Epilithic community structure and connectivity with fish assemblages on the nearshore hardbottom in Broward County, Florida

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Abstract:

Transect data characterizing nearshore epilithic communities (55 sites) and counts of associated fishes (40 co-located sites) were collected during 2001 as part of the environmental impact study of a planned beach nourishment project (Broward County, FL). The ichthyological data was presented previously (Baron et al., GCFI 2001). This poster presents epilithic invertebrate data and explores relationships between community structure, rugosity, and fish assemblages.

The study assessed differences in epilithos between nearshore hardbottom areas to be directly buried and hardbottom communities potentially subjected to secondary impacts of sedimentation and turbidity during project construction. Epilithic communities adjacent to previously nourished beaches are compared to never nourished beaches.

Fifty-five sites were investigated using belt transects along the 30 km coastline. Sample sizes ranged from seven to twenty-four square meters dependent upon sampling sufficiency for scleractinian coral diversity. Sampling produced an organism inventory and estimates of percent cover for scleractinians, octocorals, zoanthids/hydroids, and sponges. Cover alone was assessed for macroalgae, turf algae, and cyanobacteria. Sixty-one faunal species and twenty-four algal species were recorded. Macroalgae and cyanobacteria are the two principal components of the epilithos. Faunal species density was 4.6 organisms/square meter, and mean algal/cyanobacterial coverage was 20.4%. Individual scleractinian cover ranged from 0% to 28.3%. Mean percent cover by algae and cyanobacteria was highest immediately south of Port Everglades Inlet at the sites to be directly buried (mean percent cover of 48.4%). Comparisons of species diversity and scleractinian coral coverage from previously nourished sites to never nourished sites are made. The dominance of cyanobacteria and macroalgae on the nearshore hardbottom immediately south of Port Everglades Inlet is indicative of nutrification effects potentially resulting from terrestrial sources of pollution.

Forty hardbottom characterization sites are co-located with fish point-count sites and were used to examine connectivity between epilithic communities and fish assemblages in the nearshore environment.

Introduction:

Broward County is located on the southeast coast of Florida, U.S.A (Figure 1). The reef distribution pattern in southeast Florida consists of three or more parallel reef tracts, and a nearshore ridge complex that occurs from the shoreline to water depths of approximately 7 meters. The nearshore ridge complex (commonly referred to as nearshore hardbottom) is located in a physically stressed environment subject to variable wave action, sediment transport and turbulence. Nearshore hardbottom habitat has been commonly described as ephemeral due to the periodic burial and uncovering by shifting beach sand. Past studies have suggested the large rock outcrops may provide more permanent habitat in the nearshore (Gilmore et al, 1981, Continental Shelf Associates, 1985, 1987). Large outcrops usually display increased habitat heterogeneity, resulting in elevated biomass, species abundance, and richness (Peters and Nelson, 1987).

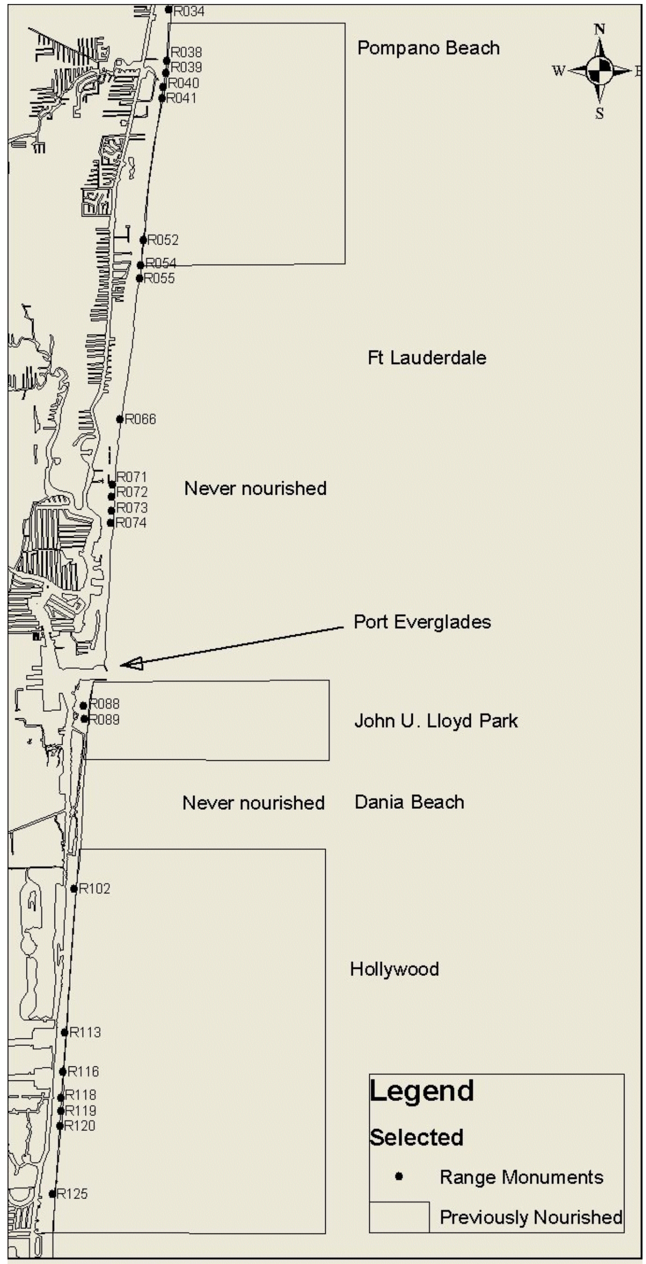

Figure 1. Location Map.
State of Florida range monuments corresponding to stations included in study. Boxes show stretch of beach nourished, not seaward extent.

Broward County has actively managed the erosion of its coastline with a series of beach nourishment projects dating back to the early 1960s. With the exception of a stretch of shoreline in Fort Lauderdale, and another small stretch of shoreline in Dania Beach, the Broward County shoreline from Hillsboro Inlet to the south county line has experienced one or more beach nourishment events (Figure 1). The primary goal of the study was to characterize the nearshore epilithos adjacent to the beaches proposed for nourishment to serve as a baseline for future comparison. Secondary goals of the study were to assess differences in epilithos between areas to be directly buried by the proposed beach fill and epilithic communities that will be potentially subjected to secondary impacts of sedimentation and turbidity during project construction; and to compare epilithic communities adjacent to previously nourished beaches to never nourished beaches as part of the environmental impact study for the project.

The nearshore hardbottom fish assemblage was documented as part of the Essential Fish Habitat study for the beach nourishment project. The results of the fish assemblage study are currently in preparation as a full paper (Baron et al., 2001, in press). Three different visual census methods were used: transect-counts, point-counts, and rover-diver counts. This poster focuses on the results of the point-count census. These counts represent the forty sites co-located with the epilithos assessment to examine connectivity between epilithic communities and fish assemblages on the nearshore hardbottom. Of the total of 164 species and over 72,000 fish recorded during the entire study, 109 species and 33,949 fishes were observed during the point-counts (Baron et al., in press).

In their analysis of the ichthyological data, Baron et al. (in press) found weak north-south regressions for both abundance and species richness. The authors suggest that their results, supported by the findings of another study (Ferro & Spieler, in preparation), imply a relatively homogeneous assemblage of fishes throughout the nearshore hardbottom of Broward County. Juvenile grunts (Family Haemulidae) are responsible for more than 90% of the juvenile population and more than 80% of the total fish assemblage. The remaining families are represented in decidedly lower numbers: wrasses (Family Labridae) at 5.0%; damselfishes (Family Pomacentridae) at approximately 2.0%; surgeonfishes (Family Acanthuridae) at 1.0%; parrotfishes (Family Scaridae) at 0.8%, and gobies (Family Gobiidae) at 0.5%. The remainder of the 47 families contributed less than 0.5% each (Baron et al., in press).

Methods:

Of the two hundred and ninety eight fish counts performed during June to August 2001, one hundred were conducted using a modified point-count method (Bohnsack and Bannerot, 1986) to census the fish population. Of these one hundred, forty were conducted at the same sites as the epilithic investigations. See Baron et al. (in press) for full details.

Epilithos were investigated at 55 sites using belt transects during July and August of 2001. Sample sizes ranged from seven to twenty four meters dependent upon sampling sufficiency for scleractinian coral diversity. The belt transects were performed by repeatedly flipping a one-square meter quadrat in a shore perpendicular (east-west) orientation. DGPS positioning was recorded at the transect end points using a Trimble AgGPS with ProBeacon. At the inshore sites (to be buried by the beach nourishment project), scientific divers entered the water and visually located the nearshore hardbottom edge to begin the transect. The DGPS location of the 40 co-located sites was provided by the fish study. The survey vessel dropped the scientific divers on the DGPS coordinates for the site, and the divers searched the immediate area for the presence of scleractinian corals. The transect began in the area suggestive of highest scleractinian coral density, thereby biasing the results towards scleractinian coral cover. Sampling produced an organism inventory (n/square meter) and estimates of percent cover for scleractinians, octocorals (alcyonarians), zoanthids/ hydroids, and sponges. Cover alone was assessed for the faunal components and for bottom type (hardbottom, rubble, and sand). Vertical relief was visually estimated for each site based upon three descriptive categories: low relief (less than one foot), moderate relief (one to two feet), and high relief (greater than 2 feet of vertical relief).

The epilithic data were summarized by calculation of species richness (floral and faunal); mean abundance (n/square meter) of the faunal components and mean percent cover of the individual taxa and higher taxonomic groups at each site; and mean percent occurrence of bottom types. The vertical relief categories were converted to a relief index by assigning numerical values of 1, 2, and 3 to the three categories, and then calculating the overall average for each sampling site. Principal Component Analysis was used to examine differences in epilithic community structure between nearshore hardbottom areas to be buried (i.e. communities located along the dynamic hardbottom edge) and epilithic communities located slightly further offshore.

The combined population data from the two studies were initially examined for relationships among invertebrates, flora, and fish. These efforts were non-productive yielding only weak relationships, as were the inquiries into population structure by Baron et al. (in press). In part, the lack of correlation between fish and invertebrates seemed to point to the disparate methods.

To surmount the lack of an equal area basis, the data were separated into data types and normalized. Independent variables were identified as those abiotic factors contributing to the structural parameters of the habitat: Depth, rugosity, various relief indices, and percent bottom type (hard, rubble, sand). Primary production data (macro algae, turf algae, cyanobacteria) were examined for correlation to the independent variables. Benthic invertebrate structural components (Porifera, Alcyonaria, Scleractinia, Zooanthidia) were then examined for relationships to the results of the physical structure-primary production analysis.

Analyses were carried out on scaled data and unscaled data to eliminate and include relative abundances among dominant taxa. Scaling consisted of normalizing each species abundance to its own maxima and minima, thereby reporting the result as a percent. The technique increases the influence of low abundance, but commonly occurring species, and decreases the overpowering effect of large schools of fishes. The presented data are the actual means.

Results:

Sixty-one faunal species and twenty-four algal species were recorded (see Table 1). Overall faunal species density was 4.6 organisms/square meter, and mean algal/cyanobacterial coverage was 20.4%. A total of 44 faunal species were recorded at the stations to be buried compared to 58 species at the stations located ±30 meters offshore of the nearshore hardbottom edge. Mean faunal density at the inshore sites was 2.7 organisms /square meter, and the mean for the offshore sites was 5.7 organisms/square meter. There was little observed difference in floral species richness between the inshore sites to be buried versus the seaward sites (23 versus 22 species respectively). Mean floral cover was 24.1% for the inshore sites and 18.0% for the seaward sites.

Mean percent floral cover (macro algae, turf and cyanobacteria) was highest immediately south of Port Everglades Inlet at John U. Lloyd State Park (Stations 87 through 92). The ten stations with cyanobacteria cover greater than 20% were located south of Port Everglades Inlet. The highest cyanobacterial coverage of 74.0% was observed at Station R120 (74.0%) in Hallandale.

The highest cover of macro algae corresponded to the lowest faunal species richness for both the inshore sites (3 species) and seaward sites (13 species) at the John U. Lloyd Stations. Algal species richness was highest in Fort Lauderdale (never nourished beach) with 18 species at the inshore stations and 17 species at the seaward sites. Faunal species richness was also highest at the seaward Fort Lauderdale sites with 46 of the 58 species recorded. Mean algal floral coverage was lowest at the Pompano Beach sites (R37 through R42, previously nourished) for both the inshore sites (4.2%) and seaward sites (0.62%).

The two principal components of the epilithos at the sites to be buried by nourishment and the seaward sites were macro algae and cyanobacteria. However, the strength of these two components was much greater at the inshore sites (88% of the cumulative composition) versus the seaward sites (54% of the cumulative composition) (Figure 2). Although stony corals did not occur often enough to be considered a principal component, their abundance differed between the inshore (1.5% of the overall community structure) and the seaward sites (7.1%). The numerically dominant scleractinian coral species was *Siderastrea* sp. (0.60 n/square meter), and *Siderastrea* recruits accounted for more than 90% of all juvenile corals (less than 2 cm in diameter) observed on the nearshore hardbottom. Individual scleractinian coral cover ranged from 0% at six sites to a high of 28.3% at Station R119. The unusually high scleractinian cover at R119 is due to a high density of large *Diploria* spp within the station.

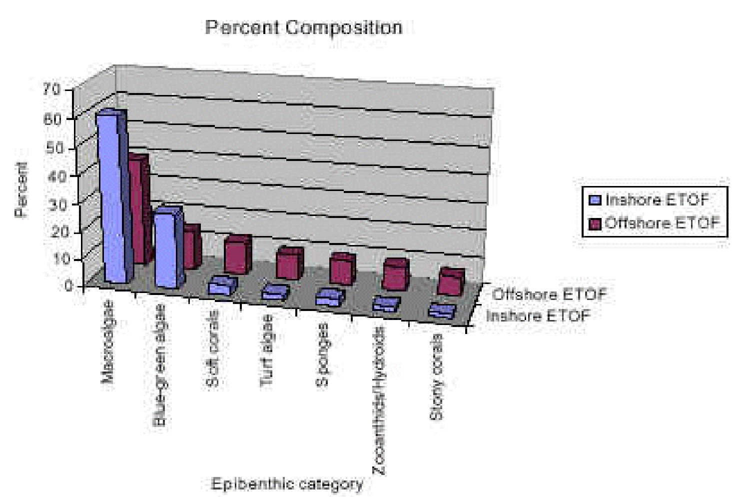

Fig 2. Species composition comparison between inshore and offshore Equilibrium Toe of Fill (ETOF). Inshore sites are expected to be buried.

The analysis of the independent variables eliminated rugosity and depth as differentiating factors. The remaining factors were dominated by the influence of bottom type (percent hardbottom, rubble, and sand). The subsequent analysis of independent variables in conjunction with primary production and epilithic invertebrate structure resulted in the formation of nine habitat groupings (Figure 3). These are labeled as groups A through I. The fish data (Baron et al., in press) were then normalized and family level relationships to the nine habitat types were examined. Table 1 presents the details of the habitat groupings as means rather than scaled data.

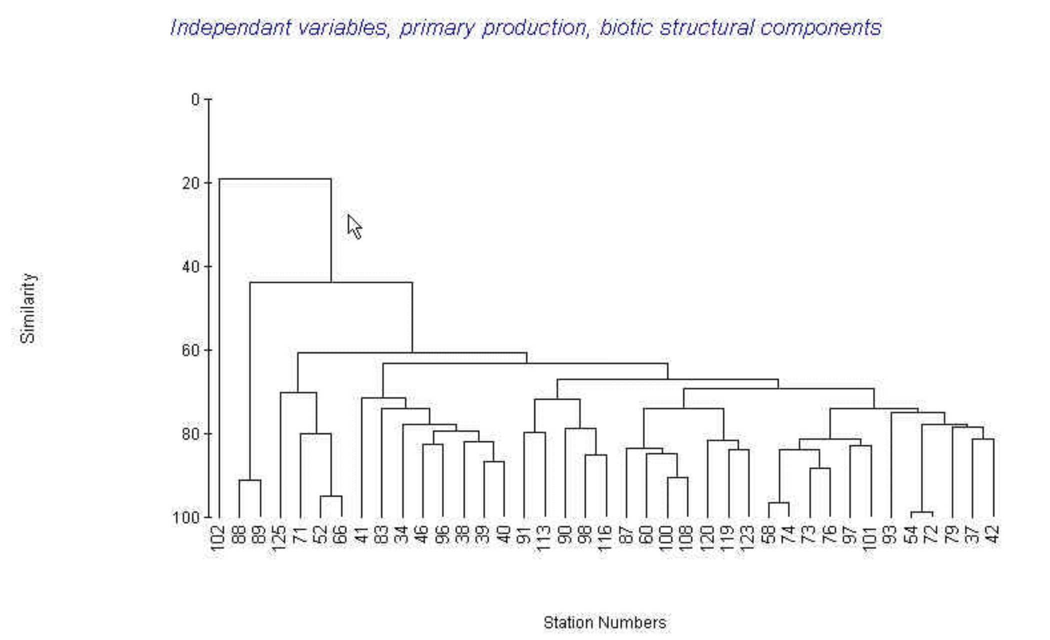

Fig 3. Similarity of stations used to derive the nine different habitat clusters (see text). Groups are labelled A through I for convenience. See text for a full description of group characteristics and the relationships to fishes.

Type A (Station R102): This station consisted of wormrock reef (*Phragmatopoma lapidosa*). This reef structure supported the largest number of juvenile members of Family Haemulidae observed at the 40 sites. Highhats (Sciaenidae) were also abundant.

Type B (Stations R88, R89): Rubble dominated by macro algae (*Caulerpa* spp.) with a strong cyanobacterial subdominant. The component stations are within 600 meters south of the entrance to Port Everglades Inlet. Only four species of invertebrates were recorded.

Type C (Stations R52, R66, R71, R125): Sand and sand-rubble, or sand-hardbottom with macro algae dominant and turf algae and Porifera subdominant. The component sites are scattered throughout the project area. More individuals of the Family Serranidae (seabasses) were located here than in other groupings.

Type D (Stations R34, R38, R39, R40, R41, R46, R83, R96): The highest relief index-hard bottom abundance group is dominated by Porifera, Alcyonaria, Zooanthidia, and turf algae. With the exception of Group A, fish were much more abundant and of a greater species richness (19 species) than in any other grouping. Every site but one is north of Port Everglades Inlet, and six of the eight are Pompano Beach/Lauderdale-by-the-Sea sites (previously nourished). The grouping had the highest cover of turf algae, the second lowest percent cover of epilithic macro algae, and the highest abundance of Family Pomacentridae. Scaridae, Acanthuridae, Labridae, and adult Haemulidae are very well represented. Sparidae were more abundant within this grouping than in any other.

Type E (Stations R90, R91, R98, R113, R116): Hardbottom-rubble dominated by macro-algae and cyanobacteria. The stations are all south of Port Everglades Inlet and extend south to Hollywood. The grouping supported low invertebrate species richness and low abundance, and a low fish species richness of moderate abundance. This grouping, along with those of Group B, represent the geographical grouping potentially located in the discharge plume of the Port Everglades Inlet (See also Station R87 in Group F).

Type F (Stations R60, R87, R100, R108): Hardbottom dominated by Porifera, Alcyonaria, and Zooanthidia. The stations are scattered along the coastline in no discernable pattern. Station R87 is in Group F rather than in Group B (R86, R88) primarily because Zooanthidia over-ride the high macro algal (59%) and cyanobacterial (13%) components. Fish abundance was reduced when compared to other groupings. The species composition was similar to that in Group G. Group F and Group G had the highest abundance of invertebrates but depressed fish populations. Invertebrate species richness was also high in these groups.

Type G (Stations R119, R120, R123): Hard bottom-rubble dominated by cyanobacteria, alcyonaria, and scleractinia. The cyanobacteria dominate one of the three member sites, while the scleractinia dominates the other two sites. Station R119 had highest scleractinian cover of the 55 sites. There is a fair amount of internal variability within this group and Station R120 had very high cyanobacterial cover. All stations are in Hollywood along approximately 1,200 linear meters of shoreline. The grouping supported the lowest abundance and species richness of fishes, and was dominated by Family Labridae and Family Haemulidae.

Type H (Stations R58, R73, R74, R76, R93, R97,R101): Hard bottom-rubble-sand mixture dominated by macro algae, Porifera and Alcyonaria. The stations are scattered along the entire project area shoreline; both north and south of Port Everglades Inlet. All sites are located offshore of never-nourished beaches. The grouping joins Group I with station R93 as an intergrade. Stations R93 and R97 are approximately 300 to 1,500 linear meters south of the 1989 John U. Lloyd State Park nourishment project area. Stations R73, R74, R76 are located adjacent to Fort Lauderdale along approximately 900 linear meters of shoreline.

Type I (Stations R37, R42, R54, R72, R79): Hard bottom-sand mixture with a fairly even distribution of turf algae, macro algae, Porifera, Alcyonaria, and Scleractinia. The grouping separates from Group H in part because of a lowered abundance of macro algae. Stations R37, R42, and R54 are from a nourished beach area.

Conclusions:

In this study, species richness and mean abundance of poriferans, alcynonarians, and scleractinians were substantially higher at the seaward sites than at the inshore sites located along the unstable hardbottom/sand interface, supporting the hypothesis that epilithic community structure is positively related to habitat stability.

A high degree of variability among and between the nourished and never nourished sites at both the inshore and seaward locations was observed. The nearshore epilithos adjacent to never nourished beaches did not show higher faunal species richness or scleractinian coral coverage than those adjacent to previously nourished beaches. The dominance of cyanobacteria and macro algae on the nearshore hardbottom immediately south of Port Everglades Inlet suggests nutrification effects potentially resulting from terrestrial sources of pollution.

Both fish and invertebrate populations are more closely allied to bottom type than to the state of nourishment, or to each other. Within bottom types, there are recognizable population shifts to the south of Port Everglades (groups B and E) and off shore of nourished and never nourished (groups H and I) beaches.

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Table 1	A	B	C	D	E	F	G	H	I
Stations ---->	102	88 89	52 66 71 125	34 38 39 40 41 46 83 96	90 91 98 113 116	60 87 100 108	119 120 123	58 73 74 76 93 97 101	37 42 54 72 79
Depth (feet)	14	9	16	12	11	12	12	11	12
Rugosity (m)	8.0	8.9	4.3	9.3	6.4	8.2	7.9	6.9	8.2
Relief index	0.0	0.2	1.2	1.5	1.0	1.0	1.0	1.0	1.1
% Hardbottom	0.0	0.0	10.4	77.3	61.9	86.0	50.9	38.7	58.8
% Rubble	0.0	90.4	14.3	0.0	28.0	3.1	47.0	25.1	2.0
% Worm rock	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
% Sand cover	0.0	9.6	75.3	22.7	10.2	10.8	2.1	36.3	38.7
% Cover Turf algae	0.0	0.0	4.6	12.3	0.4	0.6	0.0	0.0	4.2
% Cover Cyanobacteria	0.0	24.1	3.2	0.6	19.2	5.4	29.3	0.4	0.0
% Cover Macro algae	0.0	48.4	10.5	5.1	44.9	31.4	3.6	24.3	9.1
% Cover Porifera	0.0	0.1	3.2	4.1	0.4	5.5	4.3	5.6	6.0
% Cover Zoanthidia	0.0	0.0	0.1	5.9	0.2	8.5	9.1	0.8	0.0
% Cover Hydrozoa	0.0	0.0	2.0	0.1	0.3	0.1	0.8	0.1	0.1
% Cover Alcyonaria	0.0	0.0	1.2	4.6	2.6	11.3	12.0	3.4	5.9
% Cover Scleractinia	0.0	0.6	1.9	1.6	1.4	2.0	14.0	1.9	1.5
% Urochordata	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Table 1	A	B	C	D	E	F	G	H	I
Porifera N (per meter)	0.0	0.3	2.0	3.0	0.2	2.3	2.5	1.8	2.2
Zooanthidia N (per meter)	0.0	0.0	0.0	0.5	0.1	0.8	1.0	0.2	0.1
Hydrozoa N (per meter)	0.0	0.0	1.7	0.1	0.0	0.1	0.3	0.2	0.1
Alcyonaria N (per meter)	0.0	0.1	0.4	1.8	0.8	4.1	4.1	1.8	1.5
Scleractinia N (per meter)	0.0	2.5	1.0	0.7	1.4	1.4	0.9	1.4	0.7
Total Invertebrate N (per meter)	**0.0**	**2.8**	**5.1**	**6.1**	**2.6**	**8.8**	**8.9**	**5.5**	**4.7**
Total Fish Abundance (mean per grp)	**582.0**	**262.0**	**235.8**	**436.4**	**193.2**	**121.8**	**68.0**	**240.1**	**350.8**
Total Abundance (N) (mean per grp)	**582.0**	**264.8**	**240.9**	**442.5**	**195.8**	**130.5**	**76.9**	**245.6**	**355.5**
Macro Algal Species Richness (per meter)	0.0	8.5	7.0	1.8	8.8	7.5	3.3	8.3	4.8
Porifera Species Richness (per meter)	0.0	2.5	7.0	10.4	1.4	6.0	6.7	5.6	8.0
Zooanthidia Species Richness (per meter)	0.0	0.0	0.3	1.4	0.4	1.5	1.7	1.4	0.6
Hydrozoa Species Richness (per meter)	0.0	0.0	0.8	0.6	0.2	0.3	1.0	0.1	0.4
Alcyonaria Species Richness (per meter)	0.0	0.5	2.0	5.5	1.6	5.3	6.3	3.1	3.6
Scleractinia Species Richness (per meter)	0.0	1.0	4.3	3.9	1.4	4.0	4.3	3.0	2.0
Total Invertebrate Species Richness	**0.0**	**4.0**	**14.3**	**21.8**	**5.0**	**17.0**	**20.0**	**13.3**	**14.6**

Table 1	A	B	C	D	E	F	G	H	I
Total Fish Species Richness	**12.0**	**12.0**	**13.3**	**19.5**	**9.8**	**10.0**	**8.7**	**11.4**	**12.0**
Total Species Observed	**12.0**	**16.0**	**27.5**	**41.3**	**14.8**	**27.0**	**28.7**	**24.7**	**26.6**
ACANTHURIDAE	0.0	5.5	7.0	14.0	2.2	2.8	0.0	5.3	5.6
APOGONIDAE	4.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
BALISTIDAE	0.0	1.0	0.5	0.9	0.6	0.0	0.0	0.7	0.4
BLENNIIDAE	0.0	0.5	1.3	0.1	0.0	0.0	0.0	0.1	1.0
CARANGIDAE	0.0	0.0	0.0	0.0	3.4	0.8	0.0	0.1	0.6
CLINIDAE	0.0	1.5	2.3	0.4	0.0	0.3	1.0	0.0	1.0
DIODONTIDAE	0.0	0.0	0.3	0.1	0.0	0.3	0.0	0.0	0.0
GERREIDAE	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
GOBIIDAE	1.0	0.0	3.5	6.5	0.0	0.3	1.3	0.7	2.0
HAEMULIDAE (adults only)	2.0	8.5	0.3	65.0	14.0	0.3	9.0	11.9	108.4
HAEMULIDAE (juveniles)	550.0	200.0	191.3	269.4	123.8	98.8	27.3	192.1	216.0
HAEMULIDAE (total)	552.0	208.5	191.5	334.4	137.8	99.0	36.3	204.0	324.4
HOLOCENTRIDAE	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
LABRIDAE	8.0	30.0	20.8	22.6	9.2	9.8	21.3	18.3	9.6
LUTJANIDAE	0.0	0.0	0.0	0.1	0.4	0.3	1.3	0.3	0.0
MEGALOPIDAE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
MOBULIDAE	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
MONOCANTHIDAE	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0
MULLIDAE	0.0	0.0	0.0	1.5	0.4	0.0	0.0	0.4	1.0

Table 1	A	B	C	D	E	F	G	H	I
MURAENIDAE	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2
OSTRACIIDAE	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.2
PEMPHERIDAE	0.0	0.0	0.0	31.3	30.0	0.3	0.0	0.0	0.0
POMACANTHIDAE	0.0	0.0	1.3	1.0	0.0	0.0	0.0	0.0	0.2
POMACENTRIDAE	4.0	5.0	3.5	13.5	4.2	3.0	4.3	5.4	1.6
RHINCODONTIDAE	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
SCARIDAE	2.0	5.5	0.5	4.6	3.6	2.0	0.0	2.9	1.2
SCIAENIDAE	11.0	4.0	0.0	0.9	1.2	1.3	1.0	1.1	0.8
SERRANIDAE	0.0	0.5	2.8	0.4	0.0	0.8	0.0	0.3	0.2
SPARIDAE	0.0	0.0	0.3	2.1	0.0	0.0	0.0	0.1	0.0
SPHYRAENIDAE	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
TETRAODONTIDAE	0.0	0.0	0.0	0.8	0.0	0.5	0.7	0.0	0.6
UROLOPHIDAE	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.1	0.2
PER METER									
Macroalgae (percent cover)									
Amphiroa sp.	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Avrainvillea sp.	0.0	0.1	0.0	0.0	1.3	0.2	0.1	0.2	0.1
Bryothamnion triquetrum	0.0	3.0	1.1	0.0	3.1	0.6	0.0	0.2	0.1
Caulerpa mexicana	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0
Caulerpa prolifera	0.0	20.0	0.0	0.0	6.0	2.3	0.0	0.0	0.0
Caulerpa racemosa	0.0	0.4	0.2	0.0	1.1	3.4	0.4	0.6	0.2
Caulerpa sertularioides	0.0	3.1	0.0	0.0	3.5	1.8	0.0	0.2	0.0

Table 1	A	B	C	D	E	F	G	H	I
Ceramium sp.	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.2	0.0
Codium isthmocladum	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2
Dasya sp.	0.0	1.4	1.6	1.0	4.6	0.4	1.1	1.1	0.0
Dictyota sp.	0.0	6.5	3.8	2.0	7.5	9.0	0.2	8.5	5.2
Galaxaura obtusata	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Gracilaria sp.	0.0	0.0	1.7	0.0	2.3	2.7	0.0	2.7	0.7
Halimeda discoidea	0.0	3.2	0.4	0.5	9.2	7.5	1.7	3.2	1.7
Halimeda incrassata	0.0	5.6	0.0	0.0	0.3	1.3	0.0	0.0	0.0
Heterosiphonia gibbesii	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.2	0.0
Jania adherens	0.0	2.7	2.2	0.0	0.6	2.7	0.0	0.3	0.2
Laurencia sp.	0.0	0.0	1.4	0.2	3.5	0.2	0.0	2.7	0.5
Neomeris annulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Padina sanctae-crucis	0.0	0.6	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Porolithon sp.	0.0	2.4	0.0	0.0	0.8	0.1	0.0	0.4	0.3
Ventricaria ventricosa	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
Porifera									
Agelas clathrodes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthosigmella varians	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.7	0.5
Aplysina cauliformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aplysina fistularis	0.0	0.0	0.0	0.1	0.0	0.2	0.3	0.0	0.0
c.f. Dysidea etheria	0.0	0.2	0.3	0.5	0.0	0.6	0.6	0.2	0.3
Callyspongia sp.	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Cinachyra sp.	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.1	0.0
Cliona sp. ***(% cover)***	0.0	0.0	0.7	0.3	0.0	0.0	0.3	0.0	0.4

Table 1	A	B	C	D	E	F	G	H	I
Cribrochalina vasculum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diplastrella sp.	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Haliclona rubens	0.0	0.0	0.4	0.7	0.0	0.0	0.0	0.1	0.1
Halisarca sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Holopsamma helwigii	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.1
Iotrochota birulata	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1
Ircinia campana	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Ircinia felix	0.0	0.0	0.1	0.1	0.0	0.3	0.7	0.0	0.2
Ircinia strobilina	0.0	0.0	0.1	0.2	0.0	0.2	0.0	0.1	0.0
Monanchora unguifera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neofibularia nolitangere	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niphates digitalis	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
Plakortis angulospiculatus	0.0	0.0	0.1	0.1	0.0	0.5	0.2	0.3	0.0
Spheciospongia vesparium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tedania ignis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ulosa sp.	0.0	0.1	0.1	0.1	0.0	0.2	0.0	0.1	0.1
Unidentified juvenile sponge	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.3
Zoanthid									
Palythoa caribaeorum	0.0	0.0	0.0	0.4	0.1	0.4	0.8	0.1	0.1
Zoanthus pulchellus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified sun zoanthid	0.0	0.0	0.0	0.1	0.0	0.5	0.3	0.1	0.0
Hydrozoa									
Milllepora alcicornis	0.0	0.0	0.0	0.1	0.0	0.1	0.3	0.0	0.0
Unidentifed bushy hydroid	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.2	0.1

Table 1	A	B	C	D	E	F	G	H	I
Alcyonarians									
Briareum asbestinum	0.0	0.0	0.0	0.4	0.0	0.8	0.0	0.2	0.1
Erythropodium caribaeorum	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Eunicea sp.	0.0	0.0	0.1	0.5	0.5	2.4	2.0	0.2	0.2
Gorgonia ventalina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Muricea sp.	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.0
Plexaura flexuosa	0.0	0.1	0.0	0.0	0.0	0.3	0.8	0.0	0.1
Plexaurella nutans	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.0
Plexaurella sp.	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1
Pseudoplexaura sp.	0.0	0.0	0.0	0.2	0.0	0.1	0.7	0.0	0.0
Pseudopterogorgia americana	0.0	0.0	0.2	0.2	0.2	0.3	0.4	0.1	0.1
Pterogorgia anceps	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.9	0.9
Scleractinians									
Colpophyllia natans	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Dichocoenia stokesii	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Diploria clivosa	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0
Diploria labyrinthiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diploria strigosa	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Favia fragum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manicina areolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Montastrea cavernosa	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Oculina diffusa	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Porites astreoides	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0
Porites porites	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.1	0.2

Table 1	A	B	C	D	E	F	G	H	I
Siderastrea radians	0.0	2.5	0.6	0.3	1.3	0.8	0.2	1.1	0.3
Siderastrea siderea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solenastrea bournoni	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.1	0.0
Solenastrea hyades	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Stephanocoenia michilini	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0