|---|---|---|---|---|---|
| | Group S | Group N | | | | |
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| HAE SPE. | 15.65 | 55.57 | 24.83 | 1.08 | 29 | 29 |
| HAE FLAV | 27 | 0.19 | 10.78 | 0.82 | 12.59 | 41.59 |
| ACA BAHI | 8.15 | 6.29 | 5.51 | 0.77 | 6.44 | 48.03 |
| THA BIFA | 8.75 | 1.52 | 5.06 | 0.7 | 5.91 | 53.93 |
| HAL BIVI | 5.1 | 4.67 | 3.79 | 0.71 | 4.43 | 58.36 |
| HAE PLUM | 4.6 | 2.05 | 3.07 | 0.91 | 3.59 | 61.95 |
| POM VARI | 5.25 | 1.33 | 2.54 | 1.09 | 2.97 | 64.92 |
| COR GLAU | 3.6 | 1.29 | 2.29 | 0.55 | 2.68 | 67.6 |
| HAE AURO | 6.45 | 0.14 | 2.29 | 0.33 | 2.68 | 70.27 |
| SCA CROI | 2.9 | 0.67 | 1.91 | 0.72 | 2.23 | 72.5 |
| PEM SCHO | 0 | 5.24 | 1.56 | 0.32 | 1.82 | 74.33 |
| SPA AURO | 2.4 | 0.48 | 1.37 | 0.79 | 1.6 | 75.92 |
| DIP FORM | 0.05 | 2.52 | 1.34 | 0.41 | 1.56 | 77.48 |
| ACA CHIR | 0.7 | 1.48 | 1.22 | 0.48 | 1.42 | 78.9 |
| GOB OCEA | 0.5 | 1.43 | 1.09 | 0.35 | 1.27 | 80.18 |
| CAR RUBE | 1.5 | 0.24 | 0.96 | 0.5 | 1.13 | 81.3 |
| SCA TAEN | 1.3 | 0 | 0.76 | 0.6 | 0.89 | 82.19 |
| BAL CAPR | 0.8 | 0.95 | 0.74 | 0.66 | 0.87 | 83.06 |
| POM LEUC | 0.5 | 0.57 | 0.73 | 0.51 | 0.86 | 83.92 |
| POM PLAN | 1.4 | 0 | 0.68 | 0.42 | 0.79 | 84.71 |
| COR PERS | 1.8 | 0 | 0.65 | 0.4 | 0.76 | 85.48 |
| HAL MACU | 0.6 | 0.29 | 0.63 | 0.55 | 0.73 | 86.21 |
| SER TORT | 1.25 | 0 | 0.63 | 0.38 | 0.73 | 86.94 |
| HAE SCIU | 0.8 | 0.14 | 0.62 | 0.41 | 0.72 | 87.66 |
| ACA COER | 0.75 | 0.43 | 0.61 | 0.54 | 0.71 | 88.38 |
| ANI VIRG | 0.85 | 0.38 | 0.57 | 0.64 | 0.67 | 89.04 |
| MIC CARR | 0.1 | 0.43 | 0.54 | 0.29 | 0.64 | 89.68 |
| DIO HOLO | 0.15 | 0.57 | 0.51 | 0.36 | 0.6 | 90.28 |

**Table 8. Total reefs north versus south of Hillsboro Inlet SIMPER, analysis.**

| Average dissimilarity= 79.33% | | | | | | |
|---|---|---|---|---|---|---|
| | **Group S** | **Group N** | | | | |
| **Species** | **Av.Abund** | **Av.Abund** | **Av.Diss** | **Diss/SD** | **Contrib%** | **Cum.%** |
| POM PART | 13.42 | 29.25 | 10.86 | 1.13 | 13.69 | 13.69 |
| THA BIFA | 13.36 | 26.19 | 8.79 | 1.06 | 11.07 | 24.76 |
| HAE SPE. | 10.41 | 23.01 | 5.84 | 0.38 | 7.36 | 32.13 |
| HAL GARN | 5.4 | 6.74 | 3.56 | 0.89 | 4.49 | 36.61 |
| COR PERS | 1.24 | 11.14 | 3.28 | 0.4 | 4.14 | 40.75 |
| ACA BAHI | 4.8 | 5.31 | 2.73 | 0.74 | 3.45 | 44.2 |
| HAL BIVI | 4.86 | 1.73 | 2.58 | 0.76 | 3.25 | 47.45 |
| CLE PARR | 3.48 | 9.43 | 2.56 | 0.39 | 3.23 | 50.68 |
| SPA AURO | 3.29 | 4.78 | 2.34 | 0.96 | 2.95 | 53.63 |
| CAR CRYS | 0.02 | 3.81 | 2.01 | 0.23 | 2.53 | 56.17 |
| ACA CHIR | 2.94 | 2 | 1.82 | 0.62 | 2.3 | 58.46 |
| HAE FLAV | 1.83 | 3.92 | 1.62 | 0.44 | 2.05 | 60.51 |
| HAE AURO | 1.23 | 4.29 | 1.31 | 0.33 | 1.65 | 62.16 |
| HAE PLUM | 1.85 | 1.24 | 1.22 | 0.47 | 1.54 | 63.7 |
| HAE SCIU | 0.73 | 2.87 | 1.16 | 0.39 | 1.46 | 65.16 |
| SPA ATOM | 0.61 | 1.72 | 1.06 | 0.46 | 1.34 | 66.5 |
| SER TABA | 1.37 | 1.21 | 1.02 | 0.65 | 1.28 | 67.78 |
| PSE MACU | 0.6 | 2.27 | 1 | 0.7 | 1.27 | 69.05 |
| SCA TAEN | 1.6 | 1.7 | 0.97 | 0.63 | 1.22 | 70.27 |
| CAN ROST | 1.2 | 1.7 | 0.87 | 0.88 | 1.09 | 71.37 |
| ABU SAXA | 0.59 | 1.55 | 0.85 | 0.34 | 1.07 | 72.44 |
| CHA SEDE | 0.87 | 1.43 | 0.83 | 0.59 | 1.05 | 73.48 |
| ANI VIRG | 0.73 | 1.43 | 0.81 | 0.42 | 1.02 | 74.5 |
| CHR CYAN | 1.1 | 1.39 | 0.78 | 0.32 | 0.98 | 75.48 |
| DIP ARGE | 0.8 | 0.54 | 0.77 | 0.3 | 0.97 | 76.45 |
| SER TIGR | 0.95 | 1.19 | 0.74 | 0.75 | 0.94 | 77.39 |
| CHR MULT | 0.09 | 2.29 | 0.71 | 0.28 | 0.9 | 78.29 |
| KYP SECT | 1.37 | 0.68 | 0.7 | 0.2 | 0.89 | 79.18 |
| BAL CAPR | 0.62 | 0.93 | 0.7 | 0.54 | 0.89 | 80.06 |
| ACA COER | 0.5 | 1.35 | 0.65 | 0.56 | 0.82 | 80.88 |
| CAR RUBE | 0.74 | 1.06 | 0.58 | 0.42 | 0.73 | 81.61 |
| SCA CROI | 1.09 | 0.46 | 0.52 | 0.48 | 0.66 | 82.27 |
| CHR SCOT | 0.42 | 1.37 | 0.5 | 0.25 | 0.63 | 82.91 |
| SPA VIRI | 0.97 | 0.65 | 0.5 | 0.44 | 0.63 | 83.54 |
| POM VARI | 0.62 | 0.6 | 0.48 | 0.49 | 0.6 | 84.14 |
| SER TORT | 0.29 | 0.75 | 0.48 | 0.27 | 0.6 | 84.74 |
| OPI AURI | 0.45 | 0.36 | 0.43 | 0.25 | 0.54 | 85.28 |
| HAE CHRY | 1.8 | 0.19 | 0.43 | 0.19 | 0.54 | 85.82 |
| SEL CRUM | 0.39 | 1.02 | 0.42 | 0.14 | 0.53 | 86.35 |
| HAL MACU | 0.77 | 0.13 | 0.41 | 0.31 | 0.52 | 86.87 |
| POM LEUC | 0.6 | 0.43 | 0.4 | 0.44 | 0.51 | 87.37 |
| CHR INSO | 0.94 | 0.18 | 0.37 | 0.21 | 0.46 | 87.83 |
| CRY ROSE | 0.08 | 0.57 | 0.34 | 0.25 | 0.43 | 88.27 |
| SPA RADI | 0.34 | 0.36 | 0.33 | 0.33 | 0.42 | 88.68 |
| POM ARCU | 0.27 | 0.44 | 0.32 | 0.47 | 0.4 | 89.08 |
| OCY CHRY | 0.09 | 0.79 | 0.3 | 0.25 | 0.38 | 89.46 |
| POM FUSC | 0.51 | 0.07 | 0.27 | 0.27 | 0.35 | 89.81 |
| HYP UNIC | 0.41 | 0.45 | 0.27 | 0.66 | 0.35 | 90.15 |

**Table 9. Middle reef north versus south of Hillsboro Inlet SIMPER, analysis.**

| Average dissimilarity= 79.36% | | | | | | |
|---|---|---|---|---|---|---|
| | Group S | Group N | | | | |
| **Species** | **Av.Abund** | **Av.Abund** | **Av.Diss** | **Diss/SD** | **Contrib%** | **Cum.%** |
| HAE SPE. | 23.78 | 51.09 | 11.23 | 0.51 | 14.15 | 14.15 |
| POM PART | 7.44 | 30.87 | 10.44 | 1.29 | 13.16 | 27.31 |
| THA BIFA | 10.69 | 29.98 | 9.15 | 1.02 | 11.53 | 38.83 |
| COR PERS | 2.13 | 17.2 | 4.86 | 0.51 | 6.12 | 44.95 |
| HAL GARN | 3.04 | 6.63 | 2.95 | 1.04 | 3.72 | 48.68 |
| HAL BIVI | 6.8 | 2.61 | 2.65 | 0.96 | 3.34 | 52.01 |
| ACA BAHI | 5.69 | 4.89 | 2.38 | 0.94 | 3 | 55.02 |
| SPA AURO | 2.4 | 4.89 | 2.07 | 0.98 | 2.61 | 57.63 |
| HAE FLAV | 3.6 | 3.83 | 1.93 | 0.5 | 2.44 | 60.07 |
| CLE PARR | 0 | 11.74 | 1.91 | 0.37 | 2.41 | 62.48 |
| ACA CHIR | 2.96 | 1.3 | 1.4 | 0.63 | 1.77 | 64.25 |
| SPA ATOM | 0.6 | 2.02 | 1.3 | 0.44 | 1.64 | 65.88 |
| PSE MACU | 0.36 | 2.57 | 1.22 | 0.68 | 1.54 | 67.42 |
| HAE PLUM | 2.49 | 0.85 | 1.22 | 0.38 | 1.53 | 68.95 |
| CHR MULT | 0 | 4.28 | 1.2 | 0.35 | 1.51 | 70.46 |
| HAE AURO | 0.13 | 5.3 | 1.05 | 0.27 | 1.33 | 71.79 |
| KYP SECT | 3.42 | 0 | 1.05 | 0.2 | 1.32 | 73.11 |
| SER TABA | 1.31 | 1.13 | 0.99 | 0.63 | 1.25 | 74.36 |
| BAL CAPR | 1.2 | 1.35 | 0.97 | 0.63 | 1.22 | 75.58 |
| CAN ROST | 1.02 | 2 | 0.9 | 0.86 | 1.13 | 76.71 |
| SER TIGR | 1.13 | 1.46 | 0.87 | 0.8 | 1.09 | 77.8 |
| HAL MACU | 1.62 | 0.3 | 0.8 | 0.44 | 1.01 | 78.81 |
| ABU SAXA | 1.47 | 1.09 | 0.77 | 0.4 | 0.97 | 79.78 |
| HAE SCIU | 1.27 | 1.24 | 0.76 | 0.34 | 0.96 | 80.73 |
| ANI VIRG | 0.82 | 0.98 | 0.66 | 0.36 | 0.83 | 81.57 |
| ACA COER | 0.4 | 1.61 | 0.63 | 0.73 | 0.79 | 82.36 |
| HAE CHRY | 2.47 | 0.11 | 0.61 | 0.21 | 0.77 | 83.13 |
| CHA SEDE | 0.53 | 1.15 | 0.6 | 0.79 | 0.76 | 83.89 |
| CAR CRYS | 0.02 | 1.63 | 0.6 | 0.15 | 0.76 | 84.65 |
| DIP ARGE | 1.47 | 0.09 | 0.53 | 0.25 | 0.66 | 85.31 |
| POM VARI | 0.47 | 1.02 | 0.52 | 0.45 | 0.66 | 85.97 |
| OPI AURI | 0.13 | 0.76 | 0.48 | 0.33 | 0.61 | 86.58 |
| SER TORT | 0.51 | 0.37 | 0.41 | 0.34 | 0.52 | 87.1 |
| SCA TAEN | 0.42 | 0.63 | 0.36 | 0.53 | 0.45 | 87.56 |
| SPA VIRI | 0.4 | 0.67 | 0.36 | 0.45 | 0.45 | 88.01 |
| POM LEUC | 0.53 | 0.63 | 0.33 | 0.57 | 0.42 | 88.43 |
| POM ARCU | 0.36 | 0.41 | 0.33 | 0.44 | 0.42 | 88.84 |
| GNA THOM | 0.02 | 0.7 | 0.32 | 0.33 | 0.41 | 89.25 |
| MIC CARR | 0.07 | 0.41 | 0.3 | 0.22 | 0.38 | 89.63 |
| HOL ADSC | 0.51 | 0.46 | 0.3 | 0.62 | 0.38 | 90.01 |

**Table 10. Middle west north versus south of Hillsboro Inlet, SIMPER analysis.**

| Average dissimilarity= 88.95% | | | | | | |
|---|---|---|---|---|---|---|
| | **Group S** | **Group N** | | | | |
| **Species** | **Av.Abund** | **Av.Abund** | **Av.Diss** | **Diss/SD** | **Contrib%** | **Cum.%** |
| HAE SPE. | 65.71 | 140 | 24.53 | 0.82 | 27.57 | 27.57 |
| POM PART | 0.86 | 31.33 | 10 | 1.17 | 11.24 | 38.82 |
| THA BIFA | 4.29 | 31.73 | 8.49 | 0.84 | 9.54 | 48.36 |
| COR PERS | 0 | 20 | 3.5 | 0.53 | 3.94 | 52.29 |
| HAL GARN | 0.07 | 6.13 | 2.84 | 0.86 | 3.19 | 55.48 |
| ACA BAHI | 4.64 | 6.6 | 2.78 | 0.91 | 3.13 | 58.61 |
| CLE PARR | 0 | 23.2 | 2.62 | 0.38 | 2.95 | 61.56 |
| HAL BIVI | 5.79 | 3.53 | 2.39 | 0.77 | 2.68 | 64.25 |
| PSE MACU | 0.43 | 4.07 | 2.29 | 0.66 | 2.58 | 66.82 |
| HAE PLUM | 7.14 | 0.2 | 2.2 | 0.47 | 2.47 | 69.3 |
| HAE FLAV | 6.71 | 3.87 | 2.14 | 0.49 | 2.41 | 71.7 |
| CAR CRYS | 0.07 | 5 | 1.9 | 0.26 | 2.14 | 73.84 |
| SPA AURO | 0.64 | 4.2 | 1.88 | 0.96 | 2.11 | 75.95 |
| SPA ATOM | 0 | 1.67 | 1.4 | 0.34 | 1.57 | 77.52 |
| ACA CHIR | 2.93 | 1.53 | 1.22 | 0.67 | 1.37 | 78.89 |
| BAL CAPR | 1.43 | 0.6 | 1.04 | 0.4 | 1.17 | 80.06 |
| MIC CARR | 0.21 | 1.27 | 0.99 | 0.38 | 1.11 | 81.17 |
| ABU SAXA | 2.14 | 2.73 | 0.99 | 0.55 | 1.11 | 82.28 |
| CAN ROST | 0.14 | 2.4 | 0.99 | 0.74 | 1.11 | 83.39 |
| POM VARI | 0.71 | 1.93 | 0.91 | 0.48 | 1.02 | 84.41 |
| HAE CHRY | 3.57 | 0.33 | 0.63 | 0.29 | 0.71 | 85.12 |
| HAE AURO | 0.43 | 5.73 | 0.61 | 0.39 | 0.69 | 85.81 |
| OPI AURI | 0 | 0.93 | 0.59 | 0.25 | 0.66 | 86.47 |
| ANI VIRG | 1.71 | 0.13 | 0.52 | 0.32 | 0.58 | 87.05 |
| GOB OCEA | 1.57 | 0.8 | 0.52 | 0.32 | 0.58 | 87.64 |
| CHR MULT | 0 | 2.93 | 0.51 | 0.31 | 0.57 | 88.21 |
| HEM SPLE | 1.29 | 0 | 0.49 | 0.44 | 0.55 | 88.76 |
| HAL MACU | 1.14 | 0.4 | 0.48 | 0.48 | 0.54 | 89.29 |
| EQU ACUM | 0.93 | 0 | 0.44 | 0.45 | 0.5 | 89.79 |
| KYP SECT | 2.36 | 0 | 0.41 | 0.31 | 0.46 | 90.24 |

**Table 11. Middle crest north versus south of Hillsboro Inlet, SIMPER analysis.**

Average dissimilarity= 79.78%

| | Group S | Group N | | | | |
|---|---|---|---|---|---|---|
| **Species** | **Av.Abund** | **Av.Abund** | **Av.Diss** | **Diss/SD** | **Contrib%** | **Cum.%** |
| POM PART | 4.67 | 36.4 | 13.66 | 1.44 | 17.13 | 17.13 |
| THA BIFA | 13.8 | 42.53 | 12.48 | 1.32 | 15.64 | 32.77 |
| HAL BIVI | 9.73 | 2.4 | 3.45 | 1.33 | 4.33 | 37.1 |
| HAE FLAV | 4.53 | 7.87 | 3.32 | 0.82 | 4.16 | 41.25 |
| CHR MULT | 0 | 9.13 | 3.07 | 0.58 | 3.85 | 45.11 |
| CLE PARR | 0 | 11.07 | 2.94 | 0.54 | 3.69 | 48.8 |
| HAL GARN | 0.33 | 6.8 | 2.92 | 1.4 | 3.66 | 52.46 |
| SPA AURO | 1.6 | 6.67 | 2.79 | 1.28 | 3.5 | 55.95 |
| HAE AURO | 0 | 10.53 | 2.68 | 0.42 | 3.36 | 59.31 |
| KYP SECT | 8.07 | 0 | 2.64 | 0.32 | 3.31 | 62.62 |
| ACA BAHI | 6.73 | 5.13 | 2.44 | 1.08 | 3.06 | 65.67 |
| HAE SPE. | 0 | 3.33 | 1.67 | 0.26 | 2.1 | 67.77 |
| HAL MACU | 3.6 | 0.47 | 1.63 | 0.69 | 2.04 | 69.82 |
| SPA ATOM | 0.07 | 2.53 | 1.58 | 0.42 | 1.98 | 71.8 |
| HAE SCIU | 1.53 | 3.33 | 1.51 | 0.43 | 1.89 | 73.68 |
| DIP ARGE | 4 | 0 | 1.38 | 0.42 | 1.73 | 75.42 |
| ABU SAXA | 2.4 | 0.6 | 1.21 | 0.52 | 1.51 | 76.93 |
| HAE CHRY | 4.07 | 0 | 1.16 | 0.27 | 1.46 | 78.39 |
| ANI VIRG | 0.87 | 2.07 | 1.08 | 0.47 | 1.36 | 79.74 |
| ACA CHIR | 2.07 | 0.73 | 1.04 | 0.63 | 1.3 | 81.05 |
| PSE MACU | 0.27 | 2.53 | 1.03 | 0.97 | 1.29 | 82.33 |
| COR PERS | 0 | 3.27 | 0.97 | 0.41 | 1.22 | 83.55 |
| CAN ROST | 0.13 | 1.73 | 0.77 | 0.89 | 0.96 | 84.51 |
| HAE PLUM | 0.53 | 1.53 | 0.74 | 0.87 | 0.93 | 85.44 |
| ACA COER | 0.27 | 1.8 | 0.67 | 1.08 | 0.84 | 86.28 |
| SER TIGR | 0 | 1.2 | 0.63 | 0.88 | 0.78 | 87.06 |
| POM VARI | 0.67 | 1.13 | 0.6 | 0.79 | 0.75 | 87.82 |
| POM LEUC | 0.93 | 1.33 | 0.57 | 0.86 | 0.72 | 88.53 |
| BAL CAPR | 0.8 | 0.4 | 0.5 | 0.67 | 0.63 | 89.16 |
| CAR RUBE | 1.33 | 0.2 | 0.49 | 0.39 | 0.62 | 89.78 |
| SPA VIRI | 0.2 | 1.27 | 0.46 | 0.87 | 0.58 | 90.36 |

**Table 12. Inshore crest north versus south of Hillsboro Inlet, SIMPER analysis.**

| Average dissimilarity= 81.40% | | | | | | |
|---|---|---|---|---|---|---|
| | Group S | Group N | | | | |
| Species | Av.Abund | Av.Abund | Av.Diss | Diss/SD | Contrib% | Cum.% |
| CAR CRYS | 0 | 39 | 24.29 | 0.94 | 29.84 | 29.84 |
| THA BIFA | 7.5 | 9.5 | 5.67 | 1.16 | 6.97 | 36.8 |
| HAL BIVI | 9.75 | 4.17 | 5.25 | 1.14 | 6.45 | 43.25 |
| ACA BAHI | 7 | 10 | 4.35 | 1.6 | 5.34 | 48.59 |
| ABU SAXA | 0.33 | 9 | 4.34 | 0.92 | 5.33 | 53.92 |
| HAE SPE. | 0 | 9.67 | 3.65 | 0.54 | 4.49 | 58.41 |
| HAE SCIU | 0.67 | 6.83 | 3.03 | 0.95 | 3.72 | 62.13 |
| KYP SECT | 0.17 | 4.17 | 2.89 | 0.76 | 3.54 | 65.67 |
| LUT GRIS | 0 | 5.83 | 2.24 | 0.56 | 2.76 | 68.43 |
| DIP ARGE | 0.58 | 3.5 | 2.22 | 1.15 | 2.73 | 71.15 |
| HAE FLAV | 0.92 | 4 | 1.92 | 0.75 | 2.35 | 73.51 |
| ACA CHIR | 3.75 | 1.5 | 1.76 | 0.88 | 2.16 | 75.66 |
| CAR RUBE | 0.58 | 3.33 | 1.65 | 0.69 | 2.03 | 77.69 |
| HAE PLUM | 2.42 | 1.17 | 1.51 | 0.9 | 1.86 | 79.55 |
| POM LEUC | 2 | 0.33 | 1.33 | 0.64 | 1.64 | 81.19 |
| HAE AURO | 0 | 3.33 | 1.22 | 0.44 | 1.5 | 82.69 |
| ANI VIRG | 1.33 | 1.67 | 1.2 | 0.96 | 1.47 | 84.16 |
| SEL CRUM | 0 | 1.67 | 1.11 | 0.44 | 1.37 | 85.53 |
| POM VARI | 1.92 | 0.83 | 1.08 | 1.04 | 1.33 | 86.86 |
| POM FUSC | 1.42 | 0.33 | 0.83 | 0.71 | 1.02 | 87.87 |
| POM PART | 1.25 | 0.33 | 0.8 | 0.53 | 0.98 | 88.86 |
| HAE CHRY | 0 | 1.67 | 0.76 | 0.44 | 0.94 | 89.8 |
| HAL MACU | 0.92 | 0 | 0.53 | 0.47 | 0.65 | 90.44 |

**Table 13. Total and legal size groupers counted.**

| Species | # Total | # Legal | Legal Size (cm) |
|---|---|---|---|
| *Epinephelus adscensionis* | 4 | N/A | - |
| *Epinephelus cruentatus* | 127 | N/A | - |
| *Epinephelus fulvus* | 2 | N/A | - |
| *Epinephelus guttatus* | 8 | N/A | - |
| *Epinephelus morio* | 232 | 2 | 50.8 |
| *Mycteroperca interstitialis* | 1 | 0 | 50.8 |
| *Mycteroperca phenax* | 8 | 0 | 50.8 |
| *Mycteroperca venenosa* | 1 | 0 | 50.8 |

**Table 14. Total and legal size snappers counted.**

| Species | # Total | # Legal | Legal Size (cm) |
|---|---|---|---|
| *Lutjanus analis* | 84 | 16 | 40.6 |
| *Lutjanus apodus* | 34 | 27 | 25.4 |
| *Lutjanus griseus* | 188 | 72 | 25.4 |
| *Lutjanus synagris* | 99 | 71 | 20.3 |
| *Ocyrus chrysurus* | 312 | 33 | 30.5 |
| *Lutjanus jocu* | 1 | 0 | 30.5 |