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Marine Biological Monitoring in Broward County, Florida: Year 1 Annual Report

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MARINE BIOLOGICAL MONITORING IN BROWARD COUNTY, FLORIDA:

YEAR 1 ANNUAL REPORT

Prepared for:

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ABSTRACT

A five-year study has been undertaken to monitor Broward County, Florida (southeast Florida) coral communities, reef fish assemblages and sedimentation rates in relation to possible effects from a proposed extensive beach renourishment (restoration) project. Over a five-year period coral communities and reef fish assemblages will be monitored at a total of 23 stations distributed offshore Broward County. This monitoring effort will characterize and quantify populations of scleractinian (stony) corals, octocoralian (gorgonian) corals, sponges, and reef fishes. In addition, sediment traps located at each station will be sampled and analyzed.

This document reports on the data collected during the first year of this five-year project. Coral communities and fish assemblages were monitored at each of the 23 sites between January and February 2001. In addition, sedimentation analysis for the January 2001 collection is included.

Mean ($\pm$ 1 S.D.) stony coral density for the 23 sites was 2.30 $\pm$ 0.95 colonies/m^2. Mean stony coral coverage was 2.25 $\pm$ 3.41%. Mean gorgonian density was 9.27 $\pm$ 11.75 colonies/m^2 and mean sponge density was 19.81 $\pm$ 10.44 colonies/m^2. All of these measures are consistent with previous data collected (Dodge *et al.* 1995). With all First Reef sites included, the First Reef tended to have greater stony coral coverage but lower stony coral, gorgonian and sponge density than the Second and Third Reefs. First Reef coral cover is much lower and actually less than the Third Reef when site FTL4 is removed from the analysis. This suggests that FTL4 is not representative of the sites within this monitoring program and has greater than average coral cover which strongly affects the mean and variance. The Third Reef tended to have the greatest stony coral, gorgonian and sponge density. Shannon-Weaver Diversity Indices performed on the overall transect data resulted in values of 1.49 $\pm$ 0.49 and 1.73 $\pm$ 0.36 for cover and number of species respectively. Overall evenness was 0.78 $\pm$ 0.09 for number of species and 0.66 $\pm$ 0.19 for cover. Trends in fish density were similar to those identified in the coral communities with the greatest density of fishes found on the Third Reef followed by the Second and First. The fish population data was similar to previously collected data (Ettinger, in press) indicating that the methods are adequate to establish a fish population baseline. Sedimentation analysis indicates that the average grain size for the first sampling interval collected in January 2001 was significantly highest on First Reef sites with the Third Reef sites containing significantly smaller mean grain size values when compared to the Second Reef. Results of average sediment rate for the three reefs since October 1997 indicate that the First Reef typically has the highest rate of sedimentation followed by the Second, then Third Reefs.

As data are collected and analyses completed during this five-year monitoring project, the results may be useful to help evaluate effects from the proposed beach renourishment project. Past studies have not shown major detrimental effects on coral reef communities from beach renourishment activities. This would suggest that future renourishment projects could be expected to result in only minor impacts, if responsible construction practices are followed.

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SECTION 1: INTRODUCTION

1.1 Shoreline Protection (Beach Renourishment) Project

1.1.1 History

In 1998, Nova Southeastern University (Consultant) was awarded a contract to provide biological monitoring services for the proposed Shoreline Protection Project. A notice to proceed for the initial biological monitoring (Pre-construction) was issued in December 2000. Year 1 Pre-construction field monitoring took place in January and February 2001. Renourishment is scheduled to begin in either summer of 2002 or November 2002. The planned Project will involve dredging compatible sand from seven borrow areas identified offshore Broward County. The sand will be placed on selected beaches between Hillsboro Inlet and Port Everglades and from Port Everglades to the Dade/Broward County line.

1.1.2 Rationale For Monitoring

Environmental regulations dealing with sedimentation and turbidity effects from beach nourishment may not be adequate to protect stony corals and coral reef communities (Telesnicki and Goldberg 1995). The objective of this project is to monitor, with respect to the effects of beach renourishment, turbidity and siltation, ecologically important scleractinian (stony) and octocoralian (gorgonian) coral, porifera (sponge) and reef fish species off Broward County. Southeastern Florida is a unique part of the Florida marine environment and deserves special attention. Coral communities here are at their northernmost limits on the North American continent, where, compared to more southern Caribbean and Atlantic reefs, they display reduced abundance, coverage, diversity, and growth due to naturally occurring decreases in light and water temperature (Goldberg, 1973; Jaap, 1984).

Since 1970 many beach restoration projects have been conducted in the Broward, Miami-Dade and Palm Beach County area employing offshore sand supplies. Concern exists that sedimentation from future projects may create additional stress for coral communities and their associated organisms. It is important to document and quantify living marine communities over time to develop a proper database to assess the efficacy of the construction practices, possible renourishment effects and mitigation techniques currently in use.

1.2 Project Contracted Scope of Services

Biological monitoring has been organized into five separate evaluation periods:

(a) One year prior to renourishment activities (= First pre-construction monitoring, completed in early winter 2001).
(b) Approximately one year after (a) (= Second pre-construction monitoring and first construction activity monitoring).
(c) Approximately two years after (a) (= First during construction monitoring and second construction activity monitoring).

(d) Approximately three years after (a) (= Second during construction monitoring and third construction activity monitoring).
(e) Approximately fours years after (a) (= Post construction monitoring)

The 5-Year project scope of services consists of seven activities. Each activity has a separate timetable and may not be required during each of the five years of the contract. Below is a description of each activity taken directly from Exhibit A of the Agreement (Scope of Services and Timetable):

1. Upon receipt of the notice to proceed, the Consultant shall establish five (5) additional reef community monitoring sites at locations mutually agreed to by County and Consultant, at which Consultant shall install sediment collector ringstands and stainless steel transect pins, identical to those at the existing eighteen (18) locations. In addition a permanent belt quadrat transect shall be established as set forth to measure stony coral species density(colonies/m^2), diversity and evenness.

2. Annual Site Visits: These annual site visits shall be conducted upon receipt of a Notice from the Contract Administrator. During each site visit, the consultant shall perform the following:

   2.1 Coral Community Transects. At each of the twenty-three (23) reef monitoring sites (eighteen (18) ongoing, five (5) additional proposed) a permanent belt quadrat transect has been or will be established. Each transect consists of twenty-one (21), eighteen (18) inch-long, one half (0.5) inch diameter, stainless steel pins fixed in the bottom with marine, two-part epoxy or Portland Cement, exactly one (1) meter apart (± 1.0 cm) in a straight line. Transect analysis at each site will be consistent with methodology described by Dodge *et al.* (1982). A minimum of thirty (30) square meters of bottom will be analyzed at each site. After field data collection the following calculations and analysis will be conducted for each transect data set:

   2.1.1 Stony coral species density (colonies/m^2), diversity and evenness (Shannon-Weaver Index).
   2.1.2 Diversity and evenness for percent live polyp coverage.
   2.1.3 Density of octocorallia and porifera (colonies/m^2)

   2.2 Fish population analysis. At each of the twenty-three (23) reef monitoring sites, the Consultant shall conduct fish population assessments. Fish population assessments will be conducted as per methodology described in Bohnsack and Bannerot (1986) and Bortone *et al.* (1989). Two (2) thirty (30) meter long transects for fish counts and one fifteen (15) meter diameter cylinder (stationary counts) will be conducted. The thirty (30) meter transects will be established by adding ten (10) meters to the existing coral transect lines (these are already twenty (20) meters long). A second transect for fish census will be conducted from one end of the first line and perpendicular to the first line in a direction along the reef that will provide maximum topographical change. Populations of fishes will be counted one meter on either side of the transect line and two meters above the line. The center for the stationary counts will be established seven and one-half (7.5) meters from the start point of the first line. Species counts will be to the lowest taxon that conditions allow and size (total length) estimates will be by class (0-2, 2-5, 5-10, 10-20, 20-50, >50cm). Statistical analysis of the data will be done using parametric and non-parametric analysis of variance (ANOVA) techniques as appropriate.

2.3 Survey of Infaunal Organisms. Should the dredge and fill permits issued by the State of Florida or the US Army Corps of Engineers require population analysis of infaunal organisms potentially affected by the beach construction activities, the Consultant shall collect fifteen (15) core samples (8.0 cm diameter x 12 cm deep) from each of eight (8) sites. The site locations shall be determined by the Contract Administrator in compliance with dredge and fill permit requirements. The number of replicate core samples (15) is based on the "leveling" of the cumulative species curve (in Southeast Florida this number is 15). Samples shall be sorted for all organisms larger than 0.5 mm (millimeters) and stained with Rose Bengal. Organisms shall be identified to the taxon as low as reasonably achievable.

3. Sedimentation Analysis: The Consultant shall change out each ringstand trap every sixty (60) days during the first four (4) years of the term of the agreement, for a minimum of six (6) change-outs per year. Analysis of trap contents will be conducted as per Standard Operating Procedures (SOPs) published and archived by Broward County. (SOP) No. ERO-019, and SOP No. ERO-037). Site locations are positively established and are reoccupied using DGPS latitude and longitude and range triangulation photographs. These location numbers and pictures shall be supplied to the Consultant by the County with the Notice to proceed.

4. Pipeline Placement Survey: After receipt of written notice from the Contract Administrator, up to five (5) times during the term of Agreement, the Consultant shall examine and evaluate the anchor placement of the Offshore Pumpout Terminal and placement of the submerged discharge pipeline from the terminal to the beach each time the pipeline is moved and installed. The pipeline placement "corridor" across and reef community hard bottom shall be visually surveyed and photo/video documented to record the impact of the pipeline placement on the reef community habitat. After the pipeline has been removed from the reef the pipeline corridor shall be reexamined and further photo/video documented for any additional damage. The Consultant shall estimate the total square meters impacted by the placement of the pipeline on the bottom and submit this information in the Annual Report.

5. Reef Edge Surveys: During the course of construction of the Project, the Consultant shall perform weekly visual reef edge surveys at the edges of each reef community hard bottom areas adjacent to active sand borrow areas (using SCUBA). These surveys shall monitor for mechanical damage to the reef, the general condition of the reef and the amount of sediment accumulation on the reef. These surveys shall be conducted by a diver(s) with at least a Master of Science degree in Marine Biology, biological oceanography, and/or equivalent work experience necessary to identify and chart the southeast Florida reef community and document the extent of sediment or mechanical damage to those areas.

6. Reef Assessment Damage Survey: If during a Reef Edge Survey irreversible loss of the reef community resource is evident due to construction impacts, the Consultant shall immediately notify the Contract Administrator. Thereafter, upon receipt of written approval from the Contract Administrator, the Consultant shall immediately perform a reef Damage Assessment Survey to discover and reveal the full areal extent of the irreversible loss. The Reef Damage Assessment Survey shall be completed within three (3) calendar days of receipt of the Contract Administrator's written notification unless the Consultant receives prior written permission from the Contract Administrator. Performance of reef damage assessment activities prior to obtaining written approval from the Contract Administrator is at the Consultant's sole risk.

7. Reports:

   7.1 Annual Reports. Within ninety (90) days, or sooner as required by the dredge and fill permit issued by the United States Army Corps of Engineers and the State of Florida Department of Environmental Protection, of the Annual Site Visit, the Consultant shall submit its Annual Report which contains the Sedimentation analysis, Coral Transect Analysis, Fish Transect Analysis, Infaunal Analysis (as required), Reef Edge Surveys, and Pipeline Placement Surveys as applicable. Each subsequent Annual Report shall compare results of analysis with the previous reports where appropriate, and the final report will discuss the impact of the beach construction relative to any measured changes in the above parameters. These reports shall be submitted in Corel Word Perfect format or compatible as determined by the County on a compact disc.

The specific scope of work for Year 1 of the project includes:

1. Establishing five additional reef community monitoring sites at locations agreed upon by the County and the Consultant. These sites shall be installed in the same manner as the previous 18 sites and include a sediment collection ringstand.
2. Completing the Year 1 annual site visit including coral community and fish population analyses.

3. Beginning sediment collections and analysis.

SECTION 2: METHODS AND MATERIALS

2.1 Existing Sites

Of the 23 transect sites; 18 existing sites were used for the surveys. These sites were installed prior to the Notice to Proceed by Industrial Divers Corp, a subcontractor, for use in prior Broward County surveys. Table 1 shows the location and depth of these sites. Figure 1 shows the position of each site and the borrow areas off Broward County.

2.2 New Site Selection

Four new coral community monitoring sites were selected on 12 December 2000. The County and the Consultant were both present when the sites were selected. A fifth new site is actually a previously established site north of Boca inlet that was used during an unrelated project but has now been incorporated into this project. Industrial Divers Corp, installed the four sites on 9 January 2001.

2.3 Site Installation

For all sites (existing and new), stainless steel pins were inserted and cemented/epoxied into the hard reef substrate at one-meter intervals establishing the permanent 20-meter transect. Table 1 provides site information including the location of the four newly established sites and the Boca site.

2.4 Annual Site Visits

The Year 1 annual visit to the 23 coral community monitoring sites occurred in January and February 2001. Table 1 includes the date each site was visited. Three dive teams each with specific tasks were present when visiting each site. The team completing the reef fish surveys would enter the water first, locate the coral community 20-meter transect, and establish the new fish transect and point count locations (see Section 2.2.2). After establishing the transects the fish survey team would complete the fish surveys. The second dive team would enter the water after the fish team had finished the fish transects. This team would take the photographs of the 40, $0.75m^2$ quadrats along the coral transect. The third team would enter the water last and complete the coral community monitoring along the 20-meter transect (details are provided in Section 2.4.1). During most field days, two monitoring sites were completed.

2.4.1 Coral Community Transects

2.4.1.1 Phototransects

Each transect was photographed (Figure 2) using a Nikonos V fitted with a 20mm lens attached to a $0.75m^2$ quadrat framer. Each photograph was taken using Fuji® Sensia II 100 ASA 35mm slide film. Tags with the site name and quadrat number (1-40) were attached to the framer and included in each image for reference. It was necessary to use two divers to control the camera and framer positioning. The photographs were for archival purposes only and not used in quantitative data analysis.

2.4.1.2 Belt Quadrant Transects

At each site divers sampled a 20m x 1.5m belt transect with 21 permanent stainless steel pins delineating each meter. The stakes are arranged linearly running generally in a north/south direction. Using SCUBA, divers assessed the transects sequentially along one side of the 20m transect and then along the other side with a $0.75m^2$ quadrat. A total of 30 square meters was monitored along each transect ($0.75m^2$ x 40 quadrats). The quadrat in the northeast corner of each transect was assigned quadrat #1 in order to keep the photo quadrats and survey data consistent. In one case (POMP1) a section of the substrate within the transect was previously moved by storm activity; measuring tape was stretched between the remaining stakes to provide a guide for quadrats.

Field data collection was designed to permit the following calculations and analyses to be conducted for each site:

a) stony coral species density (colonies/m^2) and percent live cover,
b) Shannon-Weaver indices for coral abundance and live polyp coverage and
c) density of porifera and octocoralia (colonies/m^2).

Scleractinian coral and hydrozoan, *Millepora alcicornis,* colonies were identified to genus and species. Each colony was measured to the nearest centimeter along the long and short axes (for ellipsoid corals) or the diameter (for circular colonies). Corals with a diameter of less than 1 cm and unattached colonies were not surveyed. Conditions such as bleaching, disease and other health observations were recorded. Branching gorgonians and fleshy sponges were counted. Encrusting gorgonians and sponges were not included in the survey.

Analysis of the stony coral data collected in the field was performed in several ways. To determine density, the number of corals in each transect was divided by $30m^2$. Surface area of each coral was obtained by a) applying the length and width measurements of ellipsoid corals to the equation $A = l \times w$, or b) applying the diameter of circular corals to the equation $A = \pi r^2$. The sum of all surface area values for each transect was divided by the surface area of the entire transect ($30m^2$) to generate a percent for live coral cover. Shannon-Weaver Diversity Indices for number of species (H'N) and cover (H'C) of corals were calculated for each transect using the following equation:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

where p_i is the relative abundance or cover of species i, and s is the number of species Evenness for number of species (J'N) and cover (J'C) at each transect were calculated using the equation $J' = H'/H'_{max} = H'/\ln S$, where H'_{max} is the maximum possible diversity or cover for any given s. While H'N and H'C indicate the index of diversity or cover, evenness indicates how close those values come to the maximum possible value for each transect.

Density of octocorals, as well as sponges, was calculated by dividing the numbers of colonies counted along each transect by $30m^2$.

2.4.2 Fish Population Analysis

Fish inventories were accomplished at, and adjacent to, all the coral community transects. Two counting methodologies were used at each site: a transect-count and a point-count (Figure 3).

Two transect-counts were done at each site. The first transect line (Fish Transect #1) included the established 20m coral community transect but extended it by 10m, in a straight line normally on the same compass heading, for a total of 30m. The second 30m transect (Fish Transect #2) began at the southern end of the Fish Transect #1 and was laid out, with a PVC tape, normally at a 90 degree angle, on an easterly heading (see Figure 3). In some instances (JUL1, FTL4, POMP1, POMP6, HB1, DB2: Table 2 and Figures 4-9) this angle and/or heading was altered to stay on hardbottom and avoid extensive areas of sandy substrate. Both ends of Transect #2 were marked with a concrete block tagged with a subsurface buoy attached to a 1m line. Using SCUBA, a diver swam directly over each transect recording all fish species, a total length size interval (<2, 2-5, 5-10, 10-20, 20-30, 30-50, 50+cm), and number that were within 1m either side or 2m above the transect. Thus each transect covered $60m^2$ and $120m^3$. In addition to a slate with a waterproof data sheet and pencil the diver carried a PVC "T-Stick," 1m long and 1m wide with the topside of the "T" marked with 10cm increments, to aid in estimating fish length and distances from the transect line. It took approximately 3 min to swim a single transect depending on the number of times the diver paused to record data.

A single point-count (Bohnsack and Bannerot, 1986) was taken at each site. The center of this point-count was established 7.5m from the angle apex of the two transect lines (Figure 3). The point-count (a.k.a. Reef Fish Visual Census Technique) counts fish in an imaginary 15m-diameter cylinder from substrate to surface. Thus the point-count covered a surface area of $176.63m^2$ with varying volume depending on water depth. On initiating the count, the fish counter would pivot around to scan the entire cylinder and record all species observed during a five-minute period. Following this initial five-minute count, the abundance, mean size, minimum size and maximum size were recorded for each species observed during the initial five minutes. Sample times outside of the 5- minute initial count were generally no longer than 30 minutes. The diver was equipped with a slate with a waterproof data sheet and pencil, an underwater watch, and a one-meter "fish-stick" (1m PVC tube with perpendicularly attached 30 cm ruler) as an aid for estimating fish lengths.

The data recorded during the fish counts were entered into Microsoft Excel and analyzed with SAS (Statistical Analysis Systems) software (SAS Institute Inc., Cary, NC, USA). Microsoft Excel was used to determine general descriptive statistics. The same data entered into SAS was analyzed with parametric analysis of variance techniques (PROC GLM), and the Student-Newman-Kuels test between means (SNK).

2.4.3 Sedimentation Analysis

2.4.3.1 Sediment Trap Collection

Analysis of trap contents will be conducted as per Standard Operating Procedures (SOPs) published and archived by Broward County. (SOP) No. ERO-019, and SOP No. ERO-037). Sediment trap collection and change-out, performed by divers from Industrial Divers Corporation, Ft. Lauderdale, Florida (Subcontractor), is scheduled to occur every sixty days and started 4 January 2001. Three sediment trap bottles on each sediment trap ring stand are changed-out during each collection. To ensure no sediment was lost during the change-out process, diver(s) collected the bottles by first removing PCV trap tops and replacing them with a standard bottle top. Diver(s) also noted any anomaly that could interfere with the sediment analysis, such as the presence of large living organisms (e.g., octopuses, eels, etc.) in a particular bottle or a missing trap bottle. Topside, the standard trap lids were labeled with site and date information. Sediment ringstands were deployed at the five new monitoring sites in late December 2000/early January 2001. Although there are now 23 sites to be analyzed over the four-year period of this study, only sediment from the 18 original sites were collected in early January 2001. The analysis from this collection is included in this report. Sediment from all 23 sites was collected in early March 2001 and is currently being analyzed.

2.4.3.2 Analysis of Sediment Trap Samples

Once samples arrived at Nova Southeastern University Oceanographic Center, they were fixed with enough 37% formaldehyde to make a 10% formalin/seawater solution. Samples remained undisturbed for the following 48 hours. After samples were fixed and allowed to settle, the preservative solution was removed by aspiration. The remaining sample was then washed (using freshwater) through a No. 230 (0.063mm) sieve positioned in the sieve ring stand assembly. Particles passing through the sieve, which constitute the silt/clay fraction (based on the Wentworth scale), were collected in a 4000mL beaker. The sand fraction sample was washed with freshwater until water flowed freely through the sand in the sieve. Additionally, all organisms (fish, crabs, worms, algae, etc.) were removed from the sand fraction. The sand fraction was then washed into an appropriately sized and labeled pre-weighed Nalgene® beaker. Water in those beakers was removed by aspiration after allowing settlement for 48 hours. The beakers were placed into a drying oven for a minimum of 24 hours, until dry. Silt/clay fractions were allowed to settle for 48 hours before aspiration of wash water. The silt/clay fraction was then washed into an appropriately sized and labeled pre-weighed Nalgene® beaker and allowed to settle for an additional 48 hours before aspirating off wash water. Following removal of wash water by aspiration, the sample was placed to dry in an oven (at 100-105° C) for at least 24 hours.

Once the sand and silt/clay samples were dry, they were removed from the oven and quickly placed into desiccators for cooling. After cooling, whole samples were weighed to the nearest 0.01g. These weights (minus the weight of the beaker, which is written in indelible ink on the beaker) were then recorded on a sediment trap analysis data sheet for the appropriate collection interval. No further analysis of the silt/clay samples was completed.

2.4.3.3 Grain Size Analysis of Sand Samples

To determine the average grain size of sand fractions, only the heaviest of the three samples from each site was analyzed. Depending on the weight of the sample, the sand fractions were split through a splitter device until reaching a 40-70g sub-sample. This sub-sampled was then placed on the top (4.00mm) sieve of the stacked sieve series. The sieve series (U.S Standard Series) contained 13 sieves atop a pan used to collect grains less than 0.063mm. The 13 half-height sieves were: 4.00mm, 2.80mm, 2.00mm, 1.40mm, 1.00mm, 0.71mm, 0.50mm, 0.355mm, 0.250mm, 0.180mm, 0.125mm, 0.090mm, and 0.063mm. The sieve series topped by a lid was secured to the shaker. The shake period was 15 minutes. Fractions from each sieve were weighed in polystyrene weigh boats and the weights recorded on sieve analysis data sheets for the appropriate sample.

2.4.3.4 Data Analysis

Standard univariate statistical analyses were performed on the data generated from the early January 2001 sediment collection. General trends in sedimentation are described in the results section through examination of bar graphs and statistical analyses of data collected since sediment collection began in 1997.

SECTION 3: RESULTS/DISCUSSION

3.1 Coral Community Transects

3.1.1 Phototransects

A photograph of every quadrat included on the 23 reef monitoring sites (920 images) was successfully produced. Although occasionally gorgonians and/or large sponges may have obscured some details in the quadrats, the images provide an accurate representation of the coral community at each site. These images are archived with the Consultant, available for review upon request and will be supplied to the County at the completion of this project. Figure 10 is an example of a quadrat image.

3.1.2 Coral Community Transects

Table 3 provides summary data for stony coral, gorgonian and sponge density, percent live stony coral cover and Shannon Weaver stony coral diversity and evenness indices for each site and reef for the Year 1 (January-February 2001) assessment.

3.1.2.1 Comparisons Between Reefs

a) Stony Corals: The species area curves for each site showed apparent leveling (or reduced slope from initial sampling) before 30 m^2 were sampled, suggesting that a transect of 30 m^2 is more than sufficient to document species richness. Figures 11-17 show the species area curves for the sites by region. Coral species are listed in Table 4 for each site. A total of 1600 colonies and 29 species were observed on the reefs in this study. The most numerous species were *Siderastrea siderea, Montastrea cavernosa, Stephanocoenia michelini, Porites astreoides, Millepora alcicornis,* and *Siderastrea radians.* See Figure 18 for percent species contribution.

Generally, there was a positive correlation for coral density with increasing depth. Mean density (• 1 S.D.) was slightly higher on the Third Reef (3.00 ± 1.08 colonies/m^2); overall mean density for all sites was 2.30 ± 0.95 colonies/m^2. Figure 19 shows coral density by site. Mean live polyp cover was highest on the First Reef (3.42 ± 5.73%), although this may be attributable to one site (FTL4) with particularly high cover of 17% (Figure 20). Overall coral cover was 2.25 ± 3.41%. Because FTL4 had such a higher degree of coral cover and produced so much variance, First Reef and overall coral percent cover data was analyzed without FTL4 for comparison. The resulting coral cover for the First Reef was 1.46 ± 1.60 %, a remarkable difference from results including FTL4. This suggests that FTL4 is not representative of the sites within this monitoring program and has greater than average coral cover which strongly affects the mean and variance. There appeared to be no depth correlation associated with coral cover. Diversity indices H'C and H'N were lowest on the First Reef (0.98 ± .047 and 1.35 ± 0.32, respectively) and comparable on the second (1.69 ± 0.19 and 1.88 ± 0.20) and Third Reefs (1.82 ± 0.21 and 1.97 ± 0.11). Evenness for numbers of species and coverage was similar on all reefs (0.51-0.83), although a slightly smaller value was noted on the First Reef. Coral density, percent cover, H'C, H'N and evenness appeared to be more variable on the First Reef than on the Second and Third. A slightly positive trend of H'C, H'N, J'C and J'N with increasing depth was observed. Removing FTL4 from the data did not strongly affect these values. See Figures 19-24 for coral density, cover, H'C, H'N and evenness by site. Figure 25 shows coral density and cover by reef.

b) Gorgonians: The overall mean density (± 1 S.D.) on the 23 sites was 9.27 ± 11.75 gorgonians/m^2. Mean gorgonian density was highest (13.63 ± 17.36 colonies/m^2) on the Third Reef and lowest on the First Reef, but variability increased with depth. See Figure 26 for gorgonian density by site. Figure 27 shows gorgonian density by reef.

c) Sponges: The overall mean density of sponges (± 1 S.D.) on the 23 sites was 19.81 ± 10.44 sponges/m^2. Mean density of sponges was lowest on the First Reef (10.73 ± 6.45 sponges/m^2) and roughly equal on the Second (26.02 ± 8.72) and Third (23.48 ± 9.34) reefs. Sponge density on the First Reef was almost half that on the Second and Third Reefs, although variability was higher on the Second and Third Reefs. See Figure 27 for sponge density by site and Figure 28 for sponge density by reef.

3.1.2.2 Comparisons By Latitude

a) Stony Corals: No trend was visually observed when comparing density, cover, H'C, H'N, or evenness of corals from high (Boca) to low (Hollywood) latitude.

b) Gorgonians: No trend was observed when comparing gorgonian density from high to low latitude.

c) Sponges: A slight decrease in sponge density was observed with a decrease in latitude when the Second and Third Reefs were compared independently.

3.1.2.3 Comparisons Between 1997, 1998 and 2000 (January 2001) Data

a) Stony Corals: To compare coral density, coverage, Shannon-Weaver Indices, and evenness from 1997 to 2000, data from the new sites (BOCA1, POMP4, POMP5, POMP6, FTL4) were removed from analysis. The 2000 values were comparable to the 1997, 1998 and 1999 values; a slight increase in percent cover was observed, but no trend was indicated in density, H'C, H'N, or evenness from 1997 to 2000. With the exception of coral density, the differences are very small and may be attributable to variability associated with a new data collection team in 2000. See Figure 29 for 1997-2000 coral comparisons.

b) Gorgonians: Although overall gorgonian density did not differ greatly from 1997 to 2000, the Third Reef did have slightly greater mean gorgonian density in 2000 than the prior years. The greatest variance was also detected on the Third Reef. See Figure 30 for gorgonian density comparison from 1997 to 2000.

c) Sponges: Overall sponge density increased from 1997 to 1998 and decreased from 1998 to 2000. This trend was observed on all three reefs. The First Reef had the lowest density of sponges, while there was little difference between the Second and Third Reefs. See Figure 31 for sponge density comparison from 1997 to 2000.

3.2 Fish Population Analysis

A total of 5206 fishes of 110 species (Table 5) were counted. Tables 6, 7 and 8 provide a list of total species and abundances for the First, Second and Third Reefs. Although close, there was no statistically significant difference in total fish abundance among the reefs when both point-and transect-counts were combined (Figure 32: $p<0.06$, ANOVA). However, when the data were adjusted to density (fish/m^2) there was a significant difference (Figure 33: $p<0.005$, ANOVA) with both the Second and Third Reefs having more total fish than the First Reef but not differing from each other ($p<0.05$, SNK). Likewise, the number of species was greater on the Second and Third Reefs than the First Reef, and again the Second and Third Reefs did not differ from each other (Figure 34: $p<0.0006$, ANOVA; $p<0.05$ SNK).

When sites were pooled by census type, the point counts had higher numbers of both total fish (Figure 35: $p<0.0001$, ANOVA) and species (Figure 36: $p<0.0001$, ANOVA) than either of the two transects (the extended coral transects [Fish Transect #1] or the one placed at right angles to it [Fish Transect #2]) which did not differ from each other ($p<0.05$, SNK). Curiously, when the total fish data was adjusted for density there was still a significant difference among the counts ($p<0.01$) but point counts differed only from Fish Transect #2 counts and not the Fish Transect #1 (Fish Transect #1 and Fish Transect #2 did not differ) (Figure 37: $p<0.05$, SNK).

These initial results represent the start of a baseline database with which to compare potential gross changes in the population structure of fishes associated with beach renourishment. The data from this study are in close agreement with data previously collected in Broward. In a larger survey of Broward involving 180 point-counts, Ettinger *et al.* (in press) also reported lower numbers of total fishes and species on the First Reef compared to the Second and Third Reefs, which did not differ. The Ettinger study likewise reported similar numbers of total fishes and species per point-count, especially on the First Reef.

3.3 Sedimentation Analysis

A summary of sediment data for collection #17 is presented in Table 9 . Examination of Figure 38 reveals that the First Reef had a statistically higher rate of sedimentation than both the Second and Third Reefs ($p<0.05$, SNK) during this collection period. The Second and Third Reefs, however, did not differ significantly from each other despite an almost four-fold difference between means ($p>0.05$). Including past sediment data, Figure 39 suggests that the First Reef generally has a higher rate of sedimentation than the Second Reef, with the Third Reef averaging a lower rate than the Second Reef. Figures 40, 41, and 42 show the average sediment rates since Aug-Oct 1997 for different areas on the First, Second, and Third Reefs, respectively. It appears that Deerfield sites, which are the northern sites, had the highest rate of sedimentation for the present sampling interval. Figure 43 indicates that the average grain size for this sampling interval was significantly highest on First Reef sites

($p<0.05$, SNK) with the Third Reef site containing significantly smaller mean grain size values when compared to the Second Reef ($p<0.05$, SNK).

Since October 1997 it appears that the First Reef typically has the highest rate of sedimentation followed by the Second, then Third Reefs (Figure 44). Incidentally, the Deerfield First Reef site contained the most sediment that has been collected to date. There appears to be no consistent trend in sedimentation rate within the County since October 1997. The largest average grain size from this sampling interval occurred in samples from the First Reef. Overall, comparison among other sampling intervals for both sedimentation rate and average grain size indicates that these results do not appear inconsistent with data collected from previous years during the same sampling interval (late fall/winter).

SECTION 4: SUMMARY

This document reports on the activities and data collected during the first year of this five-year project. Five new monitoring sites were installed increasing the total number of sites from 18 to 23. Coral communities and fish assemblages were monitored at each of the 23 sites between January and February 2001. In addition, sedimentation analysis for the January 2001 collection is included.

Mean ($\pm$ 1 S.D.) stony coral density for the 23 sites was 2.30 $\pm$ 0.95 colonies/m^2. Mean stony coral coverage was 2.25 $\pm$ 3.41%. Mean gorgonian density was 9.27 $\pm$ 11.75 colonies/m^2 and mean sponge density was 19.81 $\pm$ 10.44 colonies/m^2. All of these measures are consistent with previous data collected. The First Reef tended to have the greatest stony coral cover when site FTL4 is included in the analysis while the Third Reef tended to have the greatest stony coral cover when site FTL4 is not included in the analysis. The First Reef had lower stony coral, gorgonian and sponge density than the Second and Third Reefs. The Third Reef had the greatest stony coral, gorgonian and sponge density. No major latitudinal trend in stony coral, gorgonian or sponge density was identified between the sites. Shannon-Weaver Diversity Indices performed on the overall transect data resulted in values of 1.49 $\pm$ 0.49 and 1.73 $\pm$ 0.36 for cover (H′C) and number of species (H′N), respectively. Overall evenness was 0.78 $\pm$ 0.09 for number of species (J′N) and 0.66 $\pm$ 0.19 for cover (J′C). All indices (H′C, H′N, J′C, J′N) increased with an increase in depth (from First to Third Reefs), indicating higher stony coral diversity and percent cover on the Third Reef transects.

Trends in fish density were similar to those trends identified within the coral community transects. The greatest density of fishes counted occurs on the Third Reef followed by the Second and First. The fish population data collected with the point-count method was similar to previously collected data (Ettinger, in press) indicating that the methods are adequate to establish a Broward County reef habitat fish population baseline.

Sedimentation analysis indicates that the average grain size was significantly highest on First Reef sites with Third Reef sites containing significantly smaller mean grain size compared to Second Reef sites. Average sediment rates for the three reefs since October 1997 indicate that the First Reef typically has the highest rate of sedimentation followed by the Second, then Third Reefs. Both sedimentation rate and average grain size from this sampling interval appear to be consistent with data collected from previous years during the same sampling interval (late fall/winter).

The biological response of coral reefs and coral reef organisms to sedimentation and turbidity is complicated. These ecosystems have adapted, over long time periods, to certain low levels of natural sedimentation and turbidity. However, excessive or chronic sedimentation causes documented adverse effects (Goldberg 1988). These can include reef species mortality and changes in growth (Bak 1978), as well as changes in benthic community composition, coverage, and density. These parameters, while linked, change at different rates and in different ways. The difficulty is that these changes are largely un-quantified for individual species, let alone the broad combinations of species and growth forms, which ultimately create ecosystems. Consequently, monitoring the effects of a particular event or events (e.g., a beach renourishment project) can be particularly difficult when effects are less than catastrophic (e.g., complete mortality).

As data is collected and analyses completed during this five-year monitoring project, the results may be useful to evaluate effects from the proposed beach renourishment project. Past studies (Dodge *et al*, 1995) have not shown major detrimental effects on coral reef communities from beach renourishment activities. This would suggest that future renourishment projects could be expected to result in only minor impacts, if responsible construction practices are followed. However, it is also important to recognize the limitations of this monitoring project and possible confounding effects. Limitations include the natural variability of reef communities, which decreases the ability of statistical tests to detect differences from an external cause. Confounding effects include reef community zonation with depth (e.g., First, Second, and Third Reefs), short-term disturbances (e.g., storms) and long-term change (e.g., global warming and chronic pollution from other sources).

SECTION 5: LITERATURE CITED

Bak, R.P.M. 1978. Lethal and sublethal effects of dredging on reef corals. Marine Pollution Bulletin 9:14-16.

Bohnsack, J.A. and S.P. Bannerot. 1986. A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. U.S. Dept. of Commerce, NOAA Technical Report NMFS 41:1-15.

Bortone, S.A., J.J. Kimmel, and C.M. Bundrick. 1989. A comparison of three methods for visually assessing reef fish communities: time and area compensated. Northeast Gulf Science 10:85-96.

Dodge, R.E., A. Logan and A. Antonius. 1982. Quantitative reef assessment studies in Bermuda: a comparison of methods and preliminary results. Bulletin of Marine Science 32:745-760.

Dodge, R.E., W. Goldberg, C.G. Messing, and S. Hess. 1995. Final Report Biological Monitoring of the Hollywood - Hallandale Beach Renourishment. Prepared for the Broward County Board of County Commissioners, Broward County Department of Natural Resources Protection, Biological Resources Division. 103 pp.

Ettinger, B.D., D.S. Gilliam, L.K.B. Jordan, R.L. Sherman and R. E. Spieler. The coral reef fishes of Broward County Florida, species and abundance: a work in progress. Proceedings of the Gulf and Caribbean Fisheries Institute 2000. In press.

Goldberg, W. 1973. The ecology of the coral-octocoral communities off the southeast Florida coast: geomorphology, species composition, and zonation. Bulletin of Marine Science 23:465-488.

Goldberg, W. 1988. Biological effects of beach restoration in South Florida. Gainsville. Beach Preservation Technology 88:19-27.

Jaap, W.C. 1984. The ecology of the south Florida coral reefs: a community profile. U.S. Fish and Wildlife Service FWS/OBS - 82/08. 138 pp.

Telesnicki, G.L. and W.M. Goldberg. 1995a. Effects of turbidity on the photosynthesis and respiration of two South Florida reef coral species. Bulletin Marine Science 57:527-539.

SECTION 6: TABLES AND FIGURES

Table 1: Information of each of the 23 monitoring sites. Sites in bold are the five new sites.

SITE	REEF	DEPTH	LATITUDE	LONGITUDE	DATE COMPLETED
JUL2	Third	52	26 00.2593 N	80 05.3010 W	17 Jan
JUL1	Second	40	26 00.3014 N	80 05.8134 W	8 Jan
HH2	First	19	26 00.6946 N	80 06.7572 W	17 Jan
JUL8	Third	50	26 04.9957 N	80 05.0990 W	15 Feb
JUL7	Second	32	26 04.9635 N	80 05.7321 W	15 Feb
JUL6	First	12	26 04.9120 N	80 06.2226 W	15 Feb
FTL4	**First**	**20**	**26 08.2080 N**	**80 05.8440 W**	**25Jan**
FTL3	Third	60	26 09.5183 N	80 04.6406 W	21 Feb
FTL2	Second	48	26 09.5971 N	80 04.9522 W	22 Jan
FTL1	First	19	26 09.5343 N	80 05.7475 W	22 Jan
POMP3	Third	51	26 11.2141 N	80 04.3650 W	21 Feb
POMP2	Third	48	26 11.3289 N	80 04.8039 W	24 Jan
POMP1	First	20	26 11.4356 N	80 05.2256 W	23 Feb
POMP4	**First**	**20**	**26 12.7320 N**	**80 05.2010 W**	**25 Jan**
POMP6	**Third**	**52**	**26 14.5660 N**	**80 04.3980 W**	**7 Feb**
POMP5	**Second**	**31**	**26 14.5660 N**	**80 04.7310 W**	**7 Feb**
HB3	Third	49	26 16.4255 N	80 03.8189 W	31 Jan
HB2	Second	35	26 16.5350 N	80 04.2620 W	31 Jan
HB1	First	21	26 16.8357 N	80 04.5390 W	6 Feb
DB3	Third	55	26 18.6828 N	80 03.5764 W	6 Feb
DB2	Second	37	26 18.6280 N	80 04.0262 W	2 Feb
DB1	First	18	26 18.5869 N	80 04.3928 W	2 Feb
BOCA1	**Second**	**30**	**26 20.8030 N**	**80 03.8830 W**	**23 Feb**

Table 2: Layout description of the fish transects and center of the point-counts for each site. The "Normal" layout is illustrated in Figure 2. The layout that differ from the normal are illustrated in Figures 3-8.

SITE	DESCRIPTION
JUL2	Normal
JUL1	Transect #2 runs N at 60^0 from the southern end of Transect #1
HH2	Normal
JUL8	Normal
JUL7	Normal
JUL6	Normal
FTL4	Last 10m of Transect #1 runs at 330^0
FTL3	Normal
FTL2	Normal
FTL1	Normal
POMP3	Normal
POMP2	Normal
POMP1	Transect #2 runs to the W
POMP4	Normal
POMP6	Last 10m of Transect #1 runs at 230^0, Transect #2 runs NW, Point-count 280^0 off apex
POMP5	Normal
HB3	Normal
HB2	Normal
HB1	Transect #2 runs N at 300^0, Point count 210^0 off apex
DB3	Normal
DB2	Last 10m of Transect #1 runs at 180^0, Transect #2 runs to the W, Point count SSW off apex
DB1	Normal
BOCA1	Normal

Table 3: Summary of values measured for permanent transect sites in 2000. New sites are denoted by *.

	Depth	Stony Coral Density (colonies/m^2)		Stony Coral % cover		H'C		H'N		J'C		J'N		# Coral Species	Sponge Density (per m^2)		Octo-coral Density (per m^2)	
		By site	By reef	By Site	By reef	By site	By reef	By site	By reef	By site	By Reef	By site	By reef		By site	By reef	By site	By reef
FIRST REEF																		
JUL6	12	1.77		4.68		1.04		1.19		0.47		0.47		9	9		2	
DB1	18	1.60		0.47		0.99		1.02		0.62		0.62		5	7		1	
HH2	19	1.97		1.51		0.38		0.94		0.35		0.35		3	11		6	
FTL1	19	1.60	1.7 ± 0.61	0.97	3.47 ± 5.73	1.21	0.98 ± 0.47	1.69	1.35 ± 0.32	0.53	0.51 ± 0.22	0.53	0.71 ± 0.12	10	13	10.73 ± 6.45	8	6.27 ± 5.84
FTL4*	20	2.17		17.12		0.32		1.36		0.14		0.14		11	25		5	
POMP4*	20	1.10		0.11		1.81		1.51		0.93		0.93		9	4		2	
POMP1	18	0.70		2.19		1.16		1.87		0.53		0.53		6	6		6	
HB1	21	2.67		0.31		0.90		1.23		0.50		0.50		6	12		19	
SECOND REEF																		
BOCA1*	30	2.23		1.25		1.59		1.53		0.82		0.82		7	32		7	
JUL7	32	1.97		0.88		1.77		1.99		0.71		0.71		12	14		4	
HB2	35	2.23	2.27 ± 0.50	3.22	1.23 ± 0.91	1.51	1.69 ± 0.19	2.10	1.88 ± 0.20	0.61	0.72 ± 0.10	0.61	0.81 ± 0.03	12	33	26.02 ± 8.72	2	7.70 ± 8.65
DB2	37	2.10		1.12		1.68		1.92		0.70		0.70		11	39		1	
JUL1	40	3.00		0.61		1.89		2.05		0.72		0.72		14	21		3	
FTL2	48	2.23		0.56		1.94		1.75		0.88		0.88		9	22		14	
POMP5*	48	1.30		0.97		1.45		1.85		0.63		0.63		9	21		25	
THIRD REEF																		
HB3	49	4.03		2.57		2.09		2.15		0.84		0.84		12	33		6	
POMP3	51	5.10		2.53		1.87		1.94		0.73		0.73		13	25		2	
JUL8	50	2.67		1.57		1.89		1.84		0.82		0.82		11	13		4	
POMP6*	51	2.20	3.07 ± 1.08	2.51	2.07 ± 0.61	1.42	1.82 ± 0.21	2.12	1.97 ± 0.11	0.55	0.76 ± 0.10	0.55	0.83 ± 0.04	13	39	23.48 ± 9.34	12	13.63 ± 17.36
JUL2	52	2.40		1.78		1.91		1.93		0.87		0.87		9	15		3	
POMP2	52	2.10		1.87		1.77		2.02		0.74		0.74		11	26		5	
DB3	55	3.50		2.08		1.64		1.90		0.71		0.71		10	22		51	
FTL3	60	2.30		0.76		1.95		1.91		0.85		0.85		10	13		27	
MEAN (+ 1 SD)		2.30± 0.95		2.25± 3.41		1.49± 0.49		1.73± 0.36		0.66± 0.19		0.78± 0.09		9.65	19.81± 10.44		9.27± 11.75	

Table 4: Coral species abundance at each transect site. Species are arranged by relative abundance (from top to bottom).

SPECIES	JUL6	DB1	HH2	FTL1	FTL4	POMP 1	POMP 4	HB1	BOCA 1	JUL7	HB2	DB2	JUL1	FTL2	POMP 5	HB3	POMP 3	JUL8	POMP 6	JUL2	POMP 2	DB3	FTL3
	FIRST REEF SITES							SECOND REEF SITES								THIRD REEF SITES							
Siderastrea siderea	3	31	36	8		8	6	4	10	21	19	13	22	17	6	23	20	14	14	17	20	15	14
Montastrea cavernosa					42	1			6	4	10	21	13	5	6	25	47	23	8	4	5	22	14
Stephanocoenia michelinii	1								1	9	7	10	23	18	8	11	4	14	18	18	7	29	17
Porites astreoides	37			23	4	3	6			2	5	5	8	1		22	33	12	1	8	2	9	1
Millepora alcicornis		6		1	3	1	1	1	32	3	10	2		17	5	6	21	11	6	4	12	18	10
Siderastrea radians	1	1		3	4	2	15	24	8	10	1		5		3	2	1	1					
Solenastrea bournoni		1	10			3		41	8	1			2	1	1			2		2			2
Dichocoenia stokesii	1			2	3	1	1		2	2	5	10	2	2	4	9	4		1		3	2	4
Meandrina meandrites					1					3	5	2	9	3	5	1	4		4	3	2	2	5
Madracis decactis												1		3		8	13	1	2	13		4	1
Porites porites	2		13	4			3						1								5		
Cladocora arbuscula		9						8					1			8		1					
Montastrea faveolata					1	1					2					5	3		4	3	5		
Agaricia agaricites				4	6							1					1				1		1
Diploria strigosa				1							1	3			1	1			1			3	
Acropora cervicornis	4									2													
Diploria clivosa	3				1	1				1													
Scolymia cubensis																			4			1	
Diploria labyrinthiformis					1												1		1				
Eusmilia fastigiata													1						1		1		
Favia fragum	1												1				1						
Mycetophyllia lamarkiana										1		1	1										
Solenastrea hyades							1	2															
Colpophyllia natans				1									1										
Montastrea franksii					1													1					
Agaricia fragilis																		1					
Isophyllia sinuosa				1																			
Mycetophyllia aliciae											1												
Scolymia wellsi											1												
Total species: 29																							
# species/ site	9	5	3	10	11	9	7	6	7	12	12	11	14	9	9	12	13	11	13	9	11	10	10

Table 5: Species list of fishes identified at the 23 monitoring sites (transects and point-count data combined).

COMMON NAME	SCIENTIFIC NAME
FAMILY: STINGRAY	DASYATIDAE
Yellow Stingray	*Urolophus jamaicensis*
FAMILY: RHINOBATIDAE	GUITARFISH
Guitarfish	*Rhinobatos lentiginosus*
FAMILY: LIZARDFISHES	SYNODONTIDAE
Sand Diver	*Synodus intermedius*
FAMILY: BIGEYE	PRIACANTHIDAE
Glasseye Snapper	*Heteropriacanthus cretatus*
FAMILY: SQUIRRELFISHES	HOLOCENTRIDAE
Longspine Squirrelfish	*Holocentrus rufus*
Squirrelfish	*Holocentrus adsensionis*
Blackbar soldierfish	*Myripristis jacobus*
Reef Squirrelfish	*Holocentrus coruscum*
FAMILY: TRUMPETFISHES	AULOSTOMIDAE
Trumpetfish	*Aulostomus maculatus*
FAMILY:CORNETFISH	FISTULARIIDAE
Bluespotted Cornetfish	*Fistularia tabacaria*
FAMILY: SEA BASSES	SERRANIDAE
Red Grouper	*Epinephelus morio*
Sand Perch	*Diplectum formosum*
Harlequin Bass	*Serranus tigrinus*
Tobaccofish	*Serranus tabacarius*
Graysby	*Cephalopholis cruentata*
Butter Hamlet	*Hypoplectrus unicolor*
Hamlet	*Hypoplectrus spp.*
Blue Hamlet	*Hypoplectrus gemma*
Chalk Bass	*Serranus tortugaum*
Lantern Bass	*Serranus baldwini*
Red Hind	*Epinephelus guttatus*
FAMILY: JACKS	CARANGIDAE
Almaco Jack	*Seriola rivoliana*
Blue Runner	*Caranx crysos*
Bar Jack	*Caranx ruber*
Yellow Jack	*Caranx bartholomaei*

Table 5: Continued

COMMON NAME	SCIENTIFIC NAME
FAMILY: SNAPPERS	LUTJANIDAE
Yellowtail Snapper	*Ocyurus chrysurus*
Grey Snapper	*Lutjanus griseus*
Mutton Snapper	*Lutjanus analis*
FAMILY: GRUNTS	HAEMULIDAE
White Grunt	*Haemulon plumieri*
Tomtates	*Haemulon aurolineatum*
Juvenile Grunts	*Haemulon* juveniles
French Grunt	*Haemulon flavolineatum*
Spanish Grunt	*Haemulon macrostomum*
Bluestripe Grunt	*Haemulon sciurus*
Sailors Choice	*Haemulon parrai*
Porkfish	*Anisotremus virginicus*
Smallmouth Grunt	*Haemulon chrysargyreum*
Striped Grunt	*Haemulon striatum*
Ceasar Grunt	*Haemulon carbonarium*
FAMILY: PORGIES	SPARIDAE
Spottail Pinfish	*Diplodos holbrooki*
Sheepshead Porgy	*Calamus penna*
FAMILY: DRUMS	SCIAENIDAE
Highhat	*Equetus acuminatus*
FAMILY: GOATFISHES	MULLIDAE
Spotted Goatfish	*Pseudupeneus maculatus*
Yellow Goatfish	*Mulloidichthys martinicus*
FAMILY: SEA CHUBS	KYPHOSIDAE
Bermuda Chub	*Kyphosus sectatrix*
FAMILY: Butterflyfishes	CHAETODONTIDAE
Reef Butterflyfish	*Chaetodon sedentarius*
Spotfin Butterflyfish	*Chaetodon ocellatus*
Four-eye Butterfly	*Chaetodon capistratus*
Banded Butterfly	*Cheatodon striatus*
FAMILY: ANGELFISHES	POMACANTHIDAE
Queen Angelfish	*Holocanthus cilaris*
Blue Angelfish	*Holocanthus bermudensis*
French Angelfish	*Pomacanthus paru*
Grey Angelfish	*Pomacanthus arcuatus*
Rock Beauty	*Holocanthus tricolor*

Table 5: Continued

COMMON NAME	SCIENTIFIC NAME
FAMILY: DAMSELFISHES	POMACENTRIDAE
Sergeant Major	*Abudefduf saxatilis*
Dusky Damselfish	*Stegastes fuscus*
Threespot Damselfish	*Stegastes planifrons*
Cocoa Damselfish	*Stegastes variabilis*
Beaugregory	*Stegastes leucostictus*
Bicolor Damselfish	*Stegates partitus*
Brown Chromis	*Chromis multilineata*
Blue Chromis	*Chromis cyaneus*
Purple Reeffish	*Chromis scotti*
Sunshinefish	*Chromis insolata*
Yellowtail Damsel	*Microspathodon chrysurus*
FAMILY: WRASSES	LABRIDAE
Hogfish	*Lachnolaimus maximus*
Spanish Hogfish	*Bodianus rufus*
Creole Wrasse	*Clepticus parrai*
Clown Wrasse	*Halichores maculipinna*
Slippery Dick	*Halichores bivittatus*
Yellowcheek Wrasse	*Halichores cyanocephalus*
Yellowhead Wrasse	*Halichores garnoti*
Blackear Wrasse	*Halichoeres poeyi*
Bluehead Wrasse	*Thalassoma bifasciatum*
FAMILY: PARROTFISHES	SCARIDAE
Parrotfish	*Sparisoma* sp.
Red tail Parrotfish	*Sparisoma chrysopterum*
Stoplight Parrotfish	*Sparisoma virride*
Redband Parrot	*Sparisoma aurofrenatum*
Striped Parrot	*Scarus croicensis*
Bucktooth Parrot	*Sparisoma radians*
Greenblotch Parrot	*Sparisoma atomarium*
Princess Parrot	*Scarus taeniopterus*
Queen Parrot	*Scarus vetula*
Bluelip Parrot	*Cryptotomus roseus*
FAMILY: CLINIDS	CLINIDAE
Roughhead Blenny	*Acantheblemaria aspera*
FAMILY: COMBTOOTH BLENNIES	BLENNIDAE
Seaweed Blenny	*Parablennius marmoreus*

Table 5: Continued

COMMON NAME	SCIENTIFIC NAME
FAMILY: GOBIES	GOBIIDAE
Bridled Goby	*Coryphopterus glaucofraenum*
Masked Goby	*Coryphopterus personatus*
Goldspot Goby	*Gnatholepis thomsoni*
FAMILY:JAWFISH	OPISTOGNATHIDAE
Dusky Jawfish	*Opistognthus whitehursti*
FAMILY: SURGEONFISHES	ACANTHURIDAE
Ocean Surgeon	*Acanthurus bahianus*
Doctorfish	*Acanthurus chirurgus*
Blue tang	*Acanthurus coeruleus*
FAMILY: MACKERALS	SCOMBRIDAE
Cero	*Scomberomorus regalis*
FAMILY: SCORPIONFISH	SCORPAENIDAE
Spotted Scorpionfish	*Scorpaena plumieri*
FAMILY: LEFTEYE FLOUNDERS	BOTHIDAE
Flounder	Bothidae
FAMILY: LEATHERJACKETS	MONOCANTHIDAE
Scrawled Filefish	*Aluterus scriptus*
Orangespotted Filefish	*Cantherhines pullus*
Whitespotted Filefish	*Cantherhines macrocerus*
Planehead Filefish	*Monocanthus hispidus*
FAMILY:TRIGGERFISH	BALISTIDAE
Grey Trigger	*Balistes capriscus*
Queen Trigger	*Balistes vetula*
FAMILY: BOXFISHES	OSTRACIIDAE
Scrawled Cowfish	*Lactrophrys quadricornis*
Smooth Trunkfish	*Lactrophrys triqueter*
Honeycomb Cowfish	*Lactophrys polygonia*
FAMILY: PUFFERS	TETRAODONTIDAE
Sharpnose Puffer	*Canthigaster rostrata*
Bandtail Puffer	*Sphoeroides spengleri*
FAMILY: SPINY PUFFERS	DIODONTIDAE
Porcupinefish	*Diodon hystrix*
Balloonfish	*Diodon holocanthus*
TOTAL SPECIES	**110**

Table 6: Fish abundance on each of the First Reef sites. The species are listed in order of total abundance.

COMMON NAME	SCIENTIFIC NAME	HH2	JUL6	FTL4	FTL1	POMP1	POMP4	HB1	DB1	TOTAL
Tomtates	*Haemulon aurolineatum*	0	0	0	0	110	0	0	4	114
Bluehead Wrasse	*Thalassoma bifasciatum*	0	13	21	0	40	0	20	13	107
Ocean Surgeon	*Acanthurus bahianus*	1	10	17	0	29	0	0	30	87
White Grunt	*Haemulon plumieri*	0	1	64	1	4	0	0	3	73
French Grunt	*Haemulon flavolineatum*	0	0	55	0	17	0	0	0	72
Slippery Dick	*Halichores bivittatus*	0	13	14	4	12	6	7	10	66
Clown wrasse	*Halichores maculipinna*	0	7	5	0	12	3	8	0	35
Grey Trigger	*Balistes capriscus*	0	0	3	6	1	0	11	11	32
Redband Parrot	*Sparisoma aurofrenatum*	0	3	14	1	12	0	0	0	30
Doctorfish	*Acanthurus chirurgus*	0	1	1	0	10	0	15	1	28
Striped Parrot	*Scarus croicensis*	0	0	23	3	0	0	0	0	26
Cocoa Damselfish	*Stegastes variabilis*	0	3	4	0	7	0	0	3	17
Blue tang	*Acanthurus coeruleus*	0	0	5	0	12	0	0	0	17
Threespot Damselfish	*Stegastes planifrons*	0	0	12	0	1	0	0	0	13
Juvenile Grunts	*Haemulon* juveniles	0	0	0	0	0	0	12	0	12
Ceasar Grunt	*Haemulon carbonarium*	0	0	2	0	10	0	0	0	12
Spottail Pinfish	*Diplodos holbrooki*	0	0	10	0	1	0	0	1	12
Sharpnose Puffer	*Canthigaster rostrata*	0	6	4	0	0	2	0	0	12
Stoplight Parrotfish	*Sparisoma virride*	0	0	7	0	2	0	0	0	9
Greenblotch Parrot	*Sparisoma atomarium*	0	4	5	0	0	0	0	0	9
Bridled Goby	*Coryphopterus glaucofraenum*	3	1	0	5	0	0	0	0	9
Porkfish	*Anisotremus virginicus*	0	0	7	0	0	0	0	1	8
Seaweed Blenny	*Parablennius marmoreus*	0	0	0	0	0	0	2	6	8
Bicolor Damselfish	*Stegates partitus*	0	1	1	1	4	0	0	0	7
Yellowtail Snapper	*Ocyurus chrysurus*	0	0	6	0	0	0	0	0	6
Sergeant Major	*Abudefduf saxatilis*	0	0	0	0	2	0	0	3	5

Table 6: Continued

COMMON NAME	SCIENTIFIC NAME	HH2	JUL6	FTL4	FTL1	POMP1	POMP4	HB1	DB1	TOTAL
Balloonfish	*Diodon holocanthus*	0	0	0	3	0	0	2	0	5
Red Grouper	*Epinephelus morio*	1	0	1	0	0	1	0	1	4
Grey Angelfish	*Pomacanthus arcuatus*	2	0	0	0	0	1	0	1	4
Dusky Damselfish	*Stegastes fuscus*	0	1	3	0	0	0	0	0	4
Dusky Jawfish	*Opistognthus whitehursti*	3	0	0	0	0	1	0	0	4
Squirrelfish	*Holocentrus adsensionis*	0	0	3	0	0	0	0	0	3
Bluespotted Cornetfish	*Fistularia tabacaria*	0	0	0	0	0	0	3	0	3
Bar Jack	*Caranx ruber*	0	0	1	1	0	0	0	1	3
Spotted Goatfish	*Pseudupeneus maculatus*	0	0	0	0	0	0	0	3	3
French Angelfish	*Pomacanthus paru*	0	0	3	0	0	0	0	0	3
Planehead Filefish	*Monocanthus hispidus*	0	0	0	0	1	0	0	2	3
Reef Butterflyfish	*Chaetodon sedentarius*	0	0	0	0	0	0	0	2	2
Beaugregory	*Stegastes leucostictus*	0	0	1	1	0	0	0	0	2
Yellowhead Wrasse	*Halichores garnoti*	0	0	1	0	1	0	0	0	2
Blackear Wrasse	*Halichoeres poeyi*	0	2	0	0	0	0	0	0	2
Roughhead Blenny	*Acantheblemaria aspera*	0	0	0	0	0	1	0	1	2
Smooth Trunkfish	*Lactrophrys triqueter*	0	0	2	0	0	0	0	0	2
Bandtail Puffer	*Sphoeroides spengleri*	0	0	0	0	0	0	2	0	2
Yellow Stingray	*Urolophus jamaicensis*	0	0	0	0	0	0	1	0	1
Guitarfish	*Rhinobatos lentiginosus*	0	0	0	0	0	0	1	0	1
Sand Perch	*Diplectum formosum*	1	0	0	0	0	0	0	0	1
Harlequin Bass	*Serranus tigrinus*	0	0	1	0	0	0	0	0	1
Hamlet	*Hypoplectrus spp.*	0	0	1	0	0	0	0	0	1
Blue Runner	*Caranx crysos*	0	0	0	0	0	0	1	0	1
Grey Snapper	*Lutjanus griseus*	0	0	0	0	1	0	0	0	1
Sheepshead Porgy	*Calamus penna*	0	0	0	0	0	0	0	1	1

Table 6: Continued

COMMON NAME	SCIENTIFIC NAME	HH2	JUL6	FTL4	FTL1	POMP1	POMP4	HB1	DB1	TOTAL
Highhat	*Equetus acuminatus*	0	0	0	0	1	0	0	0	1
Four-eye Butterfly	*Chaetodon capistratus*	0	0	0	0	1	0	0	0	1
Queen Angelfish	*Holocanthus cilaris*	0	0	1	0	0	0	0	0	1
Blue Angelfish	*Holocanthus bermudensis*	0	0	1	0	0	0	0	0	1
Yellowtail Damsel	*Microspathodon chrysurus*	0	0	0	0	1	0	0	0	1
Spanish Hogfish	*Bodianus rufus*	0	0	1	0	0	0	0	0	1
Parrotfish	*Sparisoma* sp.	1	0	0	0	0	0	0	0	1
Redfin Parrot	*Sparisoma rubripinne*	0	0	0	0	1	0	0	0	1
Bucktooth Parrot	*Sparisoma radians*	0	0	0	0	0	0	1	0	1
Queen Parrot	*Scarus vetula*	0	0	0	0	1	0	0	0	1
Sailfin Blenny	*Emblemaria pandionis*	0	0	0	0	0	0	0	1	1
Neon Goby	*Gobiosoma oceanops*	0	0	0	1	0	0	0	0	1
Spotted Scorpionfish	*Scorpaena plumieri*	0	0	0	0	0	0	1	0	1
Flounder	Bothidae	0	0	0	0	0	0	1	0	1
Orangespotted Filefish	*Cantherhines pullus*	0	0	0	0	0	0	1	0	1
Queen Trigger	*Balistes vetula*	0	0	0	0	0	0	0	1	1
Scrawled Cowfish	*Lactrophrys quadricornis*	0	0	0	0	0	0	1	0	1
	# FISH	12	66	300	27	294	15	90	100	904
	# SPECIES	7	14	34	11	26	7	18	22	69

Table 7: Fish abundance on each of the Second Reef sites. The species are listed in order of total abundance

COMMON NAME	SCIENTIFIC NAME	JUL2	JUL1	JUL7	FTL2	POMP5	HB2	DB2	BOCA1	TOTAL
Bluehead Wrasse	*Thalassoma bifasciatum*	23	32	33	61	22	93	138	30	432
Bicolor Damselfish	*Stegates partitus*	109	43	22	8	1	31	92	17	323
Tomtates	*Haemulon aurolineatum*	22	0	0	0	0	100	200	0	322
Creole Wrasse	*Clepticus parrai*	120	0	6	0	0	42	3	0	171
Striped Grunt	*Haemulon striatum*	150	0	0	0	0	0	0	0	150
Ocean Surgeon	*Acanthurus bahianus*	3	14	15	21	28	6	10	25	122
Redband Parrot	*Sparisoma aurofrenatum*	11	13	23	21	4	14	16	10	112
Blackear Wrasse	*Halichoeres poeyi*	100	0	0	0	0	0	0	0	100
French Grunt	*Haemulon flavolineatum*	0	0	0	0	0	75	6	1	82
Yellowhead Wrasse	*Halichores garnoti*	16	21	5	19	0	3	5	1	70
Sharpnose Puffer	*Canthigaster rostrata*	9	10	2	2	5	2	7	7	44
Slippery Dick	*Halichores bivittatus*	0	7	16	6	0	1	0	13	43
Striped Parrot	*Scarus croicensis*	4	3	20	0	0	10	0	0	37
Cocoa Damselfish	*Stegastes variabilis*	1	3	4	0	0	6	10	12	36
White Grunt	*Haemulon plumieri*	0	1	1	0	0	5	17	11	35
Yellowtail Snapper	*Ocyurus chrysurus*	0	0	5	0	0	0	21	8	34
Sergeant Major	*Abudefduf saxatilis*	0	0	0	0	0	9	15	0	24
Harlequin Bass	*Serranus tigrinus*	5	7	1	2	0	2	4	2	23
Sunsninefish	*Chromis insolata*	0	0	0	0	0	20	0	0	20
Grey Trigger	*Balistes capriscus*	0	10	1	6	0	1	0	2	20
Purple Reeffish	*Chromis scotti*	0	0	0	0	0	0	17	0	17
Stoplight Parrotfish	*Sparisoma virride*	3	0	3	1	0	5	4	1	17
Bridled Goby	*Coryphopterus glaucofraenum*	1	5	6	1	0	0	0	4	17
Spottail Pinfish	*Diplodos holbrooki*	0	0	0	0	0	0	15	0	15
Blue Tang	*Acanthurus coeruleus*	1	0	2	2	0	5	5	0	15
Reef Butterflyfish	*Chaetodon sedentarius*	4	0	2	0	0	0	1	7	14
Bar Jack	*Caranx ruber*	0	0	3	0	0	0	0	10	13
Brown Chromis	*Chromis multilineata*	1	0	0	0	0	7	5	0	13

Table 7: Continued

COMMON NAME	SCIENTIFIC NAME	JUL2	JUL1	JUL7	FTL2	POMP5	HB2	DB2	BOCA1	TOTAL
Bluestripe Grunt	*Haemulon sciurus*	0	0	0	0	0	0	10	2	12
Masked Goby	*Coryphopterus personatus*	0	0	10	0	0	2	0	0	12
Porkfish	*Anisotremus virginicus*	3	0	0	0	0	3	0	5	11
Spotfin Butterflyfish	*Chaetodon ocellatus*	2	2	2	2	0	0	0	3	11
Grey Angelfish	*Pomacanthus arcuatus*	2	4	0	3	0	0	1	1	11
Princess Parrot	*Scarus taeniopterus*	0	0	5	0	0	4	1	0	10
Grey Snapper	*Lutjanus griseus*	0	0	0	0	0	0	5	4	9
Red Grouper	*Epinephelus morio*	0	0	1	0	4	0	1	2	8
Spanish Hogfish	*Bodianus rufus*	0	0	0	0	0	2	3	3	8
Butter Hamlet	*Hypoplectrus unicolor*	2	1	1	0	0	2	1	0	7
Greenblotch Parrot	*Sparisoma atomarium*	4	3	0	0	0	0	0	0	7
Spotted Goatfish	*Pseudupeneus maculatus*	5	0	0	0	0	0	0	1	6
Four-eye Butterfly	*Chaetodon capistratus*	0	3	3	0	0	0	0	0	6
Yellow Jack	*Caranx bartholomaei*	0	0	0	0	2	0	0	3	5
Black Margate	*Anisotremus surinamensis*	0	0	0	0	0	1	1	3	5
Clown Wrasse	*Halichores maculipinna*	1	0	2	0	0	0	2	0	5
Bluelip Parrot	*Cryptotomus roseus*	0	0	0	5	0	0	0	0	5
Doctorfish	*Acanthurus chirurgus*	0	0	0	0	1	0	3	1	5
Reef Squirrelfish	*Holocentrus coruscum*	0	0	0	0	0	4	0	0	4
Tobaccofish	*Serranus tabacarius*	0	1	0	3	0	0	0	0	4
Graysby	*Cephalopholis cruentata*	0	0	0	0	0	2	2	0	4
French Angelfish	*Pomacanthus paru*	0	1	0	1	0	2	0	0	4
Beaugregory	*Stegastes leucostictus*	1	0	0	0	0	1	2	0	4
Bandtail Puffer	*Sphoeroides spengleri*	0	0	0	0	2	2	0	0	4
Trumpetfish	*Aulostomus maculatus*	0	0	0	0	0	1	0	2	3
Blue Hamlet	*Hypoplectrus gemma*	0	0	0	0	0	3	0	0	3
Ceasar Grunt	*Haemulon carbonarium*	0	0	0	0	0	3	0	0	3

Table 7: Continued

COMMON NAME	SCIENTIFIC NAME	JUL2	JUL1	JUL7	FTL2	POMP5	HB2	DB2	BOCA1	TOTAL
Yellow Goatfish	*Mulloidichthys martinicus*	0	0	0	0	0	0	3	0	3
Rock Beauty	*Holocanthus tricolor*	0	0	0	2	0	1	0	0	3
Blue Chromis	*Chromis cyaneus*	0	0	0	1	0	2	0	0	3
Goldspot Goby	*Gnatholepis thomsoni*	1	2	0	0	0	0	0	0	3
Hamlet	*Hypoplectrus spp.*	0	0	1	0	0	0	1	0	2
Blue Runner	*Caranx crysos*	0	0	2	0	0	0	0	0	2
Spanish Grunt	*Haemulon macrostomum*	0	0	0	0	0	1	1	0	2
Sailors Choice	*Haemulon parrai*	0	0	0	0	0	0	2	0	2
Banded Butterfly	*Cheatodon striatus*	0	0	2	0	0	0	0	0	2
Threespot Damselfish	*Stegastes planifrons*	0	0	0	0	0	1	1	0	2
Queen Parrot	*Scarus vetula*	0	1	0	1	0	0	0	0	2
Cero	*Scomberomorus regalis*	2	0	0	0	0	0	0	0	2
Scrawled Filefish	*Aluterus scriptus*	1	0	0	0	0	0	0	1	2
Planehead Filefish	*Monocanthus hispidus*	0	1	0	0	0	0	1	0	2
Scrawled cowfish	*Lactrophrys quadricornis*	1	0	0	1	0	0	0	0	2
Porcupinefish	*Diodon hystrix*	0	0	0	0	0	2	0	0	2
Balloonfish	*Diodon holocanthus*	0	0	0	0	1	0	1	0	2
Yellow Stingray	*Urolophus jamaicensis*	0	0	0	0	1	0	0	0	1
Sand Diver	*Synodus intermedius*	0	0	0	0	0	1	0	0	1
Longspine Squirrelfish	*Holocentrus rufus*	0	0	0	0	0	0	1	0	1
Chalk Bass	*Serranus tortugaum*	0	1	0	0	0	0	0	0	1
Red Hind	*Epinephelus guttatus*	0	0	0	0	0	0	0	1	1
FAMILY: PORGIES	SPARIDAE	0	0	0	0	0	0	0	1	1
Sheepshead Porgy	*Calamus penna*	0	0	0	0	0	0	1	0	1
Saddled Blenny	*Malcoctenus triangulatus*	0	0	1	0	0	0	0	0	1
Spotted Scorpionfish	*Scorpaena plumieri*	1	0	0	0	0	0	0	0	1
Orangespotted Filefish	*Cantherhines pullus*	0	0	0	0	0	0	0	1	1
Honeycomb Cowfish	*Lactophrys polygonia*	0	0	0	0	0	1	0	0	1
	# FISH	609	189	200	169	71	478	635	195	2546
	# SPECIES	23	20	25	17	7	35	35	29	83

Table 8: Fish abundance on each of the Third Reef sites. The species are listed in order of total abundance

COMMON NAME	SCIENTIFIC NAME	JUL8	FLT3	POMP3	POMP2	POMP6	HB3	DB3	TOTAL
Creole Wrasse	*Clepticus parrai*	0	0	125	0	0	120	0	245
Bluehead Wrasse	*Thalassoma bifasciatum*	46	31	62	38	1	7	26	211
Striped Grunt	*Haemulon striatum*	0	0	150	0	0	5	0	155
Bicolor Damselfish	*Stegates partitus*	20	10	49	16	26	29	4	154
Redband Parrot	*Sparisoma aurofrenatum*	13	11	12	7	12	41	29	125
Yellowhead Wrasse	*Halichores garnoti*	14	24	22	4	11	5	38	118
Ocean Surgeon	*Acanthurus bahianus*	21	6	22	13	32	8	10	112
Tomtates	*Haemulon aurolineatum*	0	0	25	0	0	50	0	75
Striped Parrot	*Scarus croicensis*	8	0	15	12	6	16	12	69
Bar Jack	*Caranx ruber*	0	0	50	0	0	0	0	50
Sharpnose Puffer	*Canthigaster rostrata*	5	17	8	1	5	5	3	44
French Grunt	*Haemulon flavolineatum*	0	0	6	0	0	36	0	42
Brown Chromis	*Chromis multilineata*	1	0	12	0	13	0	0	26
Bermuda Chub	*Kyphosus sectatrix*	0	0	22	0	0	1	0	23
Blue Tang	*Acanthurus coeruleus*	2	0	9	0	3	6	1	21
Princess Parrot	*Scarus taeniopterus*	2	0	4	6	0	0	6	18
Blackbar soldierfish	*Myripristis jacobus*	0	0	7	0	0	8	0	15
Grey Snapper	*Lutjanus griseus*	0	0	15	0	0	0	0	15
Reef Butterflyfish	*Chaetodon sedentarius*	4	6	0	0	1	0	2	13
Harlequin Bass	*Serranus tigrinus*	3	1	2	1	4	0	1	12
Spotfin Butterflyfish	*Chaetodon ocellatus*	2	2	4	0	0	4	0	12
White Grunt	*Haemulon plumieri*	2	0	1	3	0	3	2	11
Graysby	*Cephalopholis cruentata*	2	0	5	2	0	1	0	10
Yellowtail Snapper	*Ocyurus chrysurus*	0	0	0	0	0	9	1	10
Four-eye Butterfly	*Chaetodon capistratus*	0	0	9	0	0	0	1	10
Doctorfish	*Acanthurus chirurgus*	0	7	0	0	0	0	3	10
Scrawled Filefish	*Aluterus scriptus*	2	0	6	0	0	2	0	10

Table 8: Continued

COMMON NAME	SCIENTIFIC NAME	JUL8	FLT3	POMP3	POMP2	POMP6	HB3	DB3	TOTAL
Butter Hamlet	*Hypoplectrus unicolor*	0	0	1	2	2	2	2	9
Cocoa Damselfish	*Stegastes variabilis*	2	0	4	0	0	3	0	9
Stoplight Parrotfish	*Sparisoma virride*	2	2	4	1	0	0	0	9
Hamlet	*Hypoplectrus spp.*	2	0	0	5	0	1	0	8
Bridled Goby	*Coryphopterus glaucofraenum*	4	0	0	2	1	1	0	8
Porkfish	*Anisotremus virginicus*	1	0	2	1	0	2	1	7
Greenblotch Parrot	*Sparisoma atomarium*	0	0	3	0	4	0	0	7
Blue Hamlet	*Hypoplectrus gemma*	0	0	0	3	2	0	0	5
Blue Chromis	*Chromis cyaneus*	0	0	0	2	0	3	0	5
Grey Trigger	*Balistes capriscus*	4	0	0	0	1	0	0	5
Tobaccofish	*Serranus tabacarius*	3	0	0	1	0	0	0	4
Ceasar Grunt	*Haemulon carbonarium*	0	0	0	0	0	4	0	4
Queen Angelfish	*Holocanthus cilaris*	0	0	0	4	0	0	0	4
Trumpetfish	*Aulostomus maculatus*	0	1	0	0	0	1	1	3
Spotted Goatfish	*Pseudupeneus maculatus*	3	0	0	0	0	0	0	3
Sergeant Major	*Abudefduf saxatilis*	0	0	0	0	0	3	0	3
Redfin Parrot	*Sparisoma rubripinne*	0	0	0	3	0	0	0	3
Planehead Filefish	*Monocanthus hispidus*	1	1	0	0	1	0	0	3
Squirrelfish	*Holocentrus adsensionis*	0	0	2	0	0	0	0	2
Red Grouper	*Epinephelus morio*	0	1	0	1	0	0	0	2
Lantern Bass	*Serranus baldwini*	1	1	0	0	0	0	0	2
Bluestripe Grunt	*Haemulon sciurus*	0	0	1	0	0	1	0	2
Grey Angelfish	*Pomacanthus arcuatus*	0	0	0	2	0	0	0	2
Hogfish	*Lachnolaimus maximus*	0	0	0	0	1	1	0	2
Spanish Hogfish	*Bodianus rufus*	0	0	0	0	0	1	1	2
Clown Wrasse	*Halichores maculipinna*	0	0	1	0	1	0	0	2
Red tail Parrotfish	*Sparisoma chrysopterum*	0	0	0	0	2	0	0	2

Table 8: Continued

COMMON NAME	SCIENTIFIC NAME	JUL8	FLT3	POMP3	POMP2	POMP6	HB3	DB3	TOTAL
Scrawled Cowfish	*Lactrophrys quadricornis*	0	2	0	0	0	0	0	2
Yellow Stingray	*Urolophus jamaicensis*	0	1	0	0	0	0	0	1
Lizardfish	*Synodus* sp.	0	0	1	0	0	0	0	1
Glasseye Snapper	*Heteropriacanthus cretatus*	0	0	0	0	0	1	0	1
Reef Squirrelfish	*Holocentrus coruscum*	0	0	0	0	0	1	0	1
Almaco Jack	*Seriola rivoliana*	0	0	0	0	0	1	0	1
Mutton Snapper	*Lutjanus analis*	0	0	0	0	1	0	0	1
Smallmouth Grunt	*Haemulon chrysargyreum*	0	0	0	0	0	1	0	1
Banded Butterfly	*Cheatodon striatus*	0	0	0	0	0	1	0	1
Blue Angelfish	*Holocanthus bermudensis*	0	0	0	0	0	0	1	1
French Angelfish	*Pomacanthus paru*	0	1	0	0	0	0	0	1
Rock Beauty	*Holocanthus tricolor*	0	0	0	1	0	0	0	1
Beaugregory	*Stegastes leucostictus*	0	0	1	0	0	0	0	1
Purple Reeffish	*Chromis scotti*	0	0	0	0	0	1	0	1
Slippery Dick	*Halichores bivittatus*	0	0	0	1	0	0	0	1
Bluelip Parrot	*Cryptotomus roseus*	0	0	0	0	1	0	0	1
Goldspot Goby	*Gnatholepis thomsoni*	0	1	0	0	0	0	0	1
Orangespotted Filefish	*Cantherhines pullus*	0	0	0	0	0	1	0	1
Whitespotted Filefish	*Cantherhines macrocerus*	0	0	0	0	0	0	1	1
Bandtail Puffer	*Sphoeroides spengleri*	0	1	0	0	0	0	0	1
Balloonfish	*Diodon holocanthus*	1	0	0	0	0	0	0	1
	# FISH	171	127	662	132	131	386	146	1755
	# SPECIES	27	20	34	25	22	38	21	75

Table 9: Summary data for sediment collection No. 17. (Predredging: October - December 2000)

REEF TRACT	REEF SITE	SAMPLE REP.	DATE SET	DATE COL.	DAYS	TOTAL WEIGHT (mg)	SED RATE mg/cm^2/ day	WEIGHT < 63u (mg)	WEIGHT < 63u (mg)	PERCENT SILT/ CLAY	AVG SED RATE	AVG % FINES
FIRST	HH2	A	01-Nov	04-Jan	64	201080	153.787	154.35	46.73	23.24		
REEF		B	01-Nov	04-Jan	64	204950	156.747	153.24	51.71	25.23		
		C	01-Nov	04-Jan	64	192450	147.187	148.77	43.68	22.70	152.57	23.72
	JUL6	A	31-Oct	04-Jan	65	469370	353.455	449.94	19.43	4.14		
		B	31-Oct	04-Jan	65	609450	458.940	589.71	19.74	3.24		
		C	31-Oct	04-Jan	65	531340	400.120	511.29	20.05	3.77	404.17	3.72
	FTL1	A	30-Oct	05-Jan	67	136180	99.488	118.14	18.04	13.25		
		B	30-Oct	05-Jan	67	120150	87.777	99.76	20.39	16.97		
		C	30-Oct	05-Jan	67	136290	99.568	119.57	16.72	12.27	95.61	14.16
	POMP1	A	01-Nov	05-Jan	65	39390	29.662	30.25	9.14	23.20		
		B	01-Nov	05-Jan	65	47540	35.800	36.21	11.33	23.83		
		C	01-Nov	05-Jan	65	47550	35.807	38.03	9.52	20.02	33.76	22.35
	HB1	A	02-Nov	05-Jan	64	70970	54.278	66.17	4.80	6.76		
		B	02-Nov	05-Jan	64	73680	56.351	67.74	5.94	8.06		
		C	02-Nov	05-Jan	64	0	0	Moray eel	Moray eel	n/a	36.88	7.41
	DB1	A	02-Nov	05-Jan	64	1043190	797.839	1041.95	1.24	0.12		
		B	02-Nov	05-Jan	64	1094520	837.096	1093.13	1.39	0.13		
		C	02-Nov	05-Jan	64	961340	735.239	959.6	1.74	0.18	790.06	0.14
	POMP4	A			0		n/a		n/a	n/a		
		B			0		n/a		n/a	n/a		
		C			0		n/a		n/a	n/a	n/a	n/a
	FTL4	A			0		n/a		n/a	n/a		
		B			0		n/a		n/a	n/a		
		C			0		n/a		n/a	n/a	n/a	n/a

Table 9: Continued

REEF TRACT	REEF SITE	SAMPLE REP.	DATE SET	DATE COL.	DAYS	TOTAL WEIGHT (mg)	SED RATE mg/cm^2/ day	WEIGHT < 63u (mg)	PERCENT SILT/ CLAY	AVG SED RATE	AVG % FINES
SECOND	JUL1	A	01-Nov	04-Jan	64	13290	10.164	6.18	46.50		
REEF		B	01-Nov	04-Jan	64	14040	10.738	6.17	43.95		
		C	01-Nov	04-Jan	64	15750	12.046	8.11	51.49	10.98	47.31
	JUL7	A	31-Oct	04-Jan	65	30840	23.224	8.8	28.53		
		B	31-Oct	04-Jan	65	34090	25.671	9.37	27.49		
		C	31-Oct	04-Jan	65	37050	27.900	8.08	21.81	25.60	25.94
	FTL2	A	30-Oct	05-Jan	67	7380	5.392	3.67	49.73		
		B	30-Oct	05-Jan	67	7520	5.494	3.37	44.81		
		C	30-Oct	05-Jan	67	8110	5.925	3.49	43.03	5.60	45.86
	POMP2	A	01-Nov	05-Jan	65	9400	7.079	4.37	46.49		
		B	01-Nov	05-Jan	65	10940	8.238	4.91	44.88		
		C	01-Nov	05-Jan	65	8800	6.627	3.29	37.39	7.31	42.92
	HB2	A	02-Nov	05-Jan	64	52400	40.076	5.3	10.11		
		B	02-Nov	05-Jan	64	50250	38.432	5.06	10.07		
		C	02-Nov	05-Jan	64	49050	37.514	5.05	10.30	38.67	10.16
	DB2	A	02-Nov	05-Jan	64	67790	51.846	3.12	4.60		
		B	02-Nov	05-Jan	64	65860	50.370	2.89	4.39		
		C	02-Nov	05-Jan	64	68640	52.496	2.68	3.90	51.57	4.30
	POMP5	A			0		n/a	n/a	n/a		
		B			0		n/a	n/a	n/a		
		C			0		n/a	n/a	n/a	n/a	n/a
	BOCA1	A			0		n/a	n/a	n/a		
		B			0		n/a	n/a	n/a		
		C			0		n/a	n/a	n/a	n/a	n/a

Table 9: Continued

REEF TRACT	REEF SITE	SAMPLE REP.	DATE SET	DATE COL.	DAYS	TOTAL WEIGHT (mg)	SED RATE $mg/cm^2/$ day	WEIGHT < 63u (mg)	PERCENT SILT/ CLAY	AVG SED RATE	AVG % FINES
THIRD	JUL2	A	01-Nov	04-Jan	64	6440	4.925	3.95	61.34		
REEF		B	01-Nov	04-Jan	64	6570	5.025	3.78	57.53		
		C	01-Nov	04-Jan	64	6300	4.818	3.69	58.57	4.92	59.15
	JUL8	A	31-Oct	04-Jan	65	6020	4.533	3.31	54.98		
		B	31-Oct	04-Jan	65	6140	4.624	3.23	52.61		
		C	31-Oct	04-Jan	65	6010	4.526	3.28	54.58	4.56	54.05
	FTL3	A	30-Oct	05-Jan	67	4300	3.141	2.45	56.98		
		B	30-Oct	05-Jan	67	4460	3.258	2.63	58.97		
		C	30-Oct	05-Jan	67	4960	3.624	2.92	58.97	3.34	58.27
	POMP3	A	01-Nov	05-Jan	65	4360	3.283	2.3	52.75		
		B	01-Nov	05-Jan	65	4500	3.389	2.25	50.00		
		C	01-Nov	05-Jan	65	4700	3.539	2.41	51.28	3.40	51.34
	HB3	A	02-Nov	05-Jan	64	7010	5.361	2.58	36.80		
		B	02-Nov	05-Jan	64	7600	5.813	2.78	36.58		
		C	02-Nov	05-Jan	64	7610	5.820	2.86	37.58	5.66	36.99
	DB3	A	02-Nov	05-Jan	64	8060	6.164	2.13	26.43		
		B	02-Nov	05-Jan	64	6080	n/a	Dropped	n/a		
		C	02-Nov	05-Jan	64	8320	6.363	1.89	22.72	6.26	24.57
	POMP6	A			0	0	n/a	n/a	n/a		
		B			0	0	n/a	n/a	n/a		
		C			0	0	n/a	n/a	n/a	n/a	n/a

Table 9: Continued

Avg Sed Rate	**1st Reef**	**2ndReef**	**3rd Reef**		
Hollywood	152.574				
Lloyd Park	404.172	18.290	4.742		
Ft Laud.	95.611	5.603	3.341		
Pompano	33.756	7.315	3.404		
Hillsboro	55.315	38.674	5.665		
Deerfield	790.058	154.713	5.726	**SED RATE mg/cm^2/ day**	**PERCENT SILT/ CLAY**
Boca					
1st Reef Avg				252.175	12.18
2nd Reef Avg				23.291	29.42
3rd Reef Avg				4.603	48.74
All Sites				95.356	30.10

Figure 1: NAPP 1999 aerial photographs of Broward County showing the locations of the 23 monitoring sites. Site locations are shown as red dots; borrow areas are outlined.

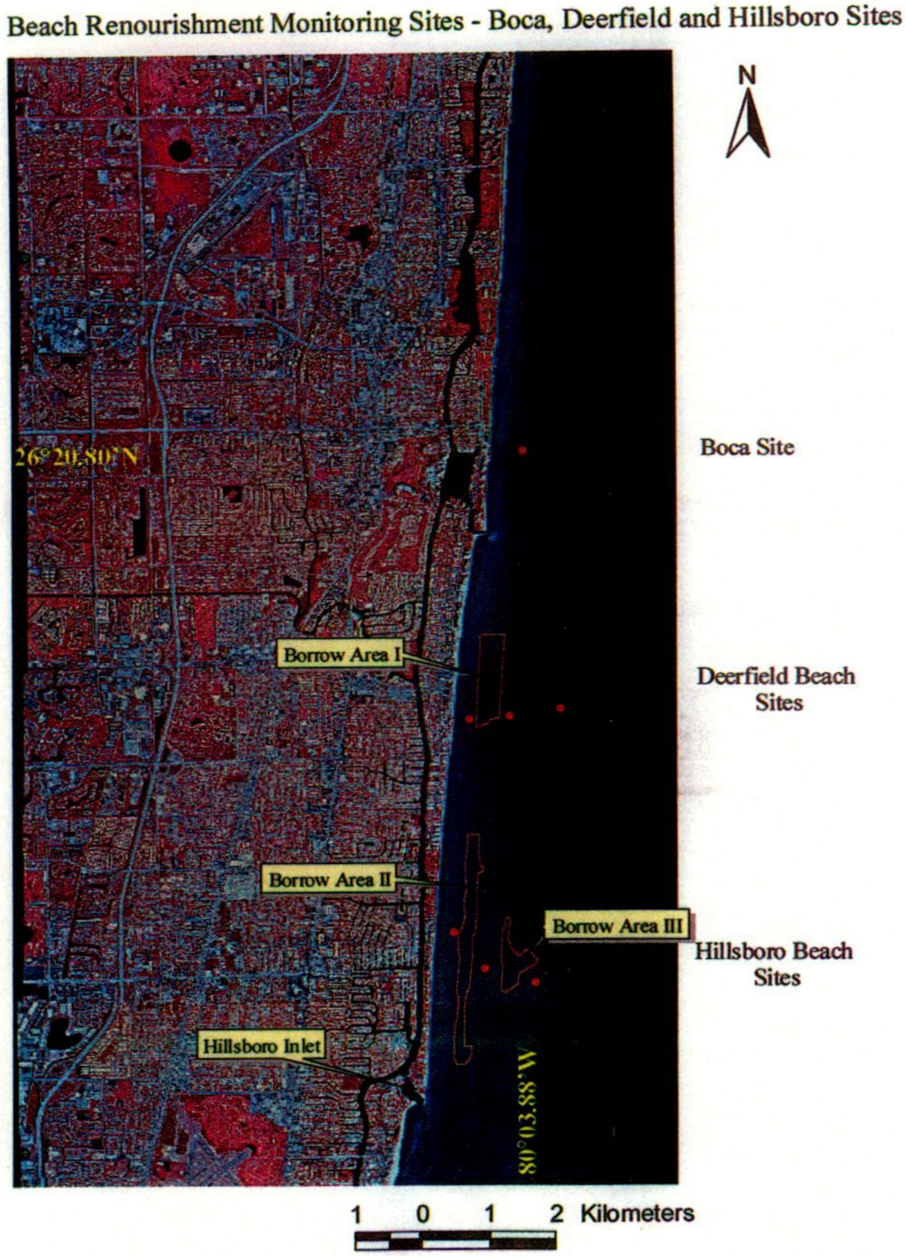


Figure 1: Continued.

Beach Renourishment Monitoring Sites - Pompano and Ft. Lauderdale Sites

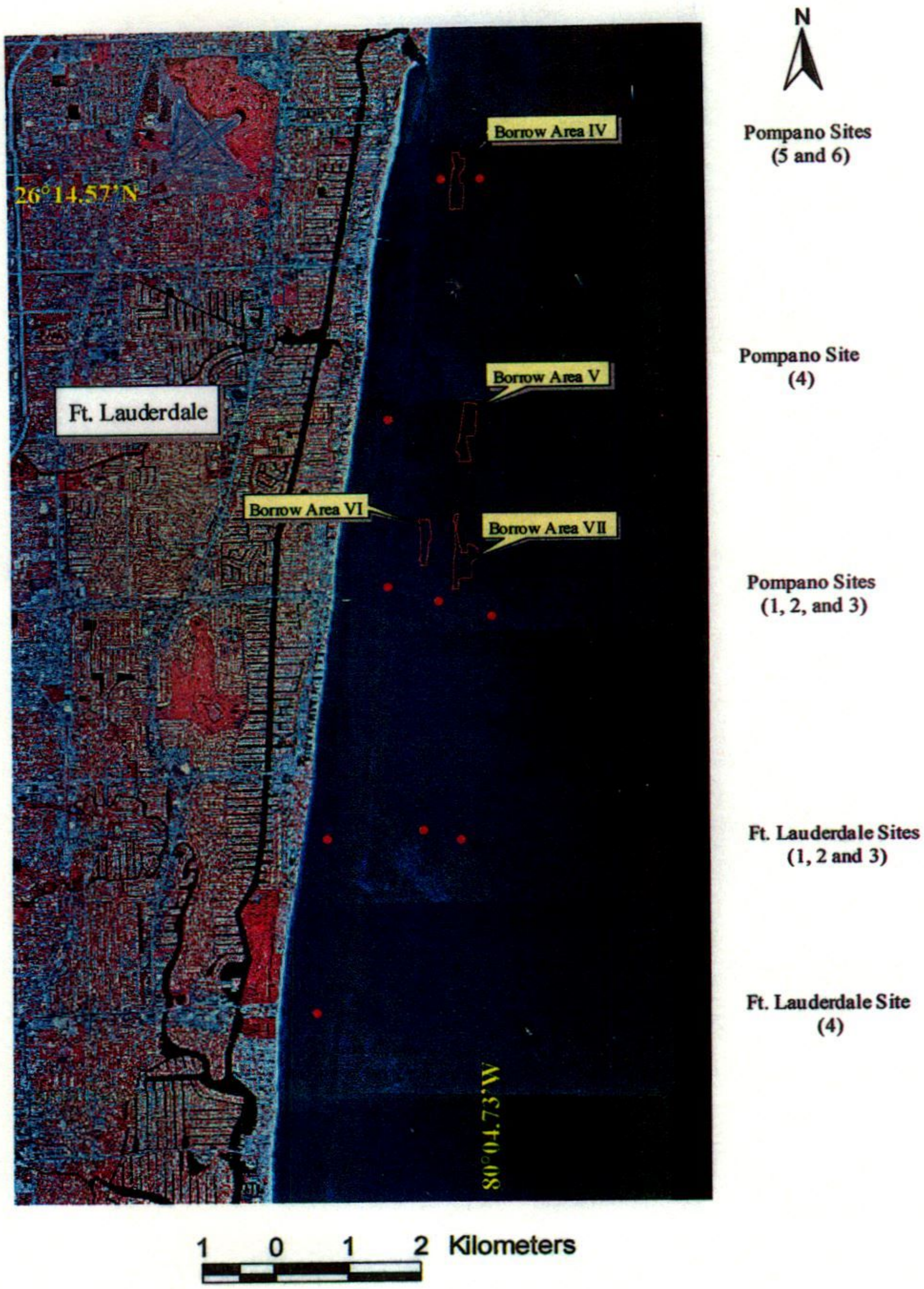
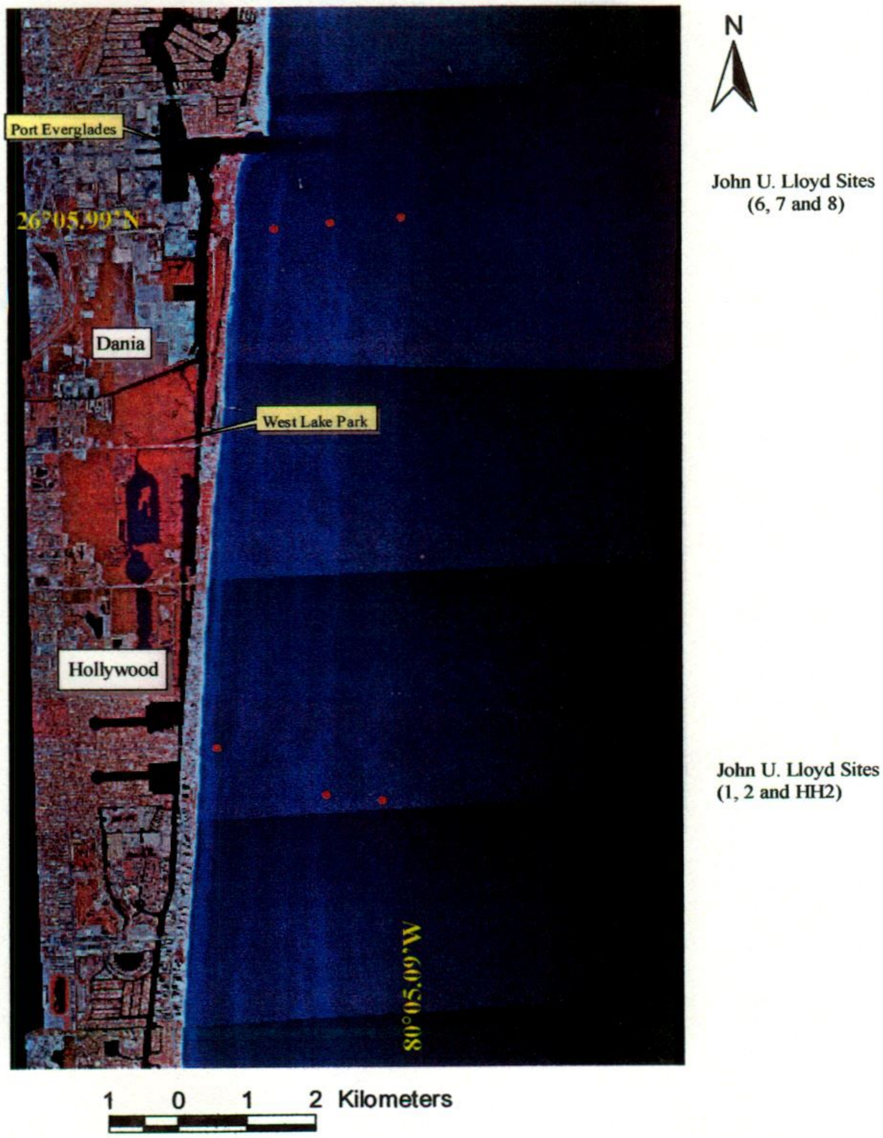


Figure 1: Continued.

Beach Renourishment Monitoring Sites - John U. Lloyd Sites



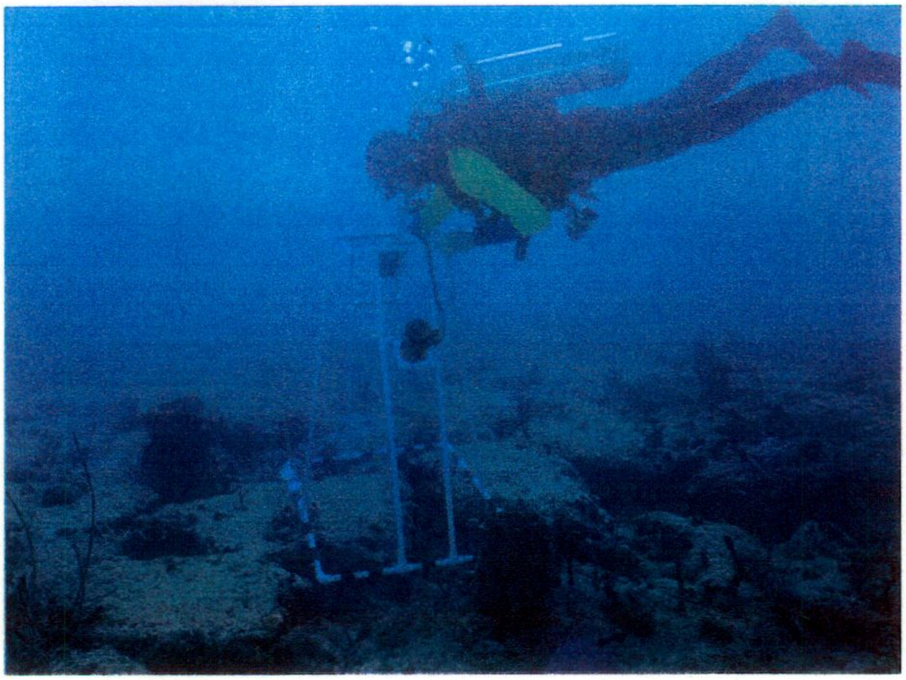


Figure 2. Diver photographing $0.75m^2$ quadrats along a $30m^2$ transect.

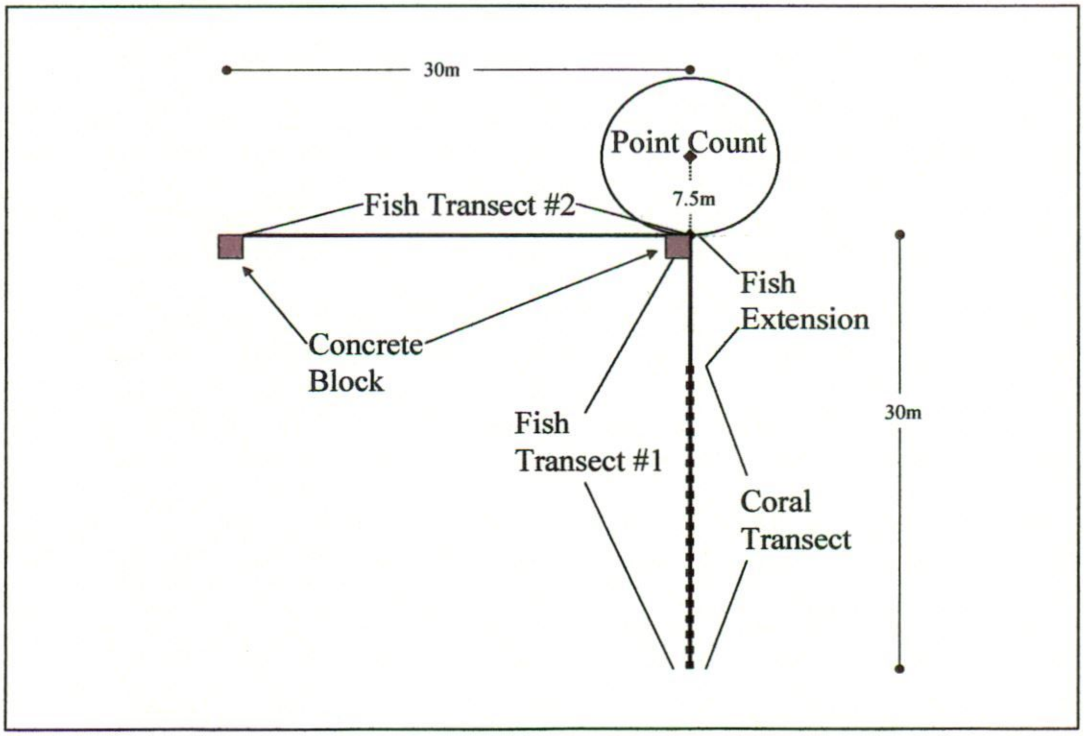


Figure 3. Schematic illustrating a "Normal" site lay-out. Not drawn to scale.

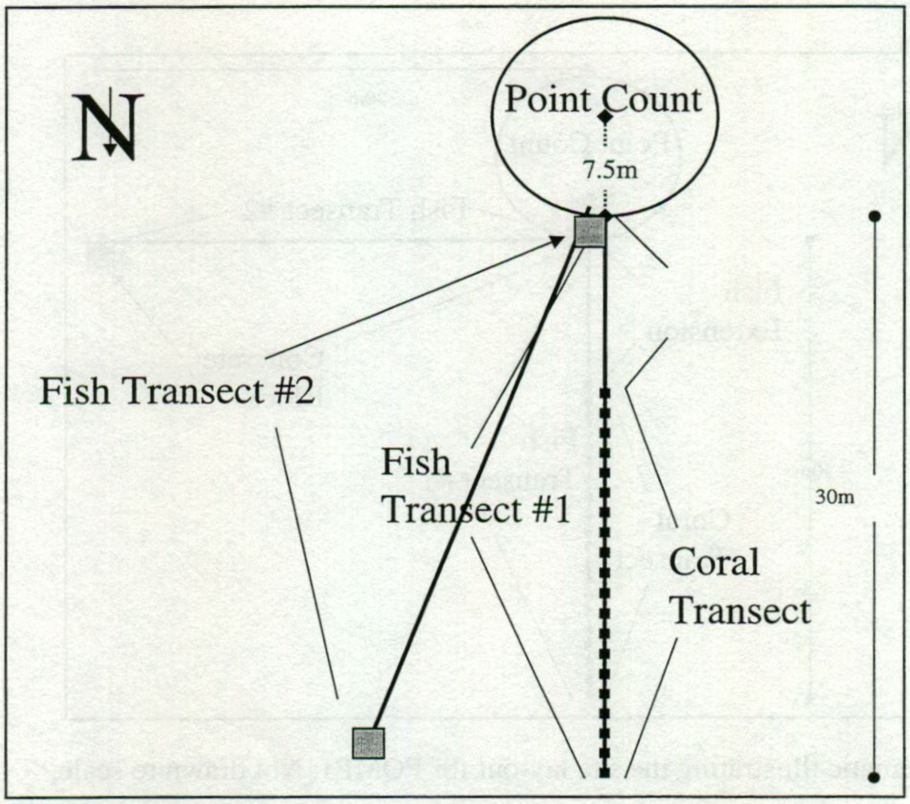


Figure 4: Schematic illustrating the site lay-out for JUL1. Not drawn to scale.

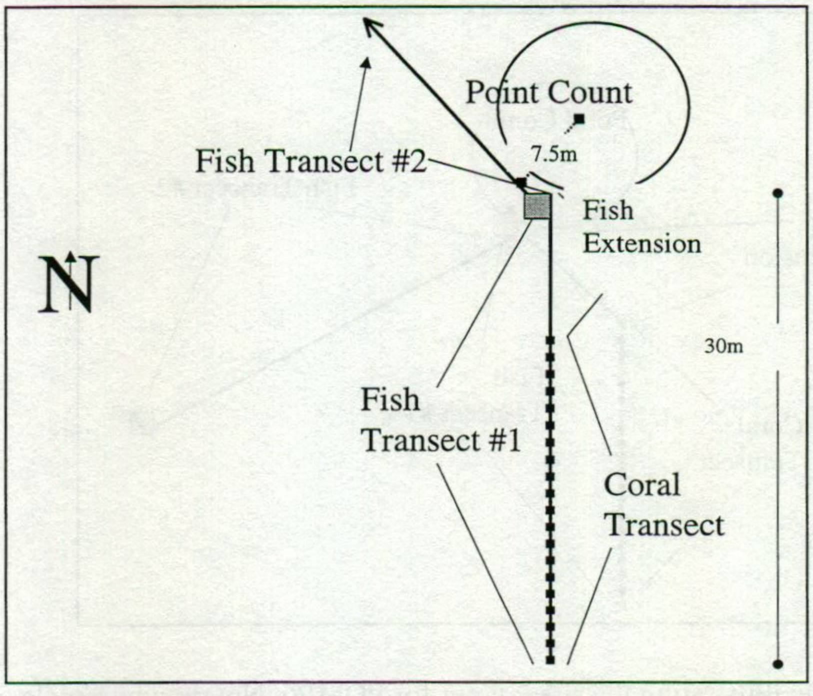


Figure 5: Schematic illustrating the site lay-out for FTL4. Not drawn to scale.

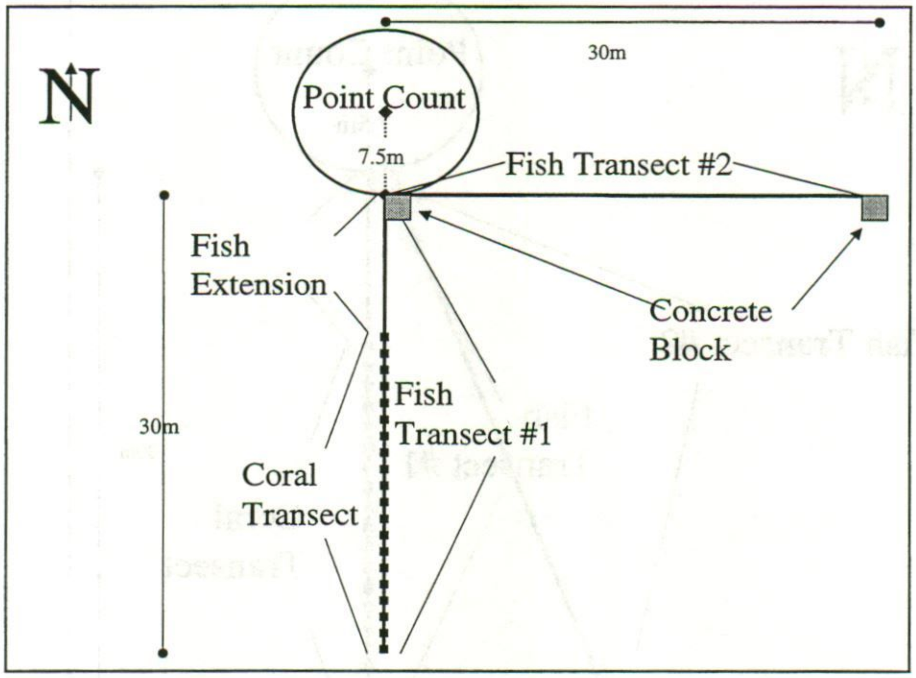


Figure 6: Schematic illustrating the site lay-out for POMP1. Not drawn to scale.

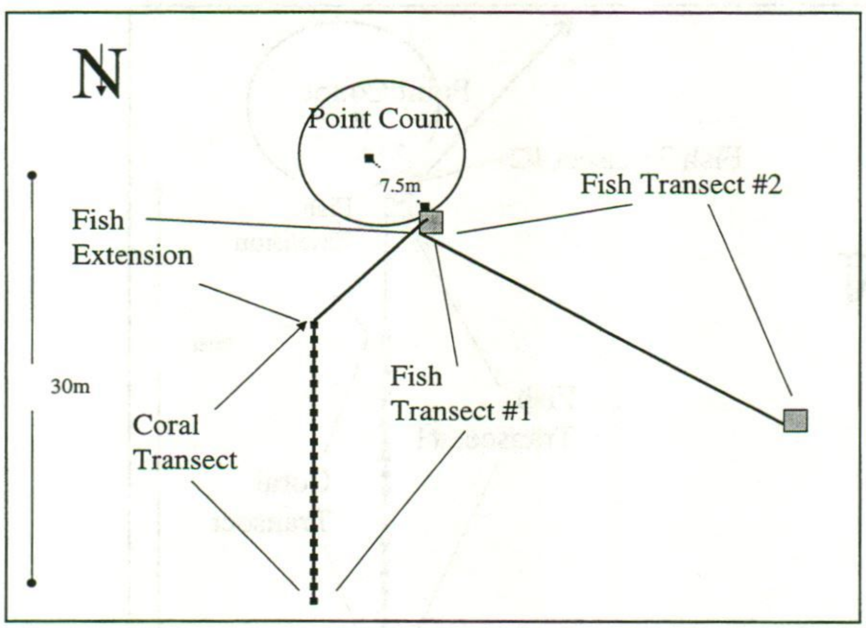


Figure 7: Schematic illustrating the site lay-out for POMP6. Not drawn to scale.

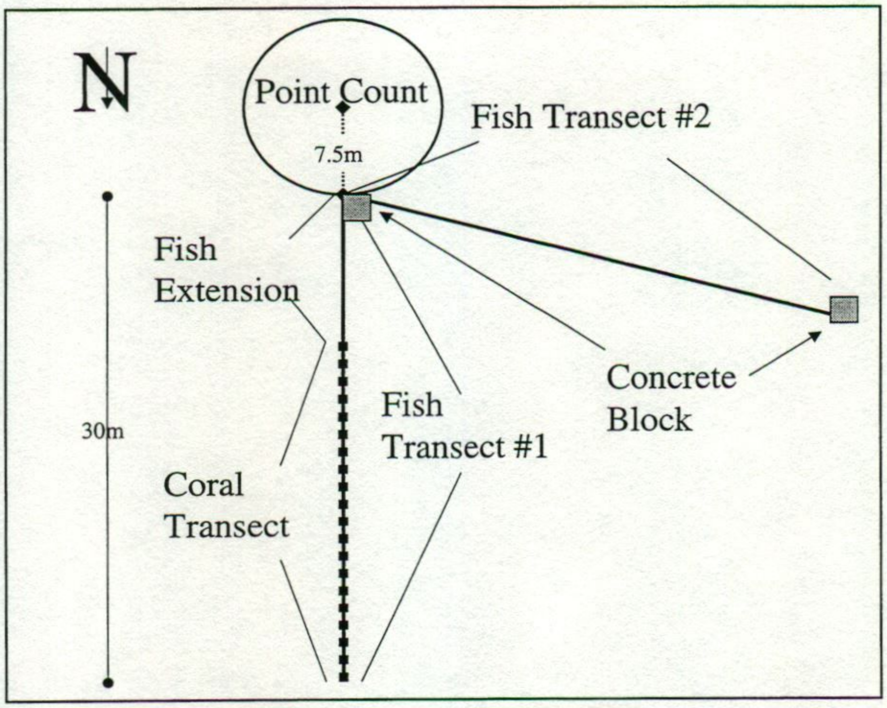


Figure 8: Schematic illustrating the site lay-out for HB1. Not drawn to scale.

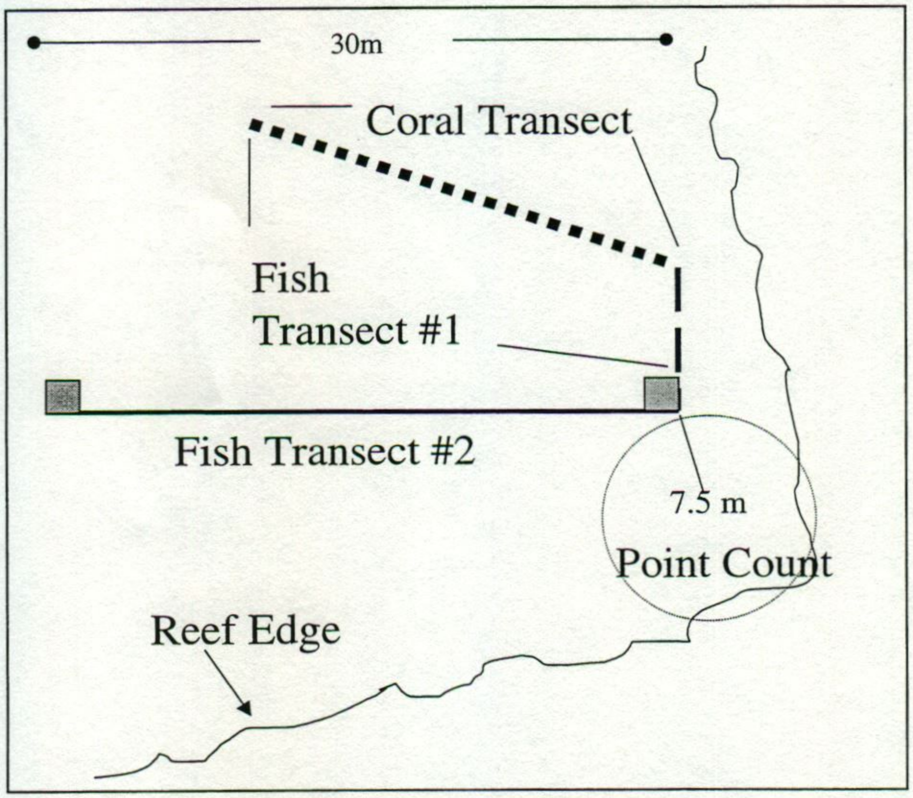


Figure 9: Schematic illustrating the site lay-out for DB2. Not drawn to scale.

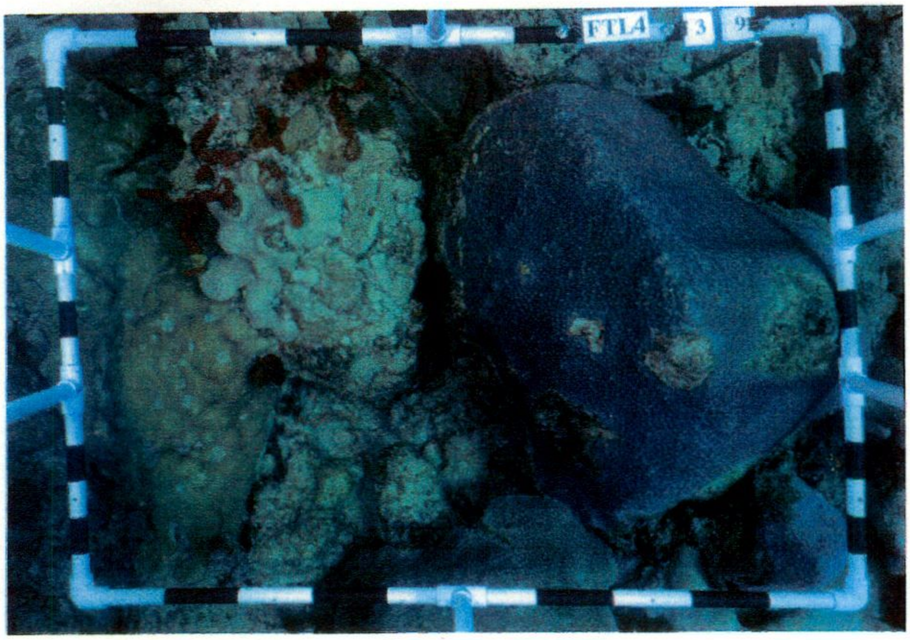


Figure 10: Example of a phototransect image. Note quadrat number (#39) and site code (FTL4).

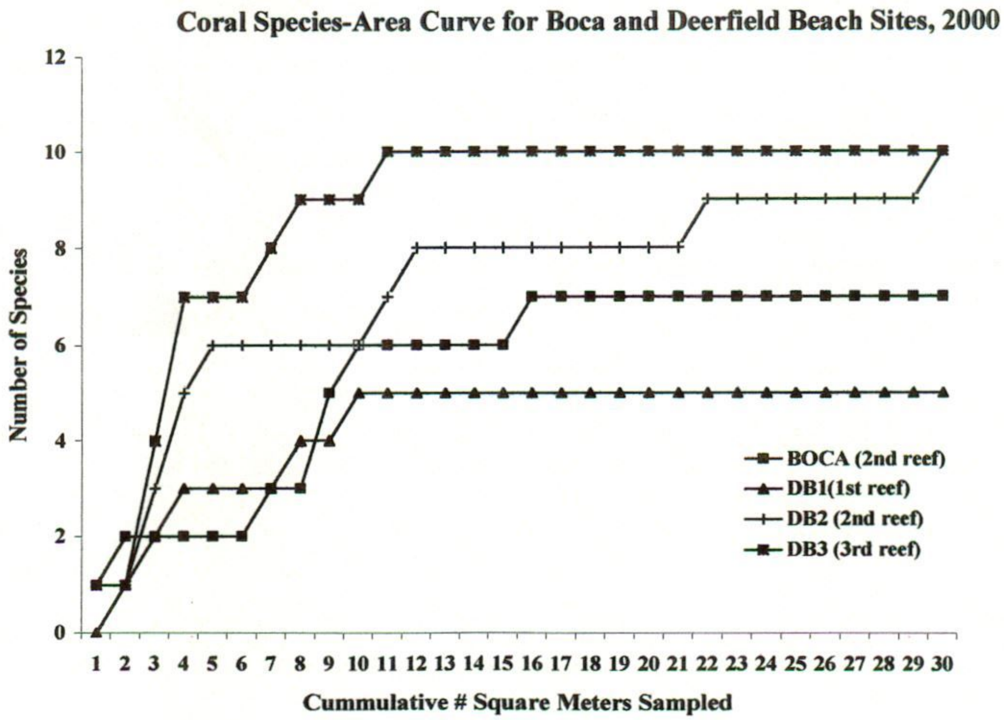


Figure 11: Coral species-area curve for transects at Boca and Deerfield Beach sites.

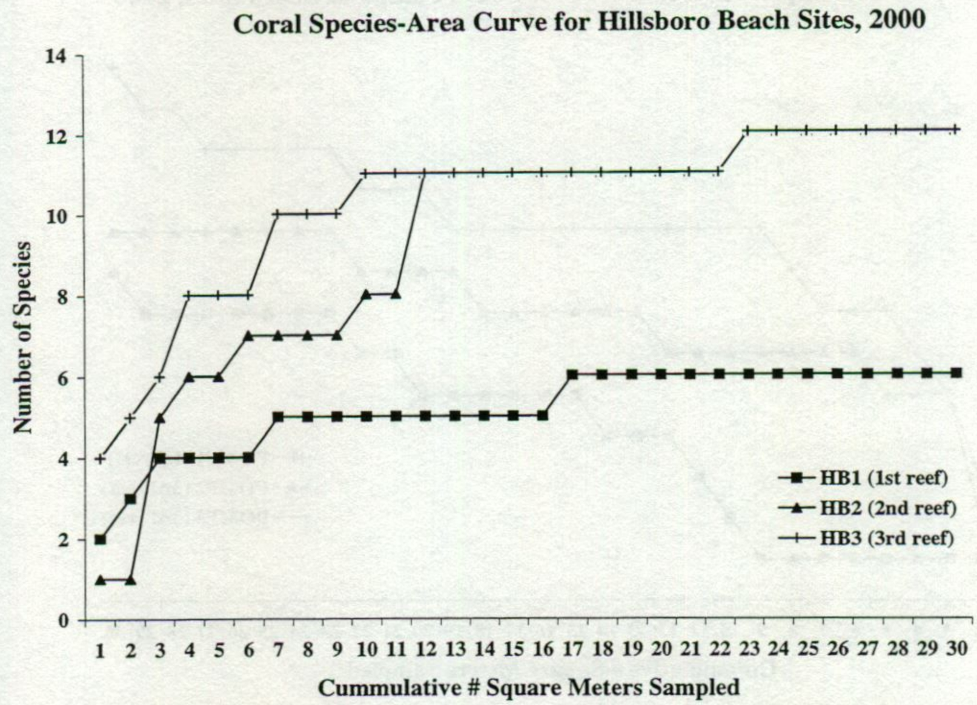


Figure 12: Coral species-area curve for transects at Hillsboro Beach sites.

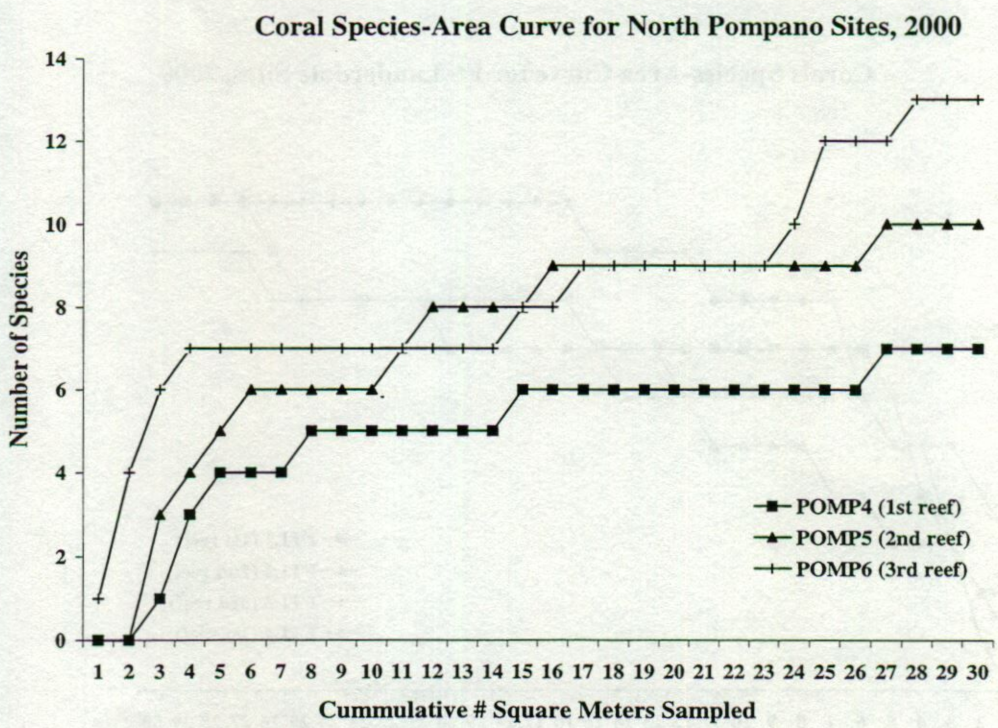


Figure 13: Coral species-area curve for transects at North Pompano Beach sites.

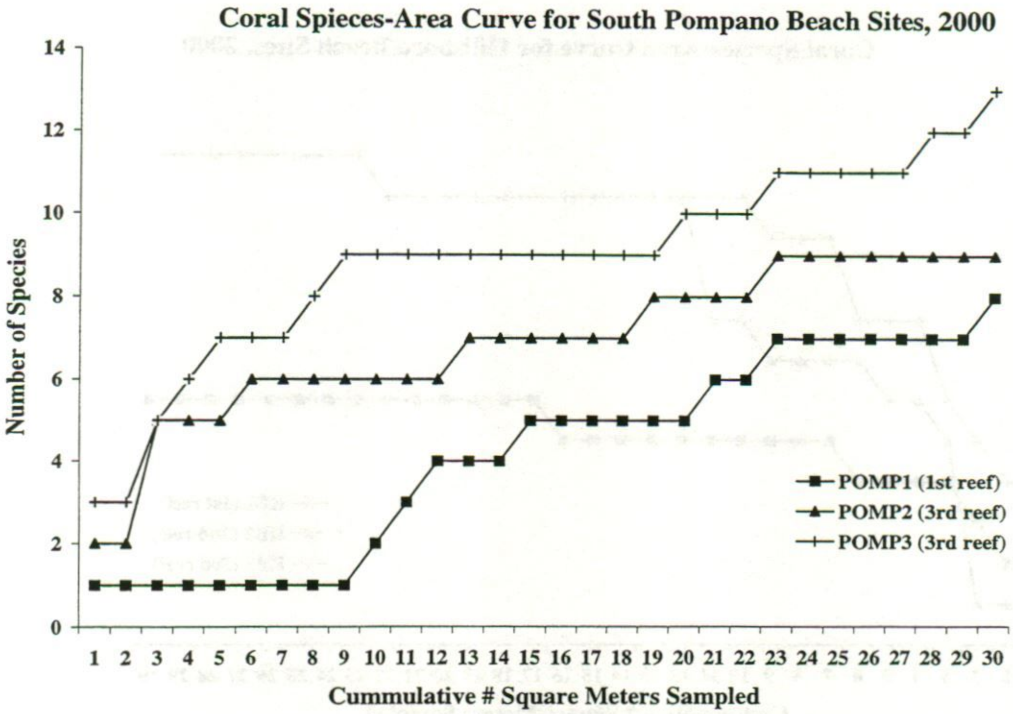


Figure 14: Coral species-area curve for transects at South Pompano Beach sites.

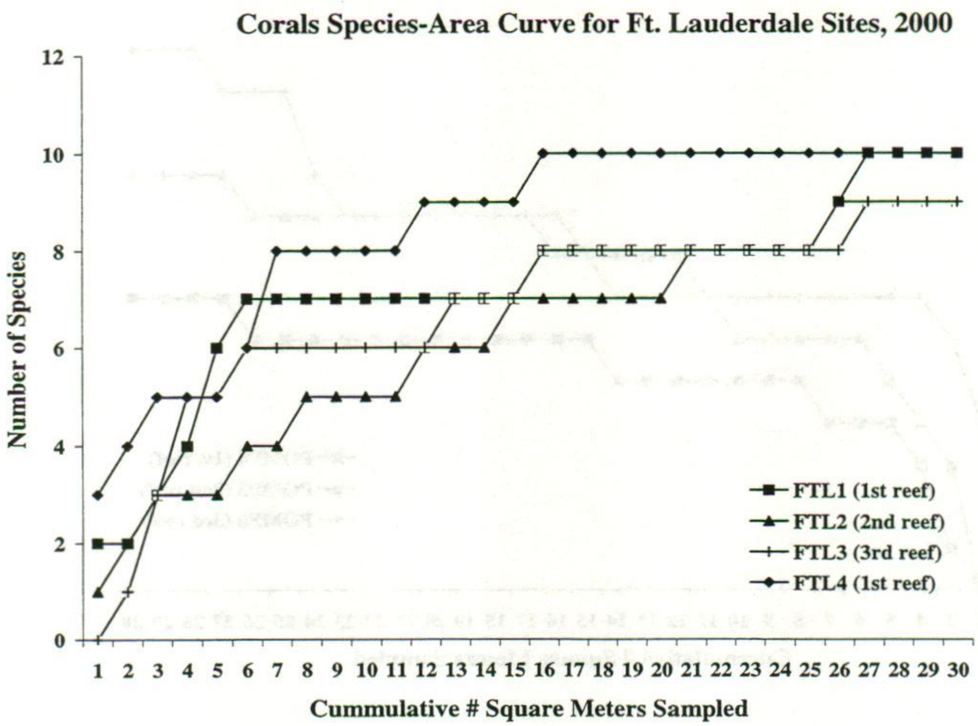


Figure 15: Coral species-area curve for transects at Ft. Lauderdale Beach sites.

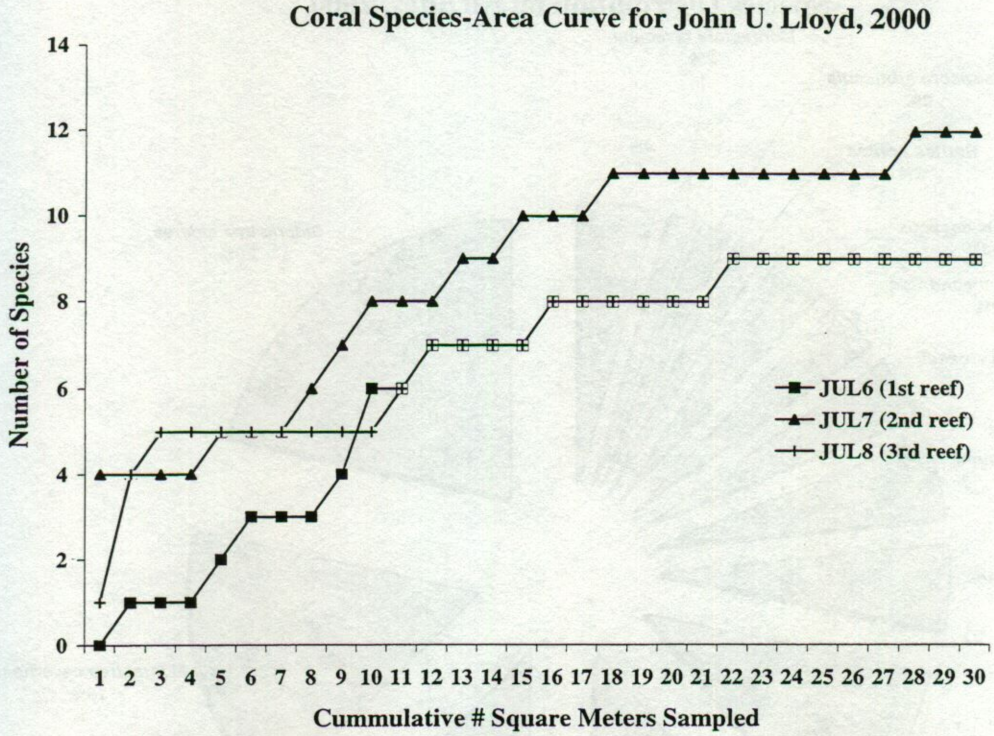


Figure 16. Coral species-area curve for transects at north John U. Lloyd

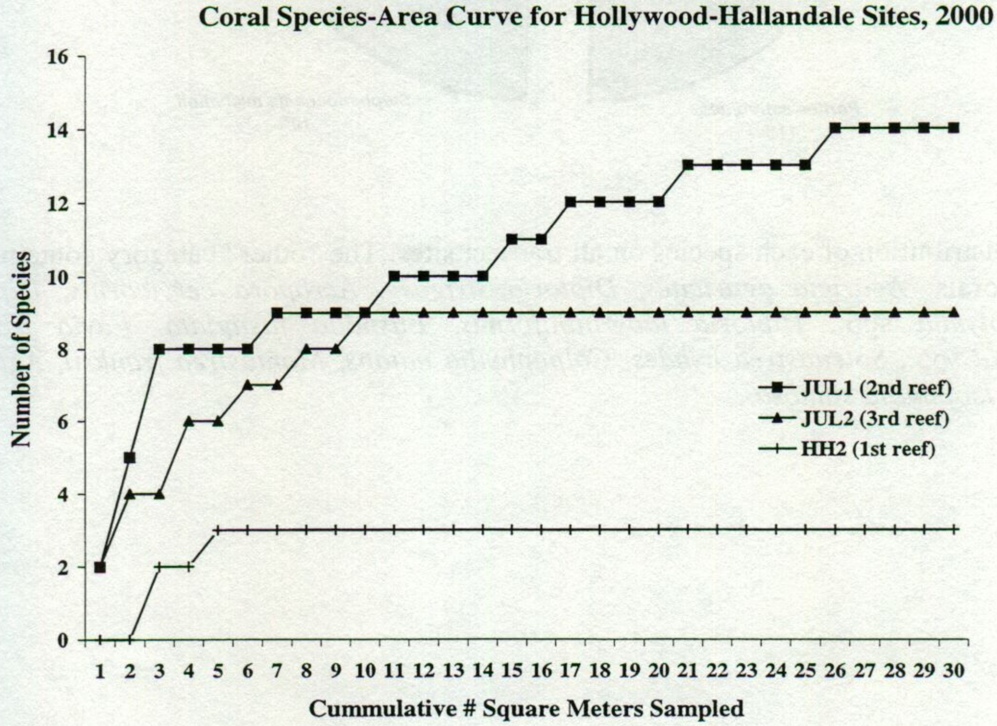


Figure 17. Coral species-area curve for transects at south John U. Lloyd sites.

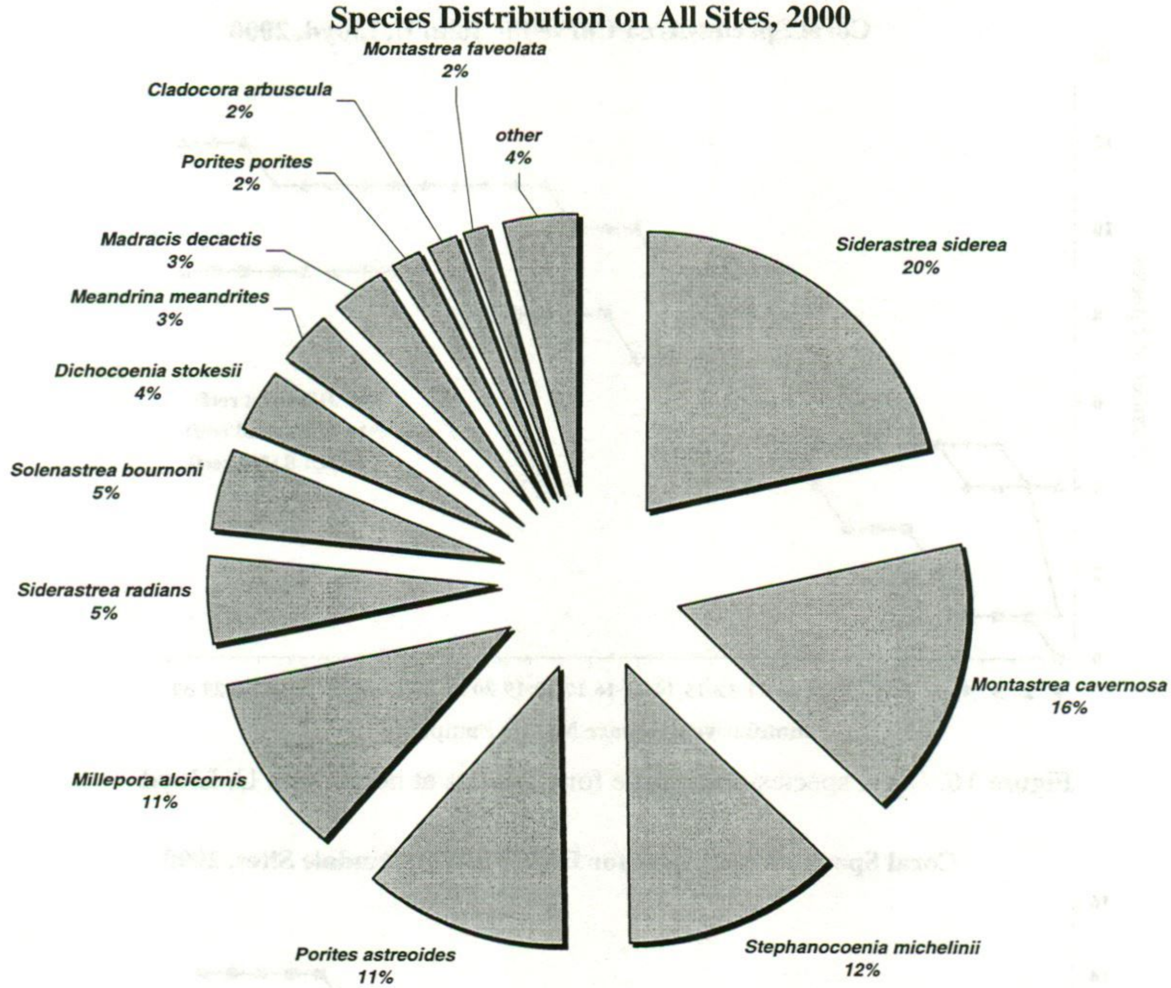


Figure 18: Distribution of each species on all transect sites. The "other" category contains less numerous corals: *Agaricia agaricites, Diploria strigosa, Acropora cervicornis, Diploria clivosa, Scolymia* spp., *Diploria labyrinthiformis, Eusmilia fastigiata, Favia fragum, Mycetophyllia* spp., *Solenastrea hyades, Colpophyllia natans, Montastrea franksii, Agaricia fragilis,* and *Isophyllia sinuosa.*

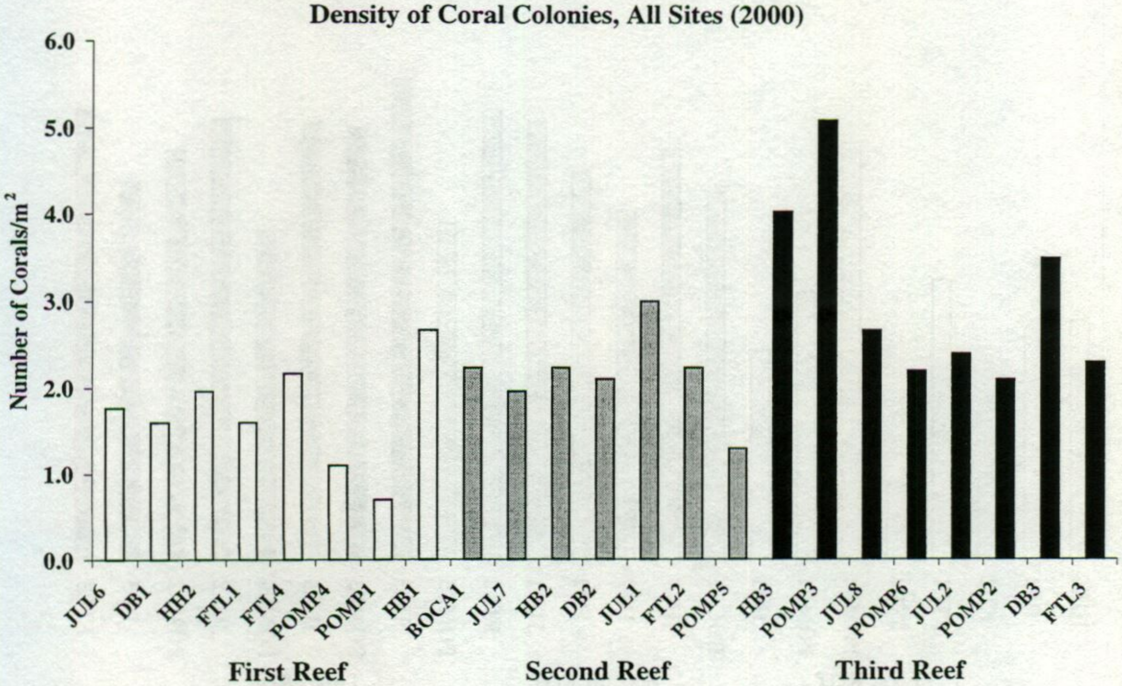


Figure 19: Density of corals at each transect site. Sites are arranged by First, Second and Third reefs.

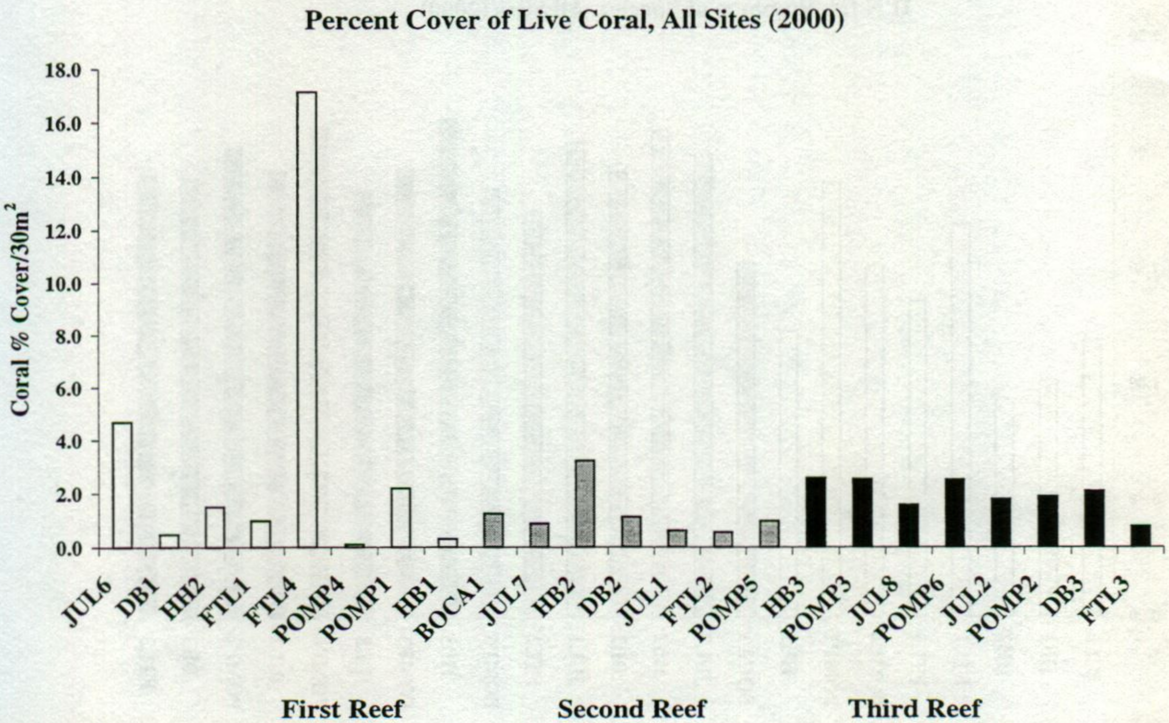


Figure 20: Percent cover of live coral tissue at each transect site. Sites are arranged by First, Second and Third reefs.

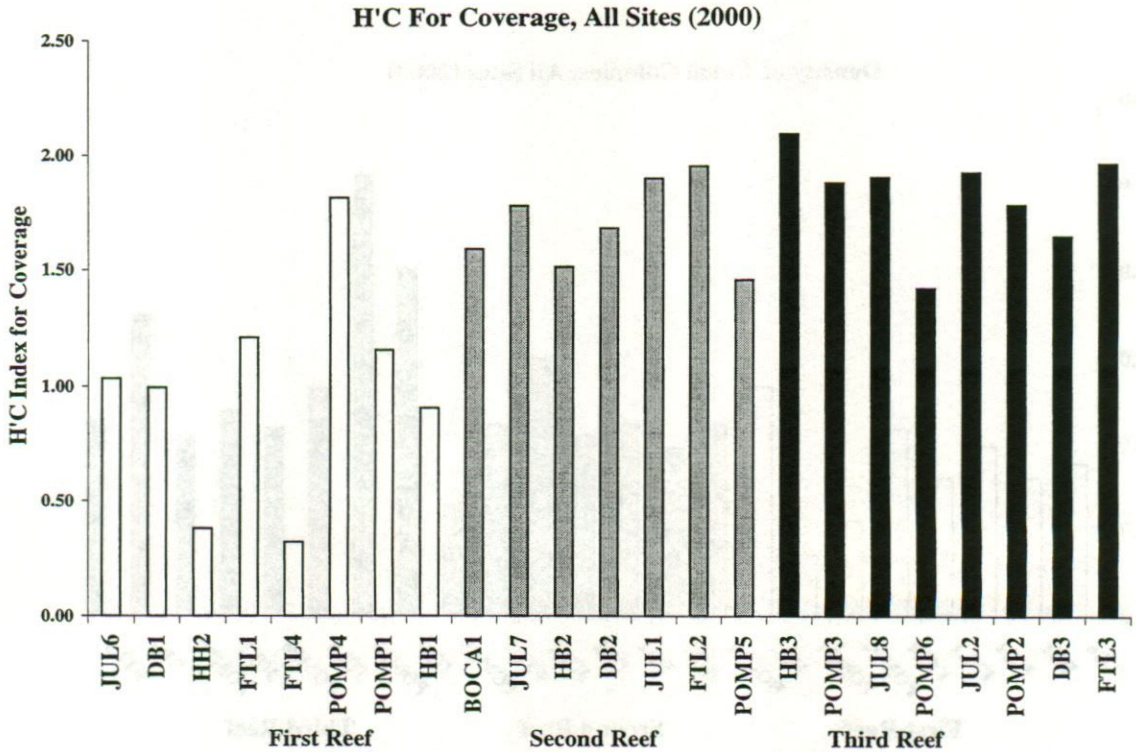


Figure 21: Shannon-Weaver Coverage Diversity of corals at transect sites. Sites are arranged by First, Second and Third Reefs.

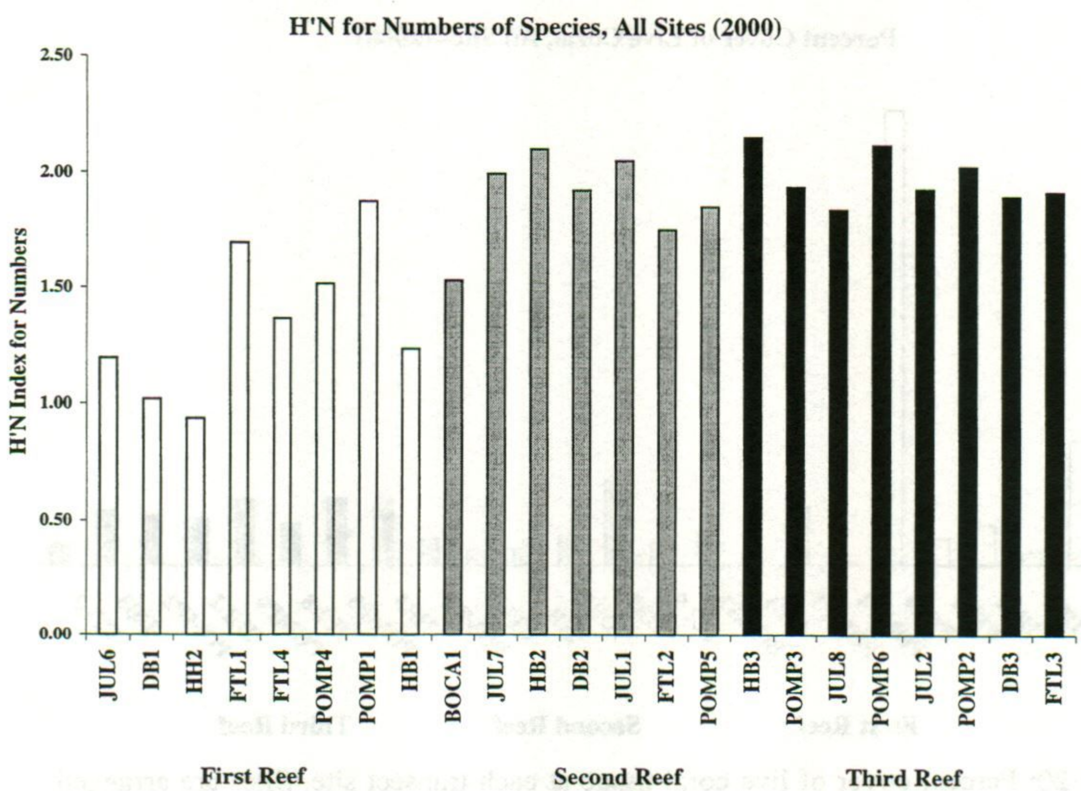


Figure 22: Shannon-Weaver Abundance Diversity of corals at transect sites. Sites are arranged by First, Second and Third Reefs.

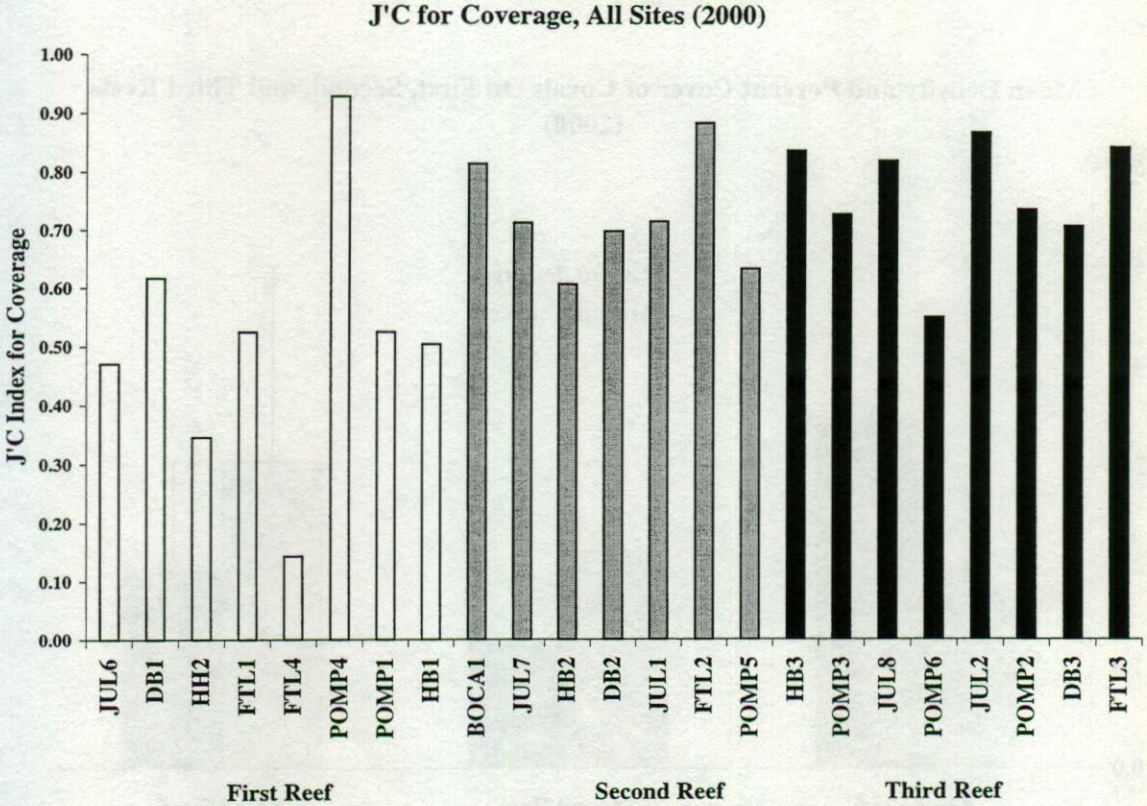


Figure 23: Evenness for coverage of corals at transect sites. Sites are arranged by First, Second and Third Reefs.

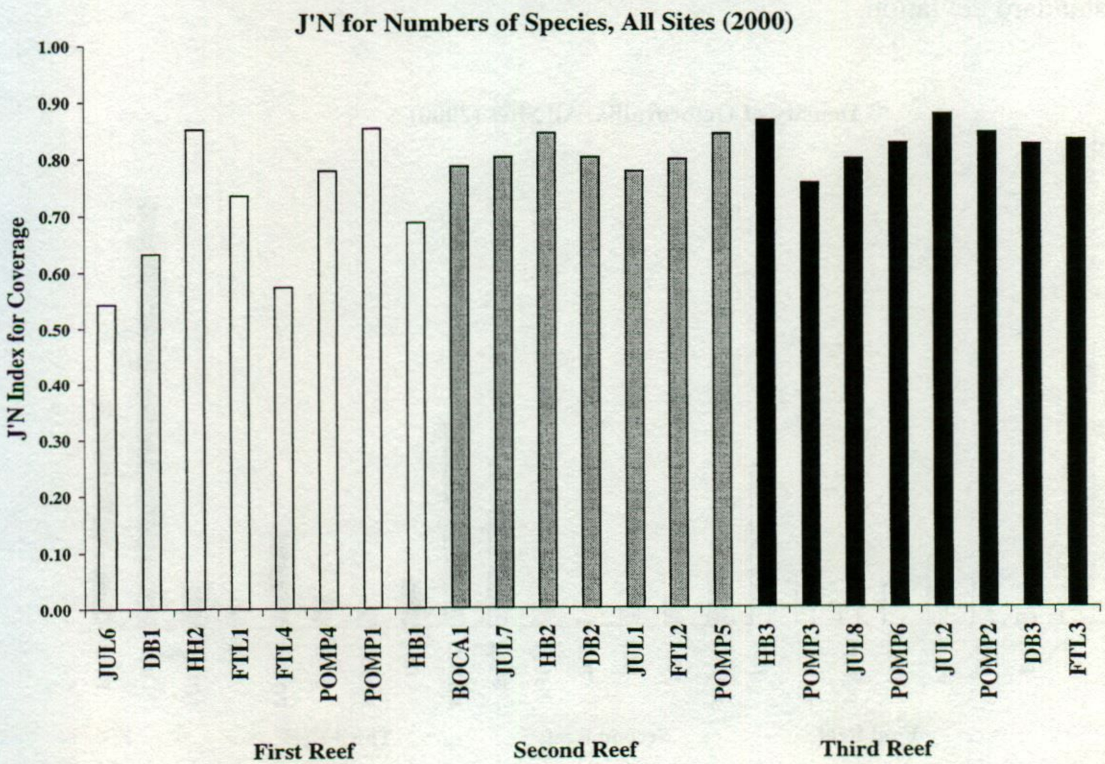


Figure 24: Evenness for numbers of species of corals at transect sites. Sites are arranged by First, Second and Third Reefs.

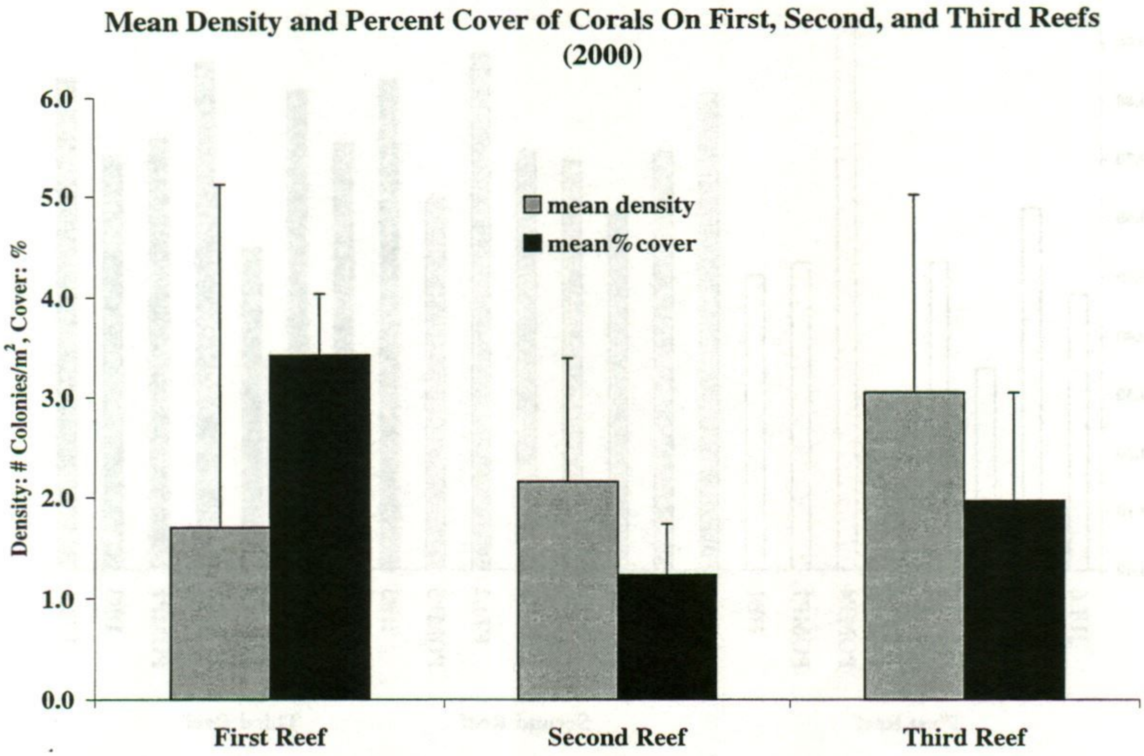


Figure 25: Density and percent cover of corals by reef. Error bars reflect one standard deviation.

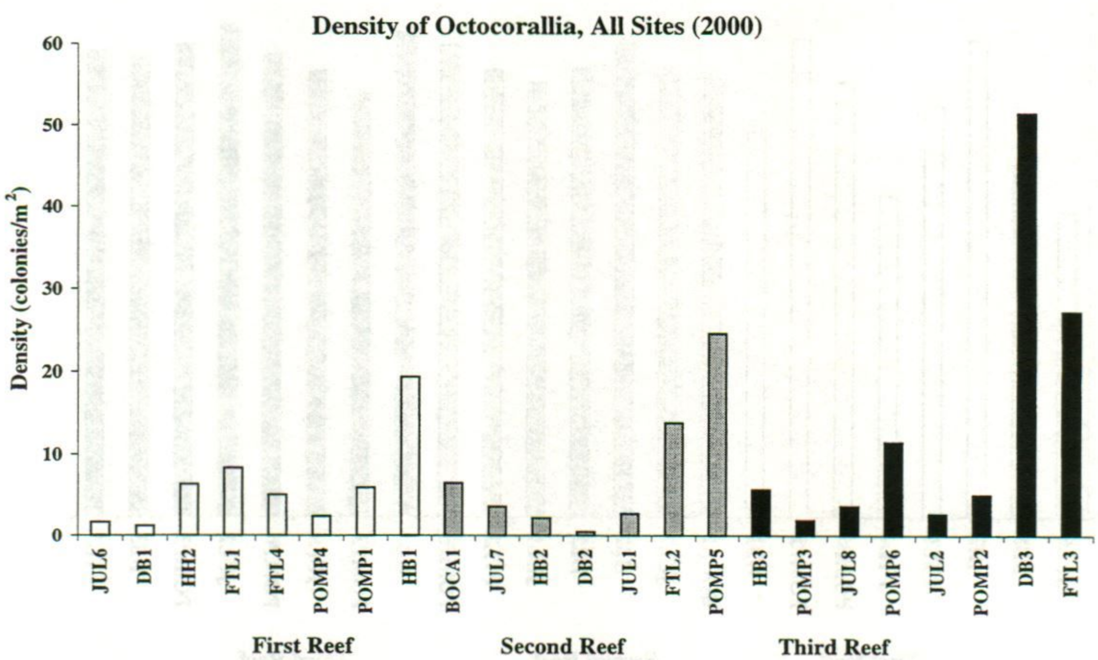


Figure 26: Density of Octocorallia (gorgonians). Sites are arranged by First, Second and Third Reefs.

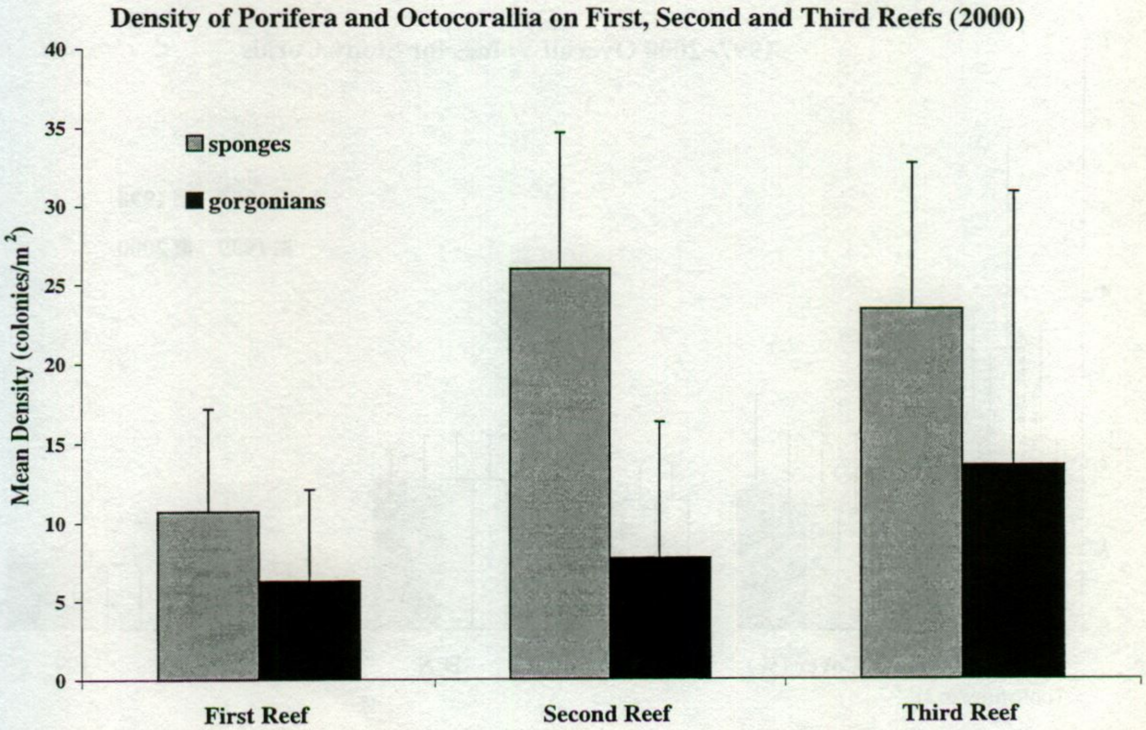


Figure 27: Density of sponges and gorgonians by reef. Error bars reflect one standard deviation.

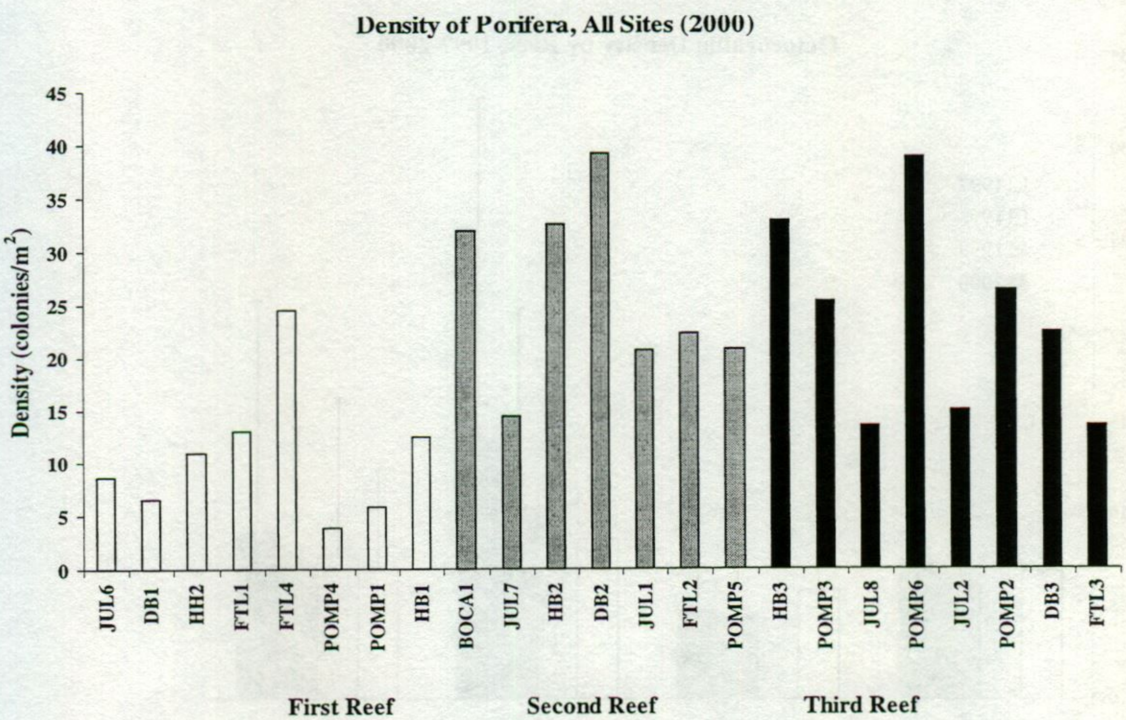


Figure 28: Density of Porifera (sponges). Sites are arranged by First, Second and Third Reefs.

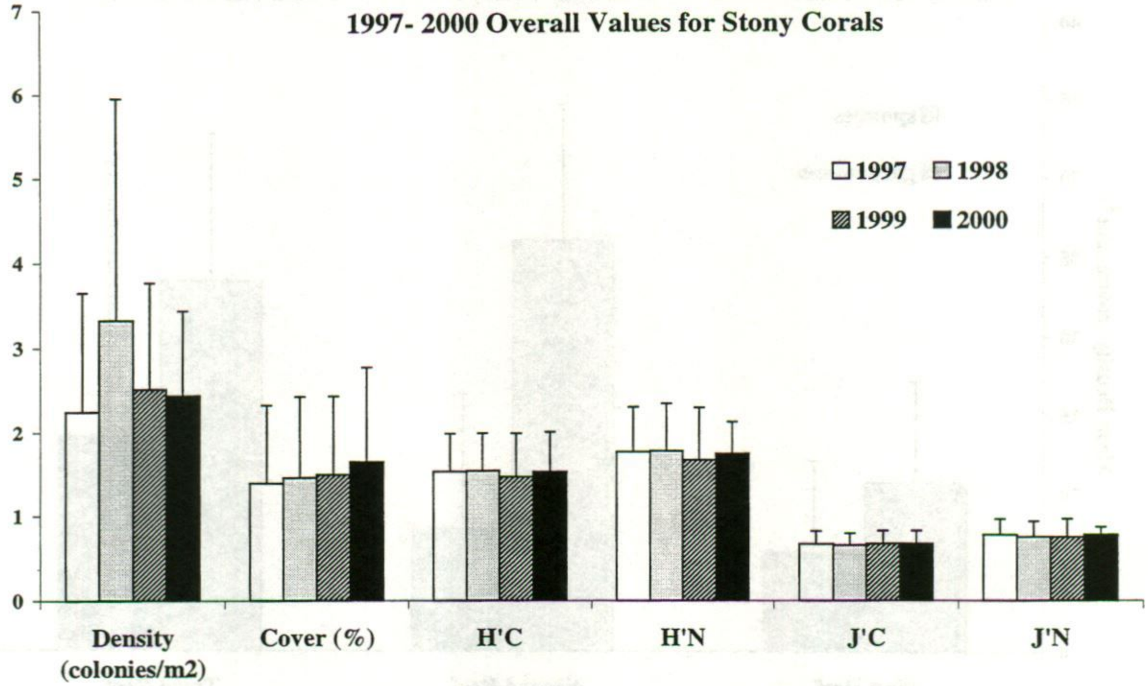


Figure 29: Comparison of overall coral density, percent cover, diversity and evenness for 1997, 1998, 1999 and 2000. New sites (BOCA1, FTL4, POMP4, POMP5, POMP6) are not included in the data.

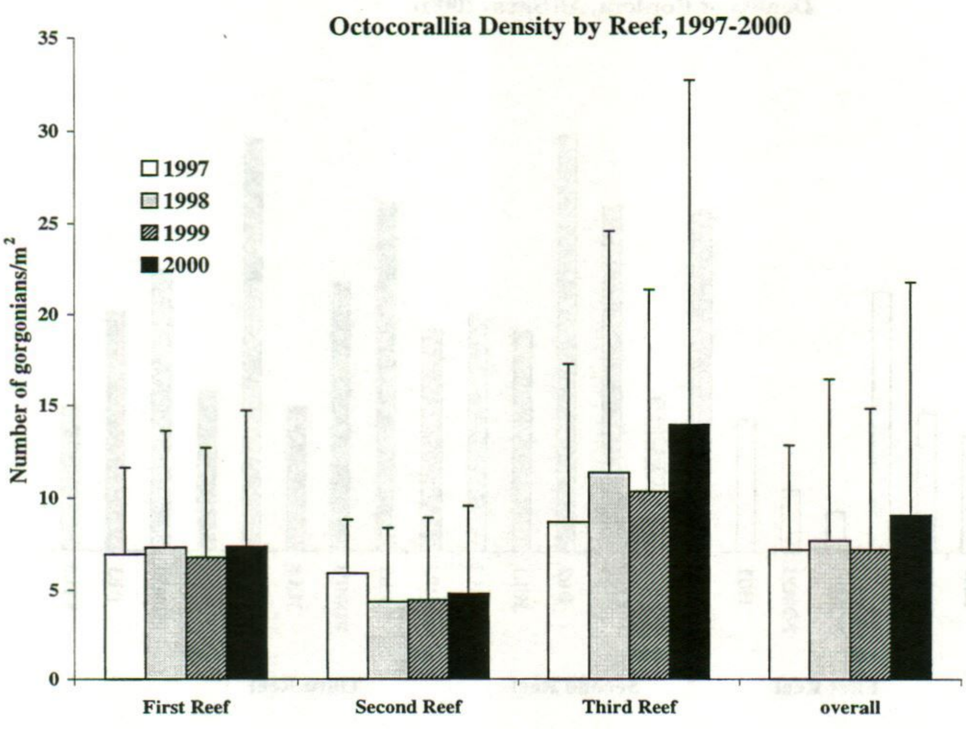


Figure 30: Comparison of gorgonian density from 1997 to 2000. New sites (BOCA1, FTL4, POMP4, POMP5, POMP6) are not included in the data. Error bars reflect one standard deviation.

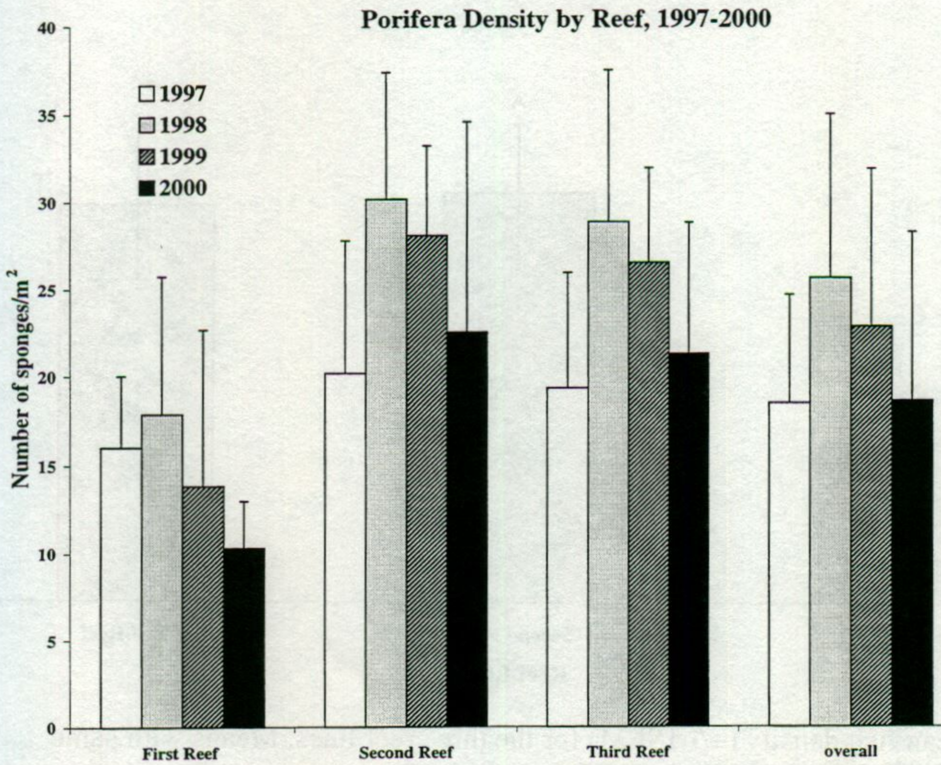


Figure 31: Comparison of sponge density from 1997 to 2000. New sites (BOCA1, FTL4, POMP4, POMP5, POMP6) are not included in the data. Error bars reflect one standard deviation.

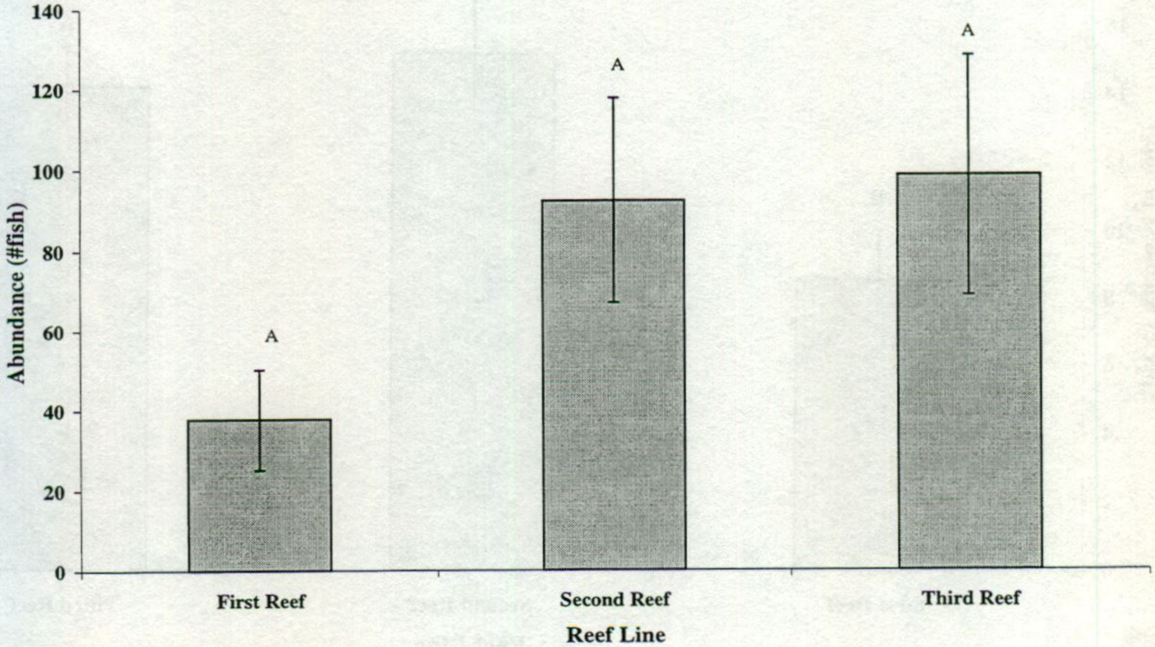


Figure 32: Mean fish abundance (+/- 1SEM) of the three reef lines. Means with same letters are not significantly different SNK tests ($p>0.05$).

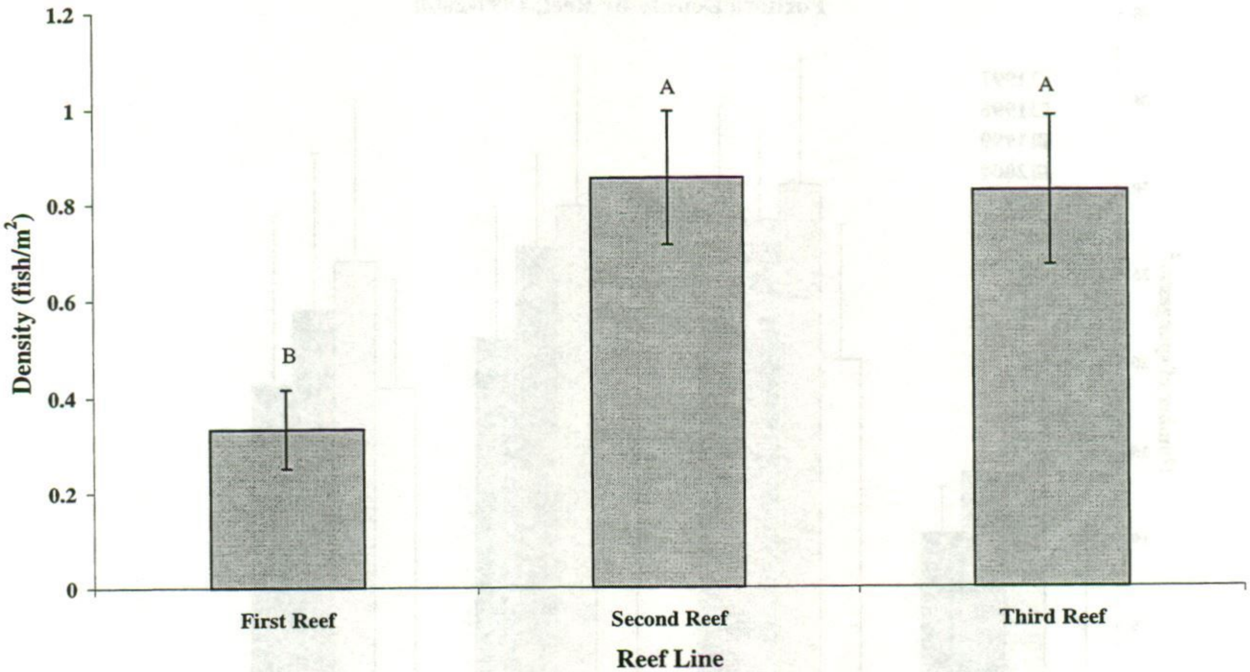


Figure 33: Mean fish density (+/- 1SEM) for the three reef lines. Means with same letters are not significantly different SNK tests (p>0.05).

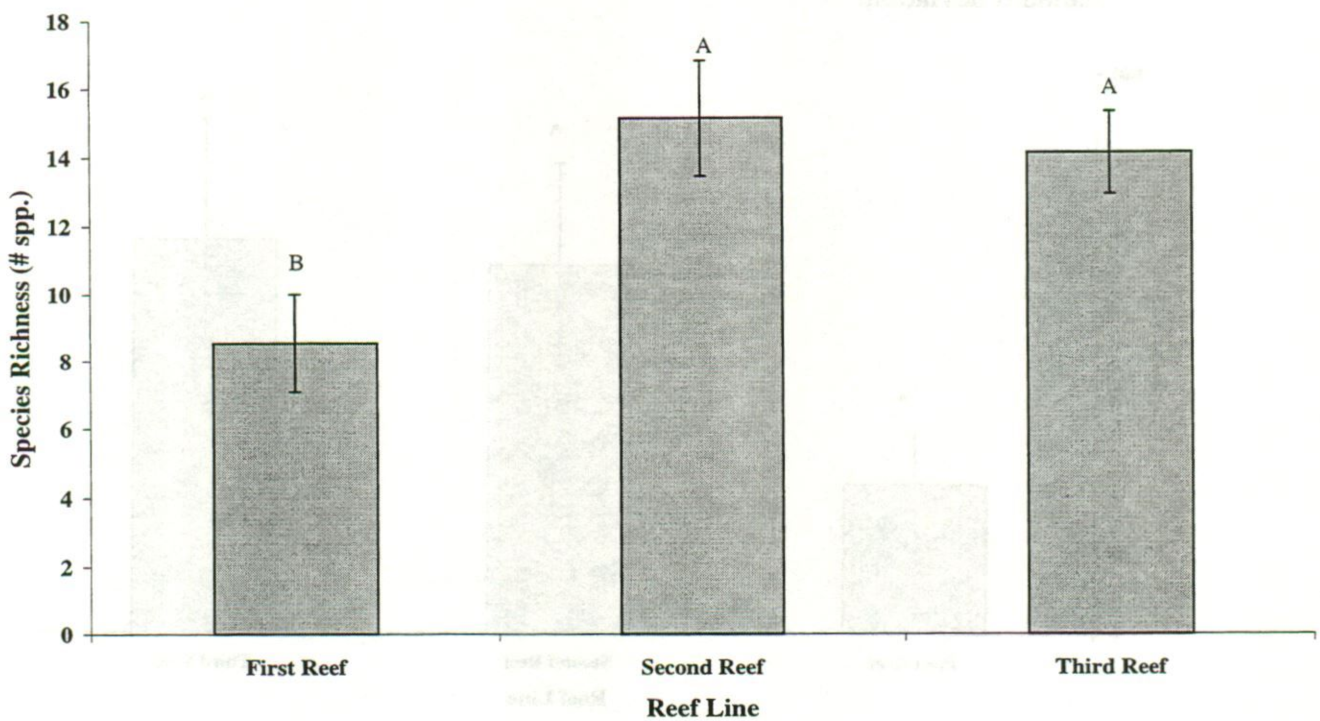


Figure 34: Mean species richness (+/- 1SEM) of the three reef lines. Means with same letters are not significantly different SNK tests (p>0.05).

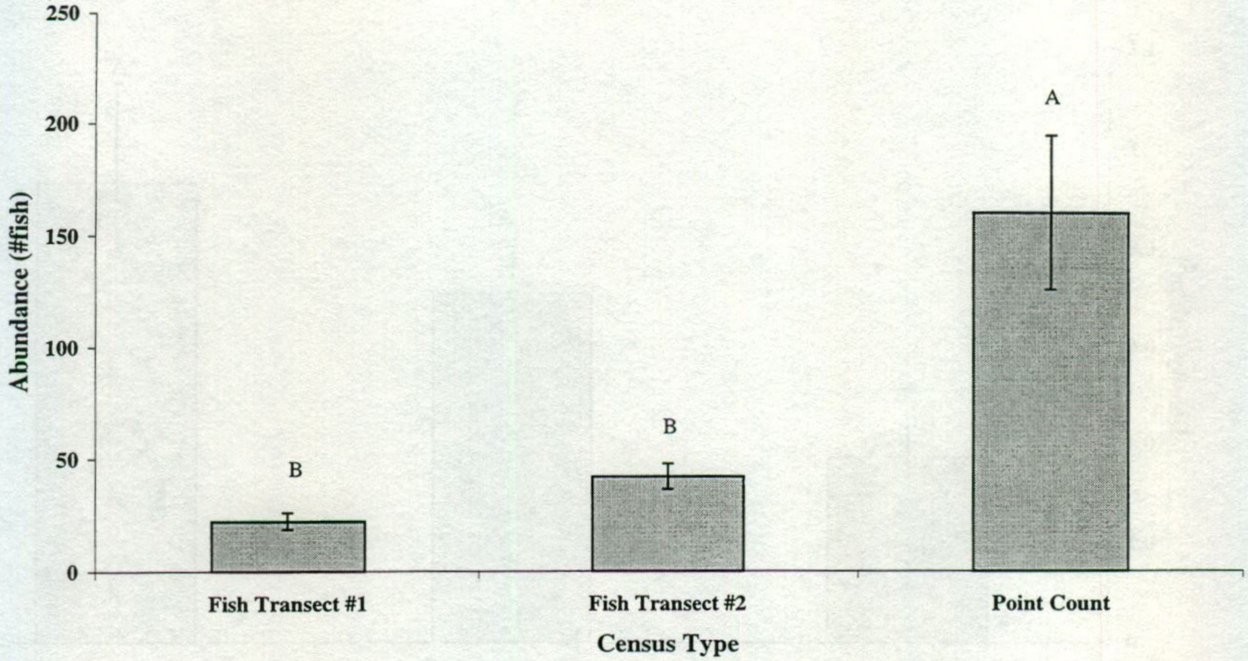


Figure 35: Mean fish abundance (+/- 1SEM) of the three different surveys. Means with same letters are not significantly different SNK tests (p>0.05).

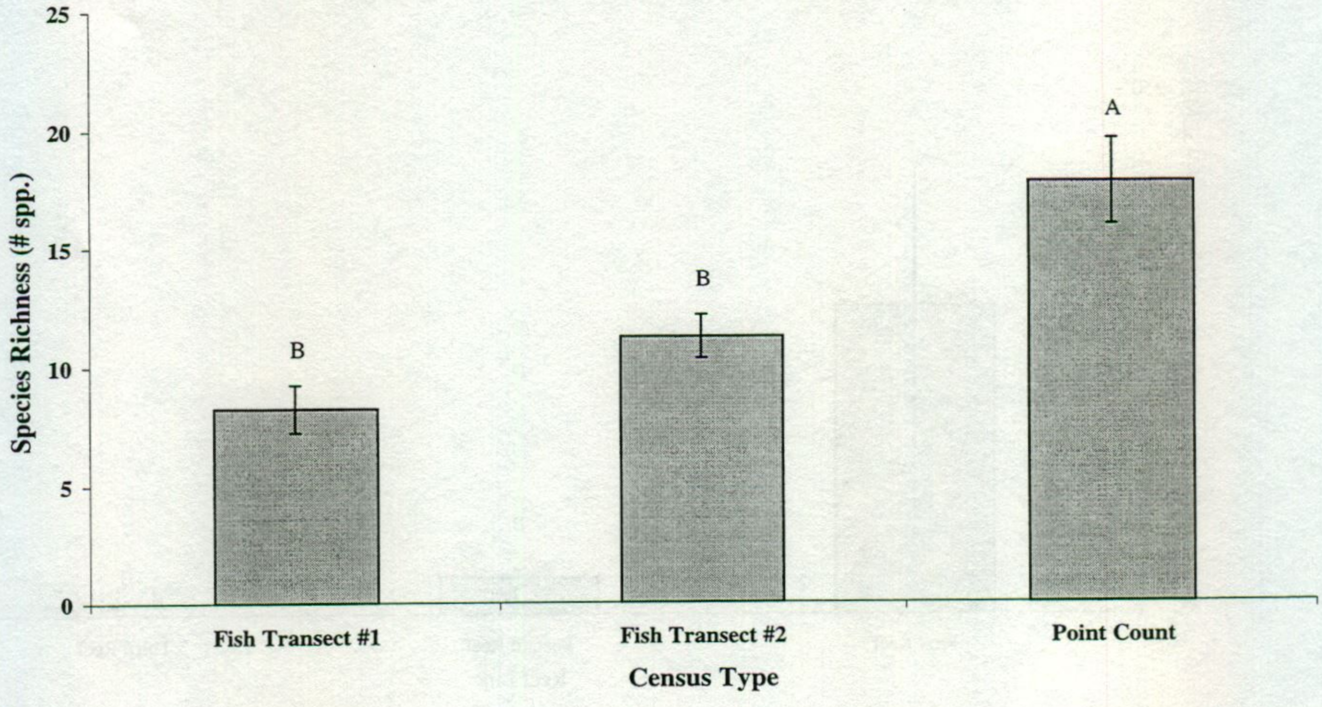


Figure 36: Mean species richness (+/- 1SEM) of the three different surveys. Means with same letters are not significantly different SNK tests (p>0.05).

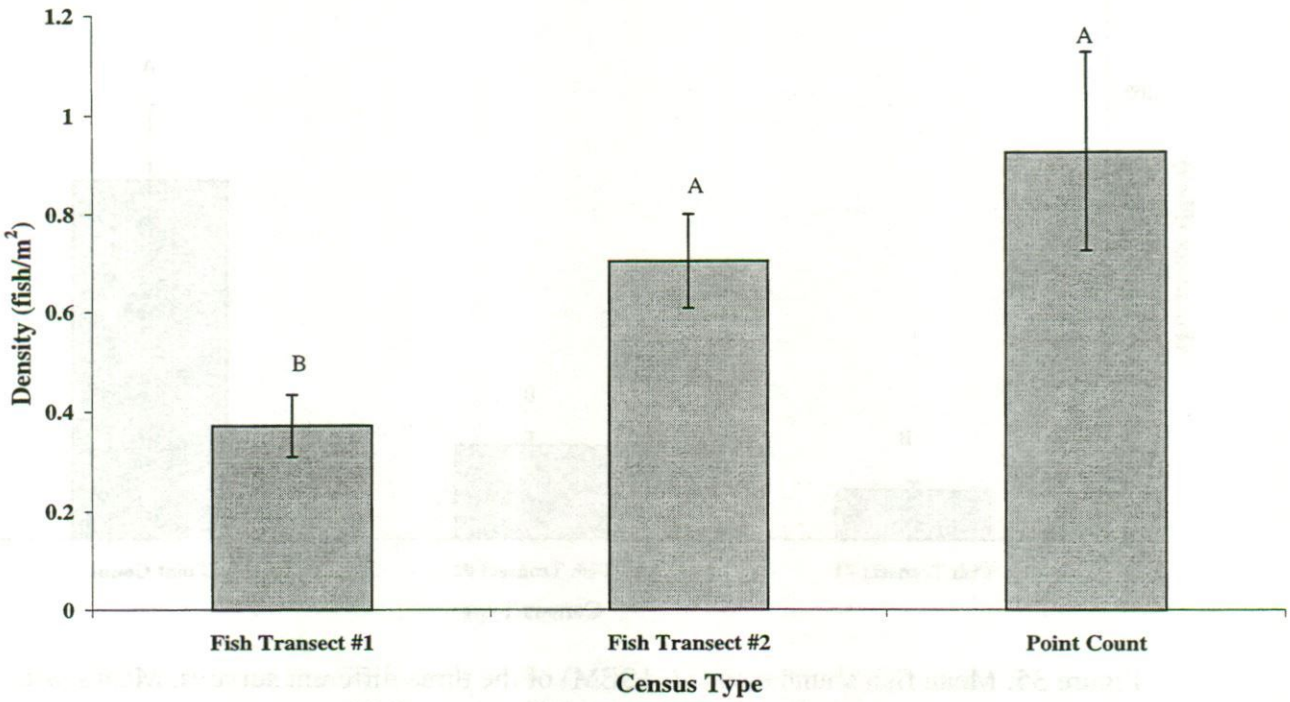


Figure 37: Mean fish density (+/- 1SEM) of the three fish different surveys. Means with same letters are not significantly different SNK tests (p>0.05).

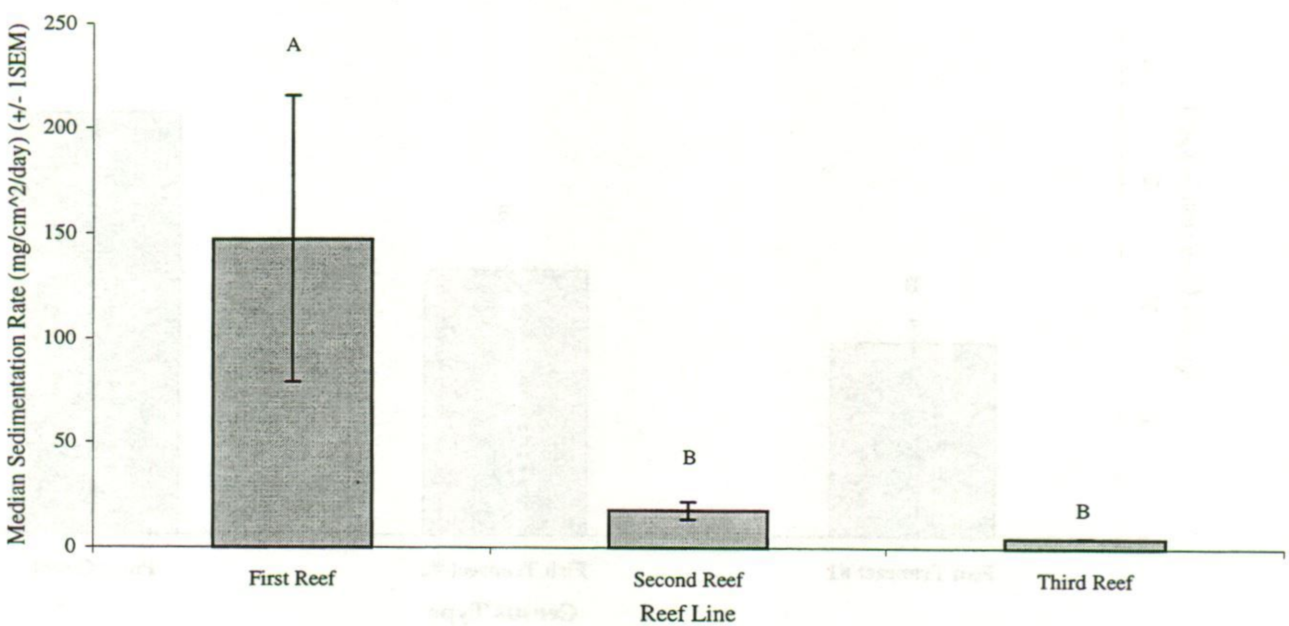


Figure 38: Median sedimentation rate (+/-1SEM) for sampling interval Oct 2000-Dec/Jan 2001. Means with same letters are not significantly different SNK tests (p>0.05). Due to the lack of normality for these data, SNK groupings were generated using ranked data.

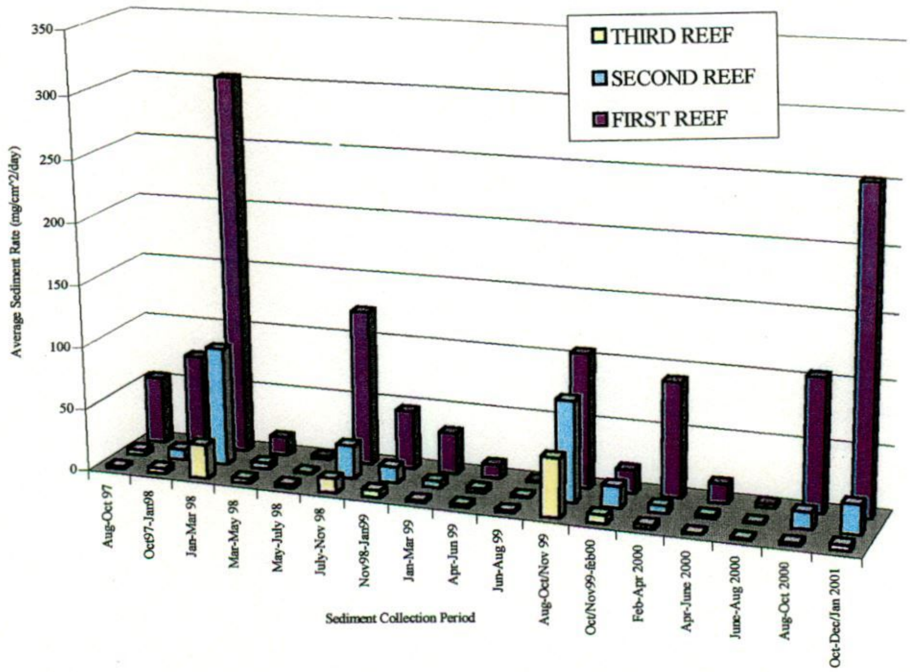


Figure 39: Average sedimentation rate (mg/cm^2/day) of all reef sites for different area for sampling intervals beginning Aug 1997 and ending Dec/Jan 2001.

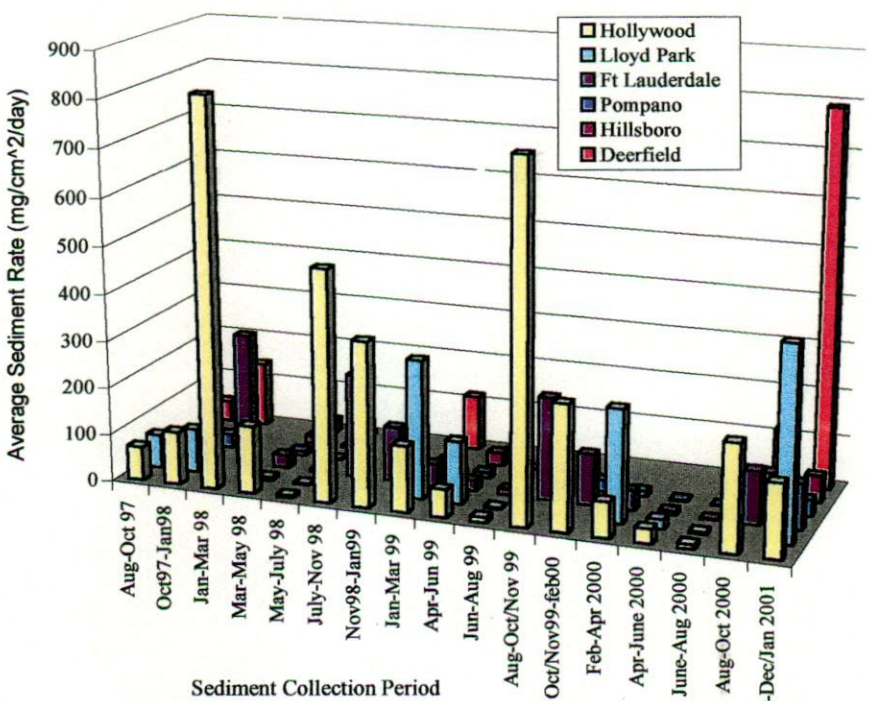


Figure 40: Average sedimentation rate (mg/cm^2/day) of First Reef sites for different area for sampling intervals beginning Aug 1997 and ending Dec/Jan 2001.

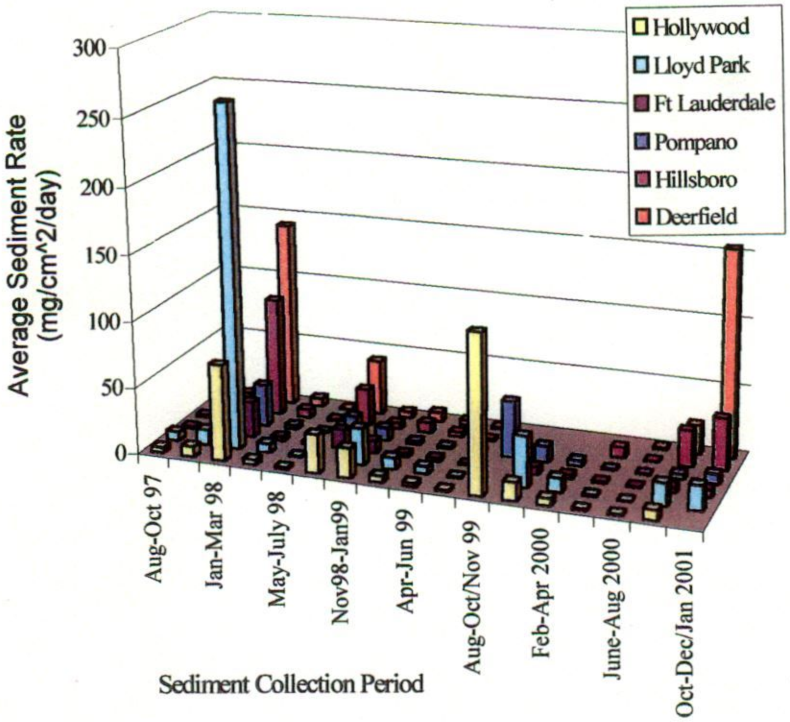


Figure 41: Average sedimentation rate (mg/cm^2/day) of Second Reef sites for different area for sampling intervals beginning Aug 1997 and ending Dec/Jan 2001.

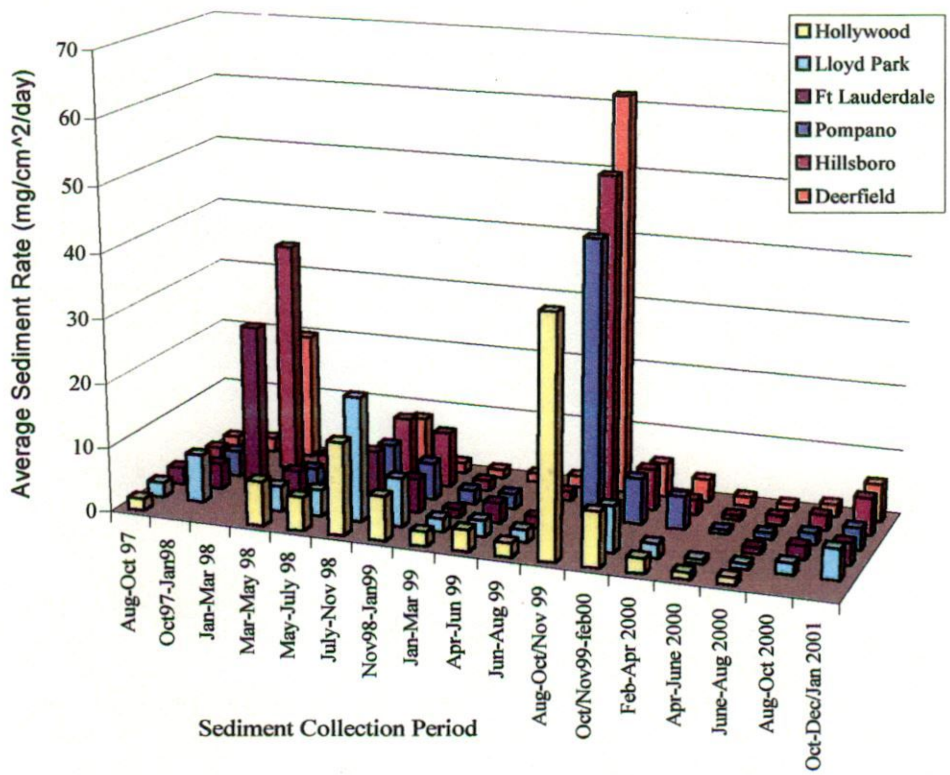


Figure 42: Average sedimentation rate (mg/cm^2/day) of Third Reef sites for different area for sampling intervals beginning Aug 1997 and ending Dec/Jan 2001.

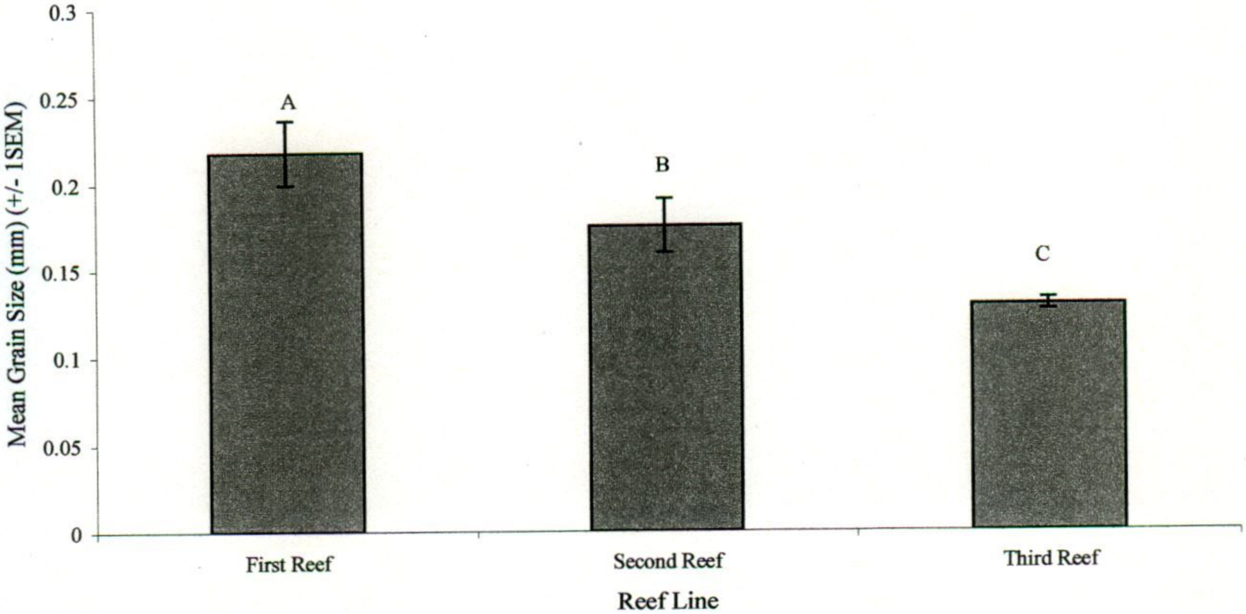


Figure 43: Mean grain size (mm) (+/- 1SEM) for the three reef lines for sampling interval Oct 2000-Dec/Jan 2001. Means with same letters are not significantly different SNK tests (p>0.05).

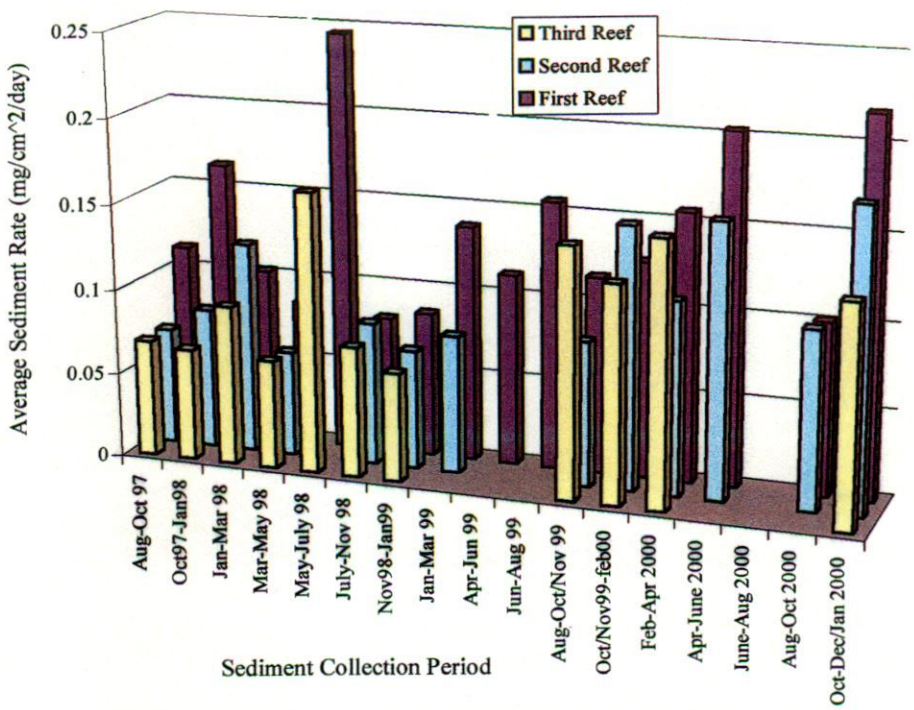


Figure 44: Average grain size (mm) for all sites pooled by Reef from Aug-Oct 97 through Oct 2000-Dec/Jan 2001.