Final Report

to the
U.S. Fish and Wildlife Service

Benthic Habitat Assessment Project
St. Thomas, U.S. Virgin Islands

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INTRODUCTION

Many recreationally caught species of fish are dependent on specific benthic habitats for food as well as shelter for at least part, if not all, of their life cycle (Jackson 1997). Benthic habitats such as algal plains, seagrass beds, and coral reefs are essential for many fish species (Ostrander et al 2000). The physical structures present within these benthic habitats: (1) protect fish from environmental stresses, (2) help small fish avoid predation, (3) reduce competition, and (4) enhance resources (Syms and Jones 2000). Healthy and complex benthic habitats can result in continued recruitment of fish and can support complex fish assemblages (Friedlander and Parish 1998).

The habitats supporting recreational fish species in the U.S. Virgin Islands (USVI) are generally fragile (Appeldoorn et al 1997). As such, there is a need to assess the current state of these resources, monitor any changes, and establish long term management strategies to ensure their sustainability.

The Inner Mangrove Lagoon within the Cas Cay/Mangrove Lagoon Marine Reserve and Wildlife Sanctuary and the St. James Marine Reserve and Wildlife Sanctuary on the southeast coast of St. Thomas were selected as the study area. These marine reserve areas were established in September 1994. The Inner Mangrove Lagoon and the St. James Marine Reserve and Wildlife Sanctuary were identified as primary nursery grounds for fish (DFW 1994).

This report summarizes the Benthic Habitat Assessment Project activities within the Inner Mangrove Lagoon and the St. James Marine Reserve and Wildlife Sanctuary. This report documents the findings of this five-year study.

OBJECTIVE

The USVI Benthic Habitat Assessments Project (BHAP) was developed: (1) to provide baseline information on a variety of critical marine habitats in USVI; (2) to provide time series information on changes in these key benthic habitats; (3) to monitor a marine reserve area and assess the status over time of protected habitats and fishery resources, within a marine reserve system and (4) to provide the information for a GIS system. This information will be used for the development of sound management strategies for these key habitats (see DFW 1999).

METHODOLOGY

Aerial Mapping

National Oceanic Atmospheric and Administration aerial photographs taken in 1999 (NOAA draft) were used to map benthic habitats for this study area (see Figures 1 to 5). Major benthic habitat types were identified from magnified aerial photographs. From these photographs, three basic bottom types could be accurately identified: hard bottoms (including coral reefs), sandy plains, and seagrass/algal beds.

Ground truthing was done using snorkel tows or SCUBA. This field verification also allowed more detailed identification of the habitat. Types of substrate, habitat and cover follow that defined elsewhere (see Anderson et al 1985; Beets et al 1985; Boulon 1985 and 1986; Devine draft; and NOAA draft). A list of the substrate, habitat and cover classifications used here are presented in Appendix 1.

Transect Site Descriptions

In 1996, an initial 18 sites were selected (see Appendix 2). Three habitat types were monitored: seagrass (transect sites 1, 2, 3, 8, 9, 10, 13, 14, 15 and 16), coral reef (transect sites 4, 5, 7, 17, and 18) and algae (transect sites 6, 11 and 12). Two additional coral reef sites (transect sites 19 and 20) were added in 2000 (see Figure 1). These two new sites replaced transect sites 5 and 13 that could not be relocated after storm damage.

Great St. James

Transect site 1 was located in a shallow bay on the northeast shore of Great St. James (see Figure 2). This is the easternmost point of the St. James Marine Reserve and Wildlife Sanctuary. The substrate at this site is sandy and dominated by seagrass with some algae. This was classified as a seagrass bottom type.

Transect sites 8, 9, and 10 were in seagrass beds (3.5 to 9 m depth) in the southern half of Great St. James' west-facing and largest bay (see Figure 3). The bay's large size and natural protection from prevailing currents make this bay a popular anchoring site for the many boats operating in the USVI.

Transect sites 14, 15 and 16 were located in the deeper (up to 14 m depth) northern half of Great St. James' west-facing bay (see Figure 3). This area is slightly more exposed to the westerly currents and winds than other sites. The northernmost transects (transect sites 14, 15, and 16) extended through coral patches, submerged bedrock, and sand, then into algal and seagrass toward the south. In the seagrass area, "blow-outs" (large circular gouges in the seagrass caused by anchors and anchor chains) are silty and covered with cyanophytic mats. Blow-outs are a distinctive feature of this area. These blow-out areas were designated as sand bottom or cyanophytic species in transect data records.

Great Bay

Transect sites 2, 3, 4, 6, 7, 13, 19 and 20 were located in Great Bay, on St. Thomas' easternmost shore (Figure 1). This bay is the northernmost area of the St. James Marine Reserve and Wildlife Sanctuary. Great Bay is quite open and the substrate is heterogeneous.

Transect sites 2, 3, 4 and 13 were seagrass sites, while site 6 was algal plain and sites 7, 19 and 20 were coral reef sites.

Transect site 13 was one of the deeper sites at 18 to 19 m. It was located in the center of the mouth of Great Bay (see Figure 1). The transect line at this site ran across classic zonation from deeper water algal and "rope" sponge plains, through a seagrass dominated habitat, across a sandy area, then onto a patch reef which rises to within 8.5 m of the surface. This transect was only sampled in 1996 and 1998. It could not be relocated in 2000.

Transect sites 19 and 20 were on the southeast edge of Great Bay (see Figure 1). These two new sites were replacement sites for sites 5 and 13. The sites were chosen in order to increase the number of coral reef sites sampled. These transect lines were laid down parallel to one another. Transect site 19 was located behind the reef crest and transect site 20 was on the reef slope of a linear reef.

Mangrove Lagoon

Transect sites 11 and 12 were located in a mangrove-lined channel between St.Thomas and Patricia Cay in the Inner Mangrove Lagoon, the southwestern extent of the Cas Cay/Mangrove Lagoon Marine Reserve and Wildlife Sanctuary (see Figure 4). The substrate of this back reef area is composed of fine silt, algae, and coral rubble. This area is protected from wave action. Transect depth was between 0.75 m to 2.6 m. The transect line for site 11 had to be bent slightly mid-point to accommodate a bend in the channel.

Jersey Bay and Cow & Calf Rocks

Transect site 5 was located in an area of patch reefs in the center of the marine reserve, Jersey Bay (see Figure 5). The depth at this site ranged from 11 to 15 m.

Transect sites 17 and 18 (Figure 5) were located just north of Cow and Calf Rocks. These two exposed rock outcrops define the southern seaward border of the St. James Marine Reserve and Wildlife Sanctuary. This area is a popular dive spot. At transect site 17, the substrate is bedrock and coral rock covered by hard corals, encrusting sponges, and branching octocorals. The depth was highly variable here due to rock canyons. The transect depths ranged from 3.5 to 6.6 m. Transect site 18 was north of and ran parallel to transect site 17. The substrate here is level bedrock and consolidated carbonate bottom dominated by branching and fan octocorals, with small boulder scleractinians.

Transect Methods

Benthic Survey

In 1996, a total of 18 permanent transect sites were established. In 2000, two more were established. These transect lines were deployed using SCUBA or snorkel. In 1996 at each transect site, three 1 m long fiberglass stakes were pounded into the substrate to a depth of 0.5 m or cemented to coral rock at 50 m intervals marking a transect line 100 m in length.

To aid in relocating sites, global position satellite (GPS) coordinates were recorded (see Appendix 2) along with land based triangulation points. In 1998, PVC stakes embedded in the cement and concrete blocks were deployed to assist in relocating the transect sites.

At each site, a 100 m transect line (with meter marks) was deployed between the three permanently fixed stakes. A second 100 m transect line at each site was located by the diver facing the direction of the shallowest stake and moving the transect line parallel to the original line and to the right 2 m. Results from the second 100 m transect provided an indication of the extent of habitat variability and patchiness of benthic organisms.

For the benthic survey, a diver recorded on a slate the species or substrate type that occurred directly underneath each meter mark of the transect line. An abbreviated code was used for species of corals and algae (see Appendices 3 and 4 respectively). Habitat codes followed those listed in Appendix 1.

The sampling dates and types of surveys completed are listed in Appendix 5. The benthic surveys were to be repeated once every two years starting in 1996.

In 1996 and 1998, in addition to recording species and substrate type, underwater videotape of each transect line was completed. A diver swam with an underwater camera one meter off the bottom and recorded the benthic habitat along the marked line. This line was weighted and marked at one and ten meter increments between the permanent stakes. The videotapes were edited and archived to provide visual and qualitative records. This sampling technique was not repeated in 2000.

In the summer of 1998, follow-up surveys were initiated. A series of small hurricanes and tropical depressions (between the initial study period and 1998) made it difficult to find the permanent transect markers. However, all transect markers (except those at sites 5 and 13) were eventually found. These were probably lost due to storm action. Some sites had to be remarked to facilitate finding them in the future.

Between May 2000 and January 2001, transect sites were resurveyed within the marine reserve areas (see Figures 1 to 5). Two new transect sites were established (transect sites 19 and 20, see Figure 1) and surveyed during this time period. A total of eighteen sites were surveyed including transect sites 1 to 4, 6 to 12, and 14 to 20.

Fish Survey

For the fish survey, the methodology presented in Bonsack and Bannerot (1986) was followed. At least one fish survey was carried out for each benthic survey site in each of the sampling years. For each fish count, the diver initially tied brightly colored ribbon to the ends of 15 m lengths along the original 100 m transect line. The diver then moved to the 7.5 m mark (mid-point). Rotating slowly 360^0 at the 7.5 m mark, the diver then recorded all species observed within a 7.5 m radius (within an imaginary 15 m diameter cylinder of water extending from the bottom to the water surface). During the first 5 minutes at this station, all species of fish within this imaginary 15 m diameter cylinder were recorded (see Appendix 6). The diver also recorded the exact location he was on the transect line. Abbreviated species names were used to simplify data collection. These abbreviated names used the first three letters of genus name and first four letters of the species name (see Appendix 7A list of fish alphabetical by species and Appendix 7B list of fish alphabetical by fish family).

After the initial species list was completed, the diver rotated 360^0 again to estimate the number and size of fish for each fish species initially listed. Large schools of fish were estimated by 10's, 100's, or 1,000's. Fish length was estimated as fork length (FL) the distance between the tip of the upper jaw and the end of the middle caudal ray. Minimum and maximum fork lengths were recorded to the nearest cm.

At each location, the site number, time, water depth and temperature, percentage cover and bottom classification, center and +7.5 m and –7.5 m marks along the 100 m transect line, and a layout of the benthic cover within a 7.5 m radius were recorded (see Appendix 6).

At least one fish census was completed for each transect site for each sampling period. As time and resources permitted, the fish census was repeated at different locations along the 100 m transect. The locations of any additional fish censuses were arbitrarily selected along the 100 m transect line.

After the fish censuses were completed, both 100 m transect lines were rolled up and removed. The three permanent markers remained in place.

For most sites, the benthic survey and a fish count survey were completed on the same day. In some cases, only the benthic survey was completed in a day. Staff would then have to return to the site at a later date to complete the fish count survey. The ability of staff to complete both surveys depended on weather conditions, staff availability, and complexity and diversity of the habitat at the particular site.

Analysis

Percentage benthic cover was calculated by dividing the total number of each habitat classification type (based on Appendix 1) by the total number of meter marks (100).

The Shannon-Weiner diversity index (H') was calculated based on the number of benthic species and number of each benthic species observed for each transect and each year. H' was also calculated based on the number of fish species and number of each fish species observed for each transect and each year.

The mean fish density (fish/m^2) for each site and each species was calculated as the total number of a fish species observed at a transect site divided by the total area of seabed surveyed at one census site. A separate fish density estimate was made for each transect site and each survey period.

For each transect line, rank abundance of fish species and proportional abundance of fish observed were calculated and compared (based on Bonsack and Bannerot 1986) among sampling dates. Area for each 15 m diameter survey site was calculated using the formula πr^2 (r = 7.5 m).

RESULTS

Benthic Cover

Changes in percentage substrate composition for each transect site sampled (in 1996, 1998 and 2000) are compared in Figures 6 to 24. Each line in the graphs indicates the average percentage cover of a specific bottom habitat type. Bars were added to show the range of percentage cover (based on the two transects 2 m apart) at each site. For Site 5 (see Figure 10) and Site 13 (see Figure 18), bar graphs are presented as transect surveys. Surveys were not completed at these sites for all three sampling periods. For sites 19 and 20 (that were established in 2000), bottom composition data were also illustrated using bar graphs (see Figure 24).

Figure 25 to 27 summarize changes in percentage seagrass coverage over time for "seagrass" sites in Great Bay and Great St. James Island. Figures 28 and 29 summarize changes in percent algae coverage over time for "algae" sites in Great Bay and Inner Mangrove Lagoon. Figure 30 and 31 summarize changes in percent coral coverage over time for "coral" sites in Great Bay, Jersey Bay and Crow & Calf Rocks. Each line in these graphs indicates the average percentage cover of a specific bottom habitat type for transects within the same geographical locale. Bars in the graphs represent standard deviation in the sites analyzed.

A list of benthic species identified during each survey period is provided in Table 1. This table also indicates the presence (or absence) and percentage cover for each of these benthic species for each survey period.

Great St. James

Between 1996 and 2000, seagrass cover in Christmas Cove, Great St. James (transects 8, 9 and 10) increased steadily from about 60 to 90 percent (see Figure 26). During this period, seagrass cover in Bareass Bay, Great St. James (transect 1) decreased from about 95 to 60 percent (see Figure 26). The dominant seagrass species was *Syringodium filiforme,* followed by *Thalassia testudinum* (see Table 1).

Between 1996 and 2000, seagrass cover in northern Christmas Cove, Great St. James (transects 14, 15, and 16), initially increased from 40 percent to 50 percent (1996 to 1998, see Figure 27). From 1998 to 2000, it declined to about 30 percent (see Figure 27). The dominant seagrass species was *Syringodium filiforme,* followed by *Thalassia testudinum* (see Table 1).

Great Bay

Between 1996 and 1998, seagrass cover in Great Bay (transects 2, 3 and 13) declined slightly from about 25 to 20 percent (see Figure 25). Between 1998 and 2000, seagrass percentage cover increased dramatically from about 20 to 80 percent. The most common seagrass species was *Syringodium filiforme* (see Table 1).

Between 1996 and 2000, algae cover in Great Bay (transect 6) increased steadily from 10 to 20 percent (see Figure 28). Green algae (Chlorophyta) were the most common algae present (see Table 1).

From 1996 to 1998, coral cover in Great Bay (transects 4, 7, 19 and 20) decreased slightly from 10 to 5 percent (see Figure 30). Then it increased to about 25 percent (by 2000). The increase in 2000 can be attributed to the high coral cover in transects 19 and 20 which were not sampled in 1996 and 1998. *Montastrea annularis* was the most common coral in transects 4 and 7 (see Table 1). *Favia fragum* and *Montastrea cavernosa* were most common coral in transect 19. *Porites astreoides* was the most common coral in transect 20 (see Table 1).

Inner Mangrove Lagoon

Between 1996 to 2000, algae cover in Inner Mangrove Lagoon (transects 11 and 12) increased steadily and dramatically from about 30 to 70 percent (see Figure 29). In transect 11, *Penicillus capitatus* and *P. pyriformis* increased during this period (see Table 1). In transect 12, *P. capitatus* and *Halimeda tuna* increased, but *Laurencia intricata* decreased during this period.

Jersey Bay/Cow and Calf Rocks

Between 1996 and 1998, coral cover in Jersey Bay and Cow and Calf Rocks (transects 5, 17 and 18) decreased from about 45 to 20 percent (see Figure 31). From 1998 to 2000, coral cover increased to about 50 percent. In transect 5, the lettuce coral, *Agarcia agaricites,* and the fire coral, *Millepora complanata,* declined from about 15 to 0 percent between 1996 and 1998 (see Table 1). Coral coverage increases between 1998 and 2000 were related to increases of *M. complanata* in transect 17, and *M. alcicornis* in transect 18 (see Table 1).

Fish Census Results

A list of fish species observed at each transect site during the three survey periods is presented in Table 2 (see Appendix 7A list of fish alphabetical by species and Appendix 7B list of fish alphabetical by fish family). During this study, a total of 154 species of fish were observed in all fish surveys over this study period. The most commonly occurring fish species included:

1. *Halichoeres bivittatus* present in 34 transects (50.8%);
2. *Acanthurus bahianus* present in 24 transects (35.8%);

3. *Stegastes partitus* present in 22 transects (32.8%);
4. *Acanthurus coeruleus* present in 21 transects (31.3%);
5. *Thalassoma bifasciatum* present in 20 transects (29.9%);
6. *Sparisoma viride* present in 19 transects (28.4%);
7. *Stegastes leucosticus* and *Acanthurus chirurgas* each present in 18 transects (26.9%);
8. *Caranx ruber* present in 17 transects (25.3%); and
9. *Sparisoma aurofrenatum* and *Scarus croicensis* each present in 16 transects (23.9%).

The density (fish/m^2) and average size of fish (FL) observed during each of the three survey periods are presented in Table 3 by transect number and species. A summary table is provided on the number of species per area and total fish density (see Table 4).

For each transect line, fish species rank abundance and proportional abundance were calculated and compared between sampling periods (see Figures 32 to 50). In addition, the Shannon-Weiner species diversity index for both fish species and bottom composition were compared (see Figures 51 to 69). In these figures, arrows were inserted to show the change in the relationship between benthic and fish H' indices over the 5 year survey period. If the indices did not change, then all plotted points would be close together. If the habitat under went major changes, then these plotted points would be far apart.

Commercially and recreationally important fish species such as groupers and snappers were commonly observed during these fish surveys. Nine species of grouper (Serranidae) and 6 species of snapper (Lutjanidae) were observed during the survey period. Grouper species observed (present in one or more of the 56 total transects completed in this study) included:

1. *Serranus tigrinus* present in 8 of 56 transects (14.3%);
2. *Hypoplectrus* spp. present in 7 transects (12.5%);
3. *Epinephelus adscensionis* and *Hypoplectrus puella* each present in 5 transects (8.9%)
4. *Epinephelus guttatus*, *Myripristis jacobus*, and *Serranus tabacarius* each present in 4 transects (7.1%); and
5. *Epinephelus cruentatus*, *Mycteroperca tigris*, and *Serranus tortugarum* each present in 1 transect (1.8%).

Snapper species observed included:

1. *Ocyurus chrysurus* present in 13 transects (23.2%);
2. *Lutjanus griseus* and *Lutjanus synagris* each present in 5 transects (8.9%);
3. *Lutjanus analis* present in 4 transects (7.1%);
4. *Lutjanus apodus* present in 3 transects (5.4%); and
5. *Lutjanus cyanopterus* present in 1transect (1.8%).

During surveys of transects 19 and 20, divers observed large schools of gray snapper, *Lutjanus griseus*, (>100 fish) on patch reefs adjacent to the linear reef. These fish periodically swam across transect line during the survey of transect 20, but were not present within the 15 m diameter circle during the fish censuses.

Great St. James

For aggregated Christmas Cove and Bareass Bay (Great St. James) seagrass sites (transects 1, 8, 9, and 10), no species of fish were observed in all four transects in all three sampling periods (see Table 3). For transects 1, 9 and 10 individually, no species of fish was observed in all three sampling periods for each of these transects. In transect 8, *Halichoeres bivittatus, Heteroconger halis*, and *Stegastes partitus* were observed in all three sampling periods.

For aggregated north Christmas Cove seagrass sites (transects 14, 15, and 16), no species of fish were observed in all three transects in all three sampling periods (see Table 3). For transects 15, no species of fish was observed in all three sampling period. In transect 14, *Halichoeres pictus* and *Thalassoma bifasciatum* were observed in all three sampling periods. In transect 16, *Halichoeres bivittatus* was observed in all three sampling period.

Great Bay

For aggregated Great Bay seagrass sites (transects 2, 3, and 13), no species of fish was observed in all three transects in all three sampling periods (see Table 3). For transect 2, *Acanthurus chirurgus, Hypoplectrus puella*, and *Sparisoma viride* were observed in all three sampling periods (1996, 1998, and 2000). For transect 3, no fish species was observed in all three sampling periods. For transect 13 (that was not surveyed in 2000), *Heteroconger halis* was the only fish species observed in both the 1996 and 1998 sampling periods.

For the Great Bay algae site (transect 6), no species of fish was observed in all three sampling periods (see Table 3). *Calamus calamus* was observed in the last two sampling periods (1998 and 2000).

For aggregated Great Bay coral sites (transects 4 and 7), *Stegastes leucostictus* and *Thalassoma bifasciatum* were present in both sites for all three sampling periods (see Table 3). The other Great Bay coral sites (transects 19 and 20) were only surveyed in 2000, but also had these two species present. In transect 4, several species of fish were present during all three sampling periods. In addition to the two species mentioned above, *Acanthurus bahianus, A. chirurgus, A. coeruleus, Halichoeres bivittatus, Sparisoma viride,* and *Stegastes partitus* were present. In transect 7, no other species (besides *S. leucostictus* and *T. bifasciatum*) were present in all three sampling periods.

Inner Mangrove Lagoon

For aggregated Inner Mangrove Lagoon algae sites (transects 11 and 12), no species of fish was observed in all three sampling periods (see Table 3). In transect 11, *Acanthurus chirugus* and

Halichoeres bivittatus were observed in all three sampling periods. For transect 12, no species of fish was observed in all three sampling periods.

Jersey Bay/Cow and Calf Rocks

The Cow and Calf Rocks transects 17 and 18 were surveyed in 1996 and 2000. For aggregated coral sites at Cow and Calf Rocks (transects 17 and 18), only *A. coeruleus* was observed in 1996 and 2000 (see Table 3). In transect 17, in addition to *A. coeruleus, Microspathodon chrysurus* was also observed during both sampling periods. In transect 18, besides *A. coeruleus*, twelve other species of fish were observed in 1996 and 2000. The Jersey Bay site (transect 5) was only surveyed in 1996 and *A. coeruleus* was observed on this transect.

DISCUSSION

Benthic Mapping

The area studied here are sites where data on benthic composition were previously not available (see Anderson et al 1985). Field data collected based on aerial mapping and ground truthing were provided to the Conservation Data Center (CDC) at the University of the Virgin Islands campus on St. Thomas in 1997. CDC inputted this information into their GIS database, and produced benthic habitat maps of the area.

Field Work

Most transect site stakes and posts have persisted through eight tropical systems (including six hurricanes) that have passed over or near the Virgin Islands over the last several years (see Appendix 8). Some stakes have been lost. They may have been caught and moved by boat anchors or lost to wave or surge action. In general, most of the original stakes and posts are still present. The recent increase in GPS accuracy has made it easier to find these stakes.

The 1.5 m PVC poles in concrete, while often useful in finding a site, move in storms, stakes driven into sand or embedded in concrete in the reef are the only markers that do not move. These sites appear to be adequately marked for long-term monitoring.

During this project period (between 1996 to 2000), staff turnover prevented or limited fieldwork. In addition, there were several staff changes that occurred during this project period. New staff had to be trained in the survey protocol at each survey time. This made adherence to the field schedule and execution of this project very difficult.

Detailed data summaries were not compiled at the end of each sampling period. This can be attributed to high staff turnover. In addition, although there was one standard methodology for performing this survey, procedures undoubtedly varied a bit (due to staff turnover and level of experience of field staff).

Benthic Composition

In this study, benthic species percentage cover remained relatively stable at most sites, but fluctuated greatly at other sites (see Figures 8, 16, 17, 19, and 22).

For seagrass sites in this study (including both Great St. James and Great Bay areas), the seagrass present was primarily *Syringodium filiforme* followed by *Thalassia testudinum*. At some seagrass sites, percent seagrass cover increased dramatically between 1998 and 2000 (Great Bay transect 3, Figure 8; Great St. James transects 9 and 10, Figures 14 and 15). At other seagrass sites, percent seagrass cover fluctuated between the three sampling periods (Great Bay transect 2, Figure 7; Christmas Cove, Great St. James, transects 8, 14 and 15, Figures 13, 19 and 20). At two seagrass sites, percent seagrass cover actually declined between the three sampling periods (Bareass Bay, Great St. James transect 1, Figure 6; Christmas Cove, Great St. James transect 16, Figure 21).

In Christmas Cove seagrass density was higher along the southwest shore (Transects 8, 9 & 10, Figure 26) than the northwest shore (Transects 14, 15, and 16, Figure 27). Seagrass density increased between 1996 and 2000 on the southwest shore but varied on the northwest shore showing a slight increase in 1998 and a decline in 2000.

For algae sites in this study (including both Great Bay and Inner Mangrove Lagoon areas), the most common algae species varied between transect site and sampling period (see transects 6, 11, and 12 in Table 1). The Inner Mangrove Lagoon algae site (transect 11) showed a dramatic increase in algal cover from 1996 to 2000 (see Figure 16). Percent algal cover increased from about 20 to 80 percent. During this same period, the Great Bay algae site (transect 6) showed a slight increase in algae cover from about 10 to 20 percent (see Figure 11). The other Inner Mangrove Lagoon algae site (transect 12) also showed a dramatic increase in algal cover, but only from 1998 to 2000 (see Figure 17). Percent algal cover increased from about 35 to 85 percent. At algae sites studied here, there was a general trend of increased algal cover over this study period.

For coral sites in this study (including Great Bay, Jersey Bay and Cow and Calf Rocks), the most common coral species varied between transect site and sampling period (see transects 4, 5, 7, and 17 to 20 in Table 1). *Montastrea annularis* was commonly found in most coral transect sites (transects 4, 5, 7, 17, 18 and 20). For most coral sites studied here, percent coral cover fluctuated between sites and survey periods (Great Bay transect 4, Figure 9; Cow and Calf Rocks transects 17 and 18, Figures 22 and 23). At one site (Great Bay transect 7, see Figure 12), percent coral cover actually declined slightly over the sampling periods. Great Bay transects 19 and 20, and Jersey Bay transect 5 were only surveyed one time, therefore time series data are not available for these coral sites. Based on survey results here, no general trend was evident regarding percent coral coverage.

Changes in bottom composition over this study period may be related to the occurrence of major ecological events. Two major environmental events that affected the marine environment of the

Virgin Islands are hurricanes (see Appendices 8 and 9) and global El Niño or La Niña conditions (see Appendix 10). In 1995 before the onset of this study, Hurricane Marilyn (a Category 2 hurricane) devastated the Virgin Islands ripping up seagrass beds and creating huge windrows of seagrass blades along the shoreline. In the Charlotte Amalie waterfront bulldozers were employed to remove the mounds of seagrass. Between 1996 and 2000 (the period of this study), a total of six hurricanes approached or hit the USVI (see Appendix 8). During the 1997/1998 El-Niño period, there was extensive rainfall and large waves hitting the coasts of Caribbean islands (personal observation). This undoubtedly resulted in unusually high sedimentation rates in the region.

The physical interaction of large storm waves loaded with eroded materials results in massive destruction of hard and soft bottom type habitats (Pielke and Landsea 1999, and Ostrander et al 2000). During storm periods, anchored yachts and boats caused extensive blowouts in the algae and seagrass beds (in bays such as Great Bay and Christmas Cove). Anchors dragged and chains moved across the seabed ripping up seagrass and algal beds. In addition, storm wave action and resultant scouring can also destroy benthic habitat. Heavy rains associated with storms can also result in chemical and soil runoff into the marine environment (Rogers et al 1994, and Adams 2000). All of these storm-associated actions can stress and destroy coral, seagrass, and algae. Unhealthy or polluted benthic habitats can result in low fish abundance (Syms and Jones 2000, Rogers 1990, and Nagelkerken et al 2000).

Rogers (1990) and Rogers et al (1994) and Molles and Dahm (1990) have suggested that El Niño and La Niña events are related to the severity of hurricane and tropical storm destruction in the Caribbean and the world. According to Rogers et al (1994), during certain El Niño events some coral reefs experience a reduction in fish abundance and diversity. However, during other El Niño events, coral reef fish species and other marine organisms flourish. In 1998, coral bleaching and die-off was unprecedented in geographic extent, depth, and severity (Molles and Dahm 1990, and Pielke and Landsea 1999).

Fish distribution and composition

Fish density (fish/m^2) varied widely between transect site, habitat, and survey periods (see Table 4). In 1996 and 1998, a seagrass site (Great Bay transect 13) had the highest fish density compared with all other sites surveyed those years. In 2000, a coral site - the fore reef slope of a linear reef (transect 20, see Table 4) had the highest fish density (3.826 fish/m^2) compared with all other sites surveyed that year. Conversely, a seagrass site (Great Bay transect 1, see Table 4) also had the lowest fish densities for all three survey periods.

Fish species per area (species/m^2) also varied widely between transect site, habitat, and survey period (see Table 4). In 1996 and 1998, seagrass sites (Great Bay transect 13 and Great Bay transect 2, respectively) had the highest number of species per unit area. In 2000, a coral site (transect 20) had the highest number of species per unit area. Again, a seagrass site (Great Bay transect 1) also had the lowest number of fish species per unit area in 1996 and 1998. In 2000, an algae site (Great Bay transect 4) had the lowest number of fish species per unit area.

In this study, the 10 most frequently observed grouper and snapper species (in four or more of the 56 transects completed in this study) included:

1. yellowtail snapper, *Ocyurus chrysurus* (in 13 of 56 transects, 23.2%);
2. harlequin bass, *Serranus tigrinus* (in 8 transects, 14.3%);
3. rock hind, *Epinephelus adscensionis* and barred hamlet, *Hypoplectrus puella,* grey snapper, *Lutjanus griseus* and lane snapper, *Lutjanus synagris* (in 5 transects each, 8.9%);
4. red hind, *Epinephelus guttatus,* blackbar soldier, *Myripristis jacobus*, and tobaccofish, *Serranus tabacarius*, mutton snapper, *Lutjanus analis* (in 4 transects each, 7.1%).

The commercial finfish catch in St. Thomas/St. John District in the 1999-00 fishing year (1 July 1999-30 June 2000) is dominated by species in the following groups: snapper (29%), triggerfish (14.7%), grouper (10.2%) and jacks (10.2%). Snapper, grouper, and jacks are recreationally important species as well. Many of the grouper and snapper species spend their juvenile phase exclusively in coastal areas (Nagelkerken et al 2000) and are primarily associated with seagrass beds (Syms and Jones 2000 and Nagelkerken et al.2000).

In the past, USVI fisherman primarily fished for grouper species (Wolff 1996). Now due to the decrease in the availability of these fish, fishermen had to change focus and catch other fish species such as the squirrel fish, *Holocentrus adscensionis*, the doctorfish, *Acanthurus chirurgus*, the glasseye snapper, *Priacanthus cruentatus*, and the bigeye, *Priacanthus arenatus*. These fish were once termed "trash fish" meaning that they were not harvested.

At some stage of their life cycle, many fish species live in and around the perimeters of the coastal shelves (Nagelkerken et al 2000; and Boulon 1985 and 1986). As such, areas such as the Inner Mangrove Lagoon and the St. James Marine Reserve and Wildlife Sanctuary play an important part in maintaining a sustainable fishery.

Long-Term Monitoring

Data from this study is being provided to the UVI-CDC GIS system. This study provided initial estimates of benthic cover in seagrass beds, coral reefs and algal plains, and provided fish species abundance in each of these habitats. With continued periodic monitoring of these sites, time series data can be obtained and changes of habitat type and size and species abundance can be compared. Results of this survey provide baseline data on this marine reserve area that can be used to determine the effectiveness of this protected area.

There are still many topics that require investigation within this marine reserve area. These include: (1) fish mating and spawning locations, (2) egg transport and larval migration patterns, (3) location and condition of larval and fry nursery grounds, (4) adult fish migration patterns, and (5) mapping of deeper habitats using side scan sonar.

Despite high staff turnover at DFW, the main goals of this project were achieved. In future follow-up studies, less time will be required to identify historic data for comparisons. In addition, with advances in GPS technology, it will be easier to relocate specific survey sites.

Impacts on Marine Resources and Management

Between 1996 and 2000, the primary impact on the resources of these marine reserves was likely hurricanes and coral bleaching. However, the effect of anchoring on seagrass in Christmas Cove, Great St. James Island was noticeable. Anchors and chains removed seagrass and algae, creating blow-outs. These blow-outs can be prevented by installing appropriate mooring.

If marine protected areas are to be effective, they must, as in the case of the Mangrove Lagoon/Cas Cay and Great St. James marine reserves, include diverse habitats necessary to accommodate a wide range of fish species. Management measures need to address issues that negatively impact sensitive habitats.

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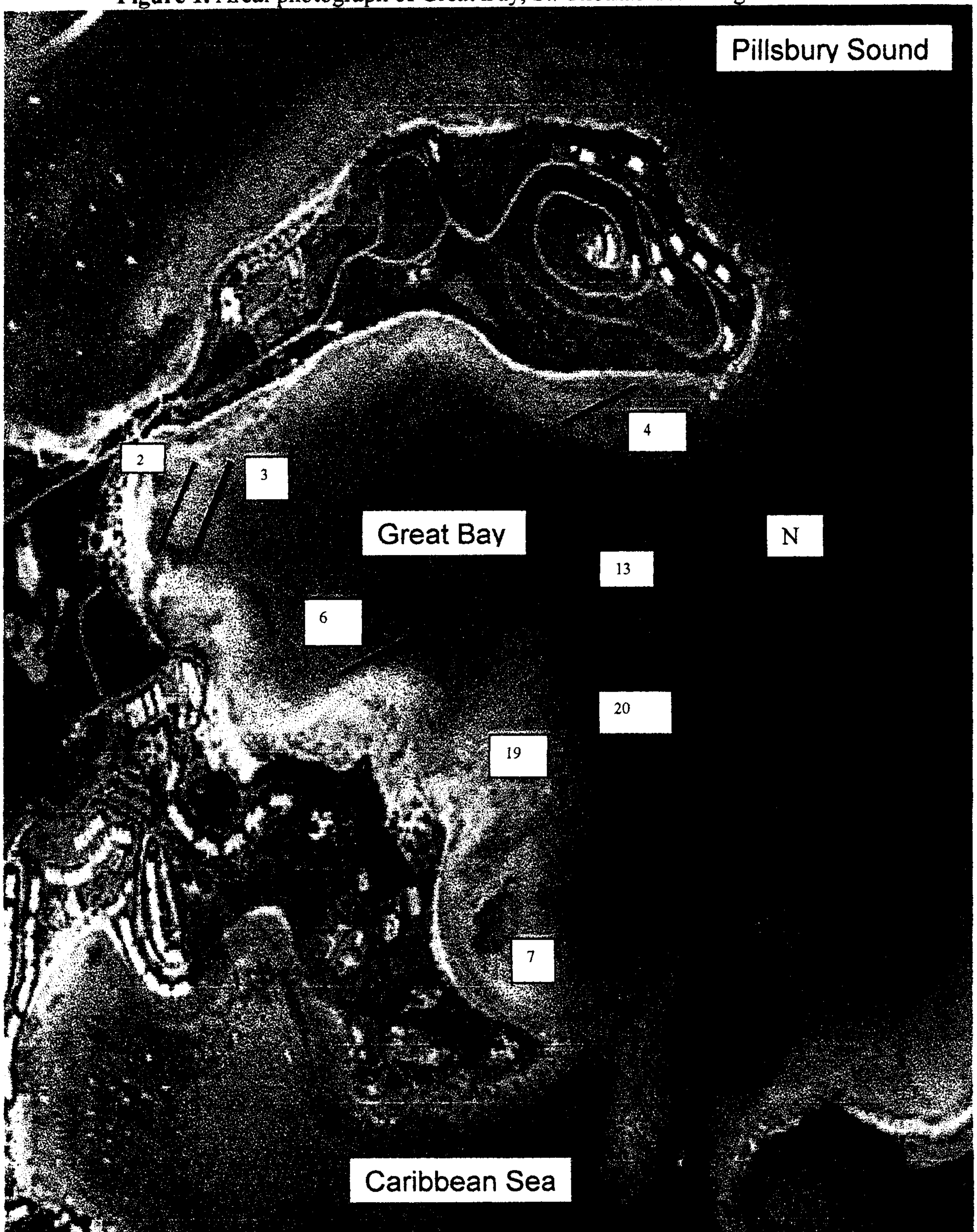
ACKNOWLEDGMENTS

This work was completed under the supervision of Department of Planning Natural Resources' Division of Fish & Wildlife staff. Financial support for this study was provided by grant from Recreational Fisheries Habitat Assessment Project and Sportfish Restoration Funds, U.S. Fish & Wildlife Service.

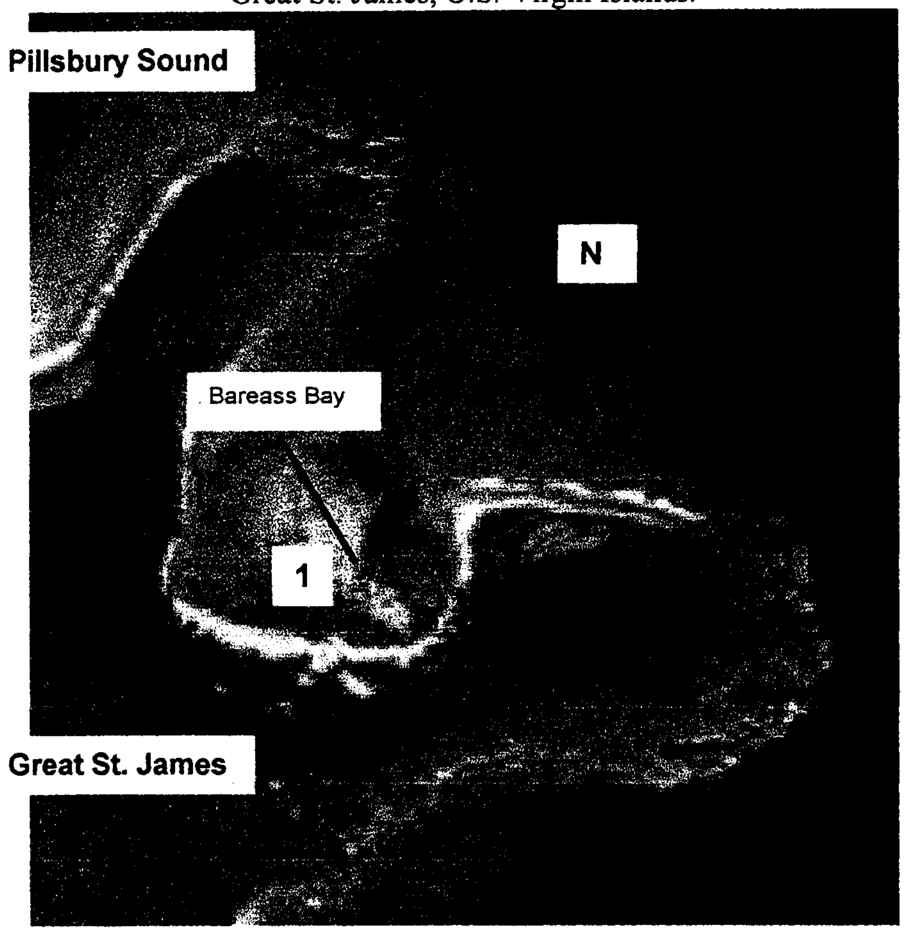
Figure 1. Areal photograph of Great Bay, St. Thomas U.S. Virgin Islands.



1:6400 scale

Base Map source: NOAA (Draft)

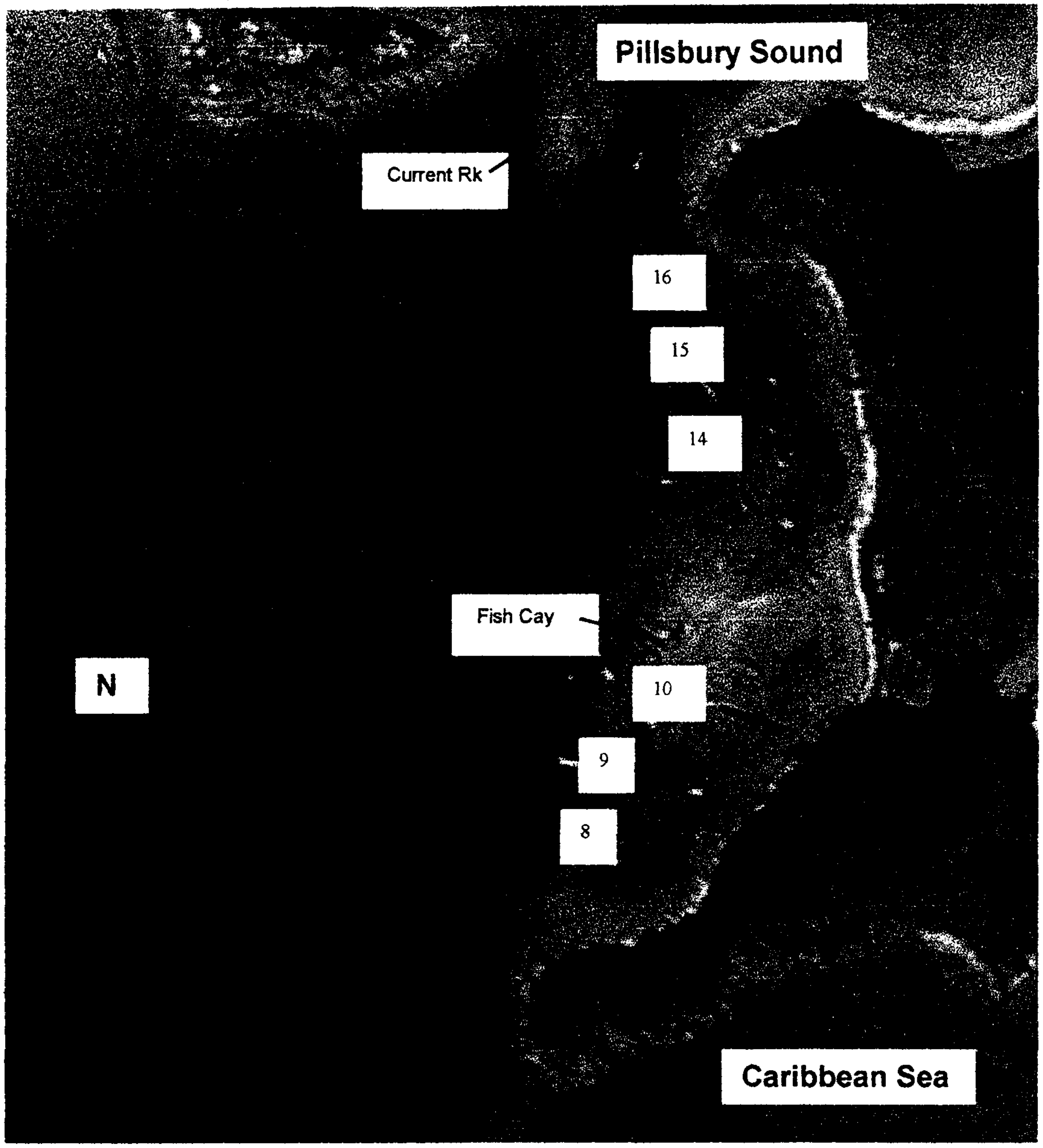
Figure 2. Aerial photograph of Bareass Bay,
Great St. James, U.S. Virgin Islands.



1:6300 scale

Base map source: NOAA (Draft)

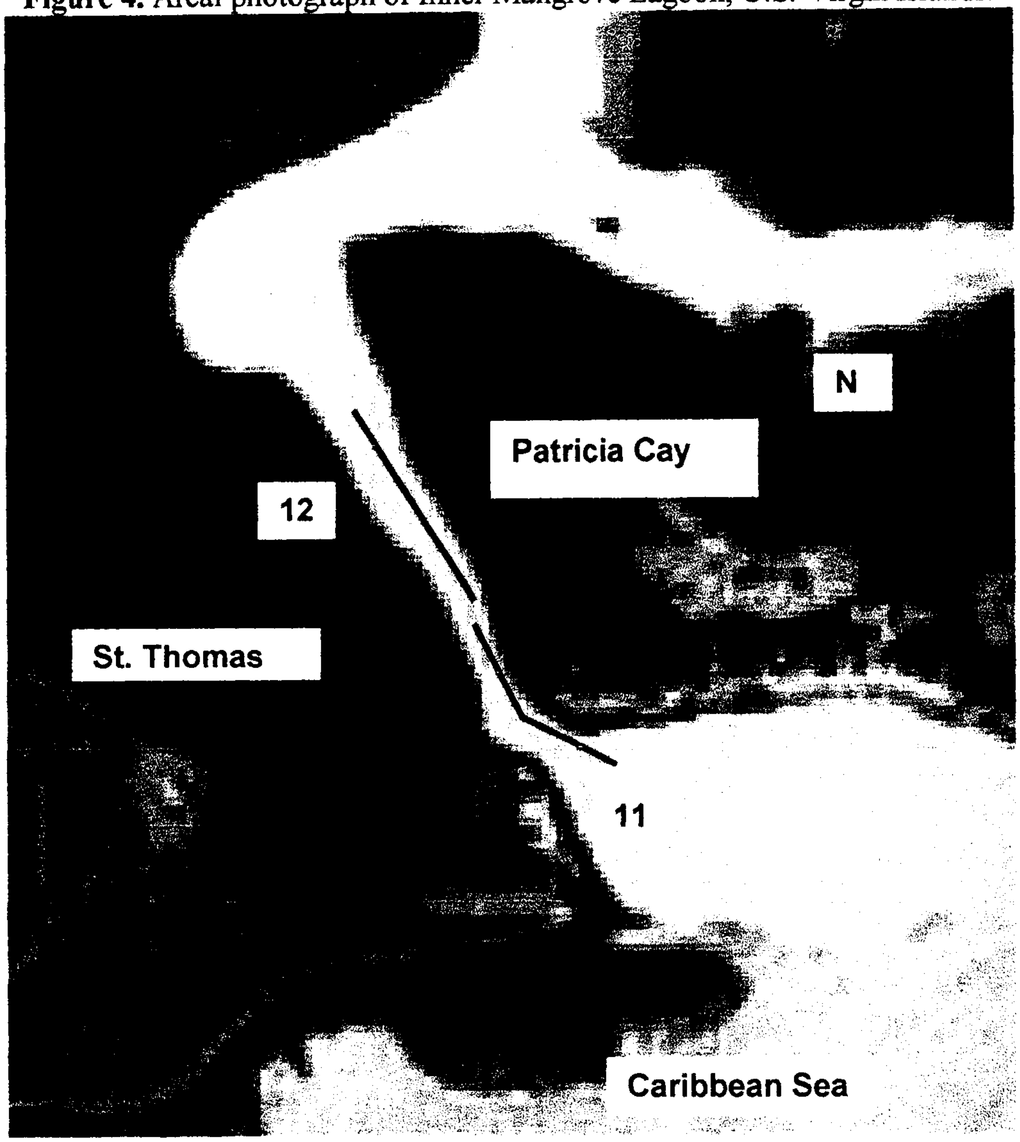
Figure 3. Areal photograph of Great St. James U.S. Virgin Islands.



1:9,600 scale

Base map source: NOAA (Draft)

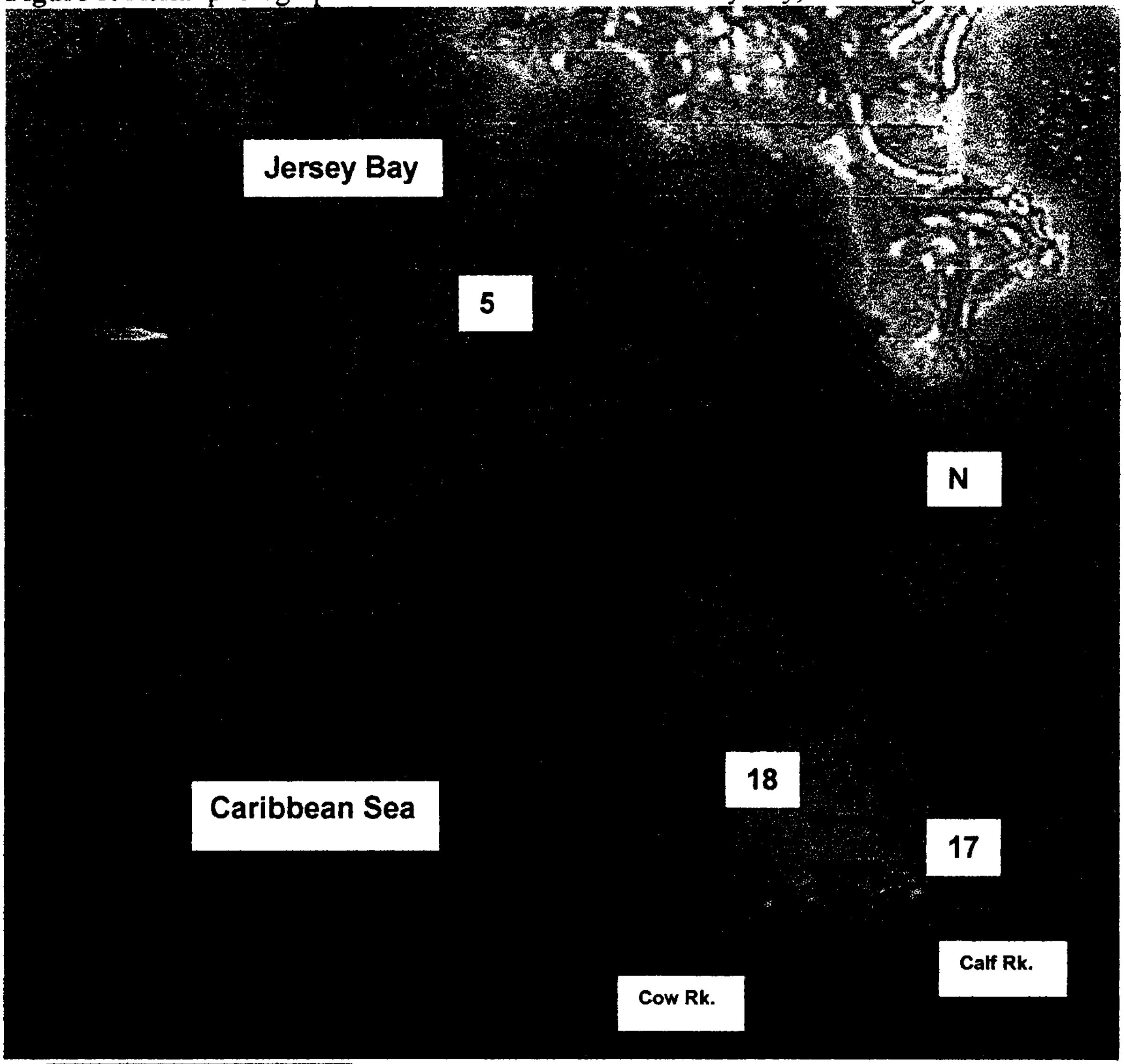
Figure 4. Areal photograph of Inner Mangrove Lagoon, U.S. Virgin Islands.



1:3600 scale

Base map source: NOAA (Draft)

Figure 5. Aerial photograph of Cow & Calf Rocks and Jersey Bay, U.S. Virgin Islands.



1:10900 scale

Base map source: NOAA (Draft)

Figure 6. Bareass Bay, Great St.James, US Virgin Islands: Change in years percent benthic cover in Transect 1 among 1996, 1998 and 2000. Vertical lines represent range percentage cover for Transects 1a & 1b.

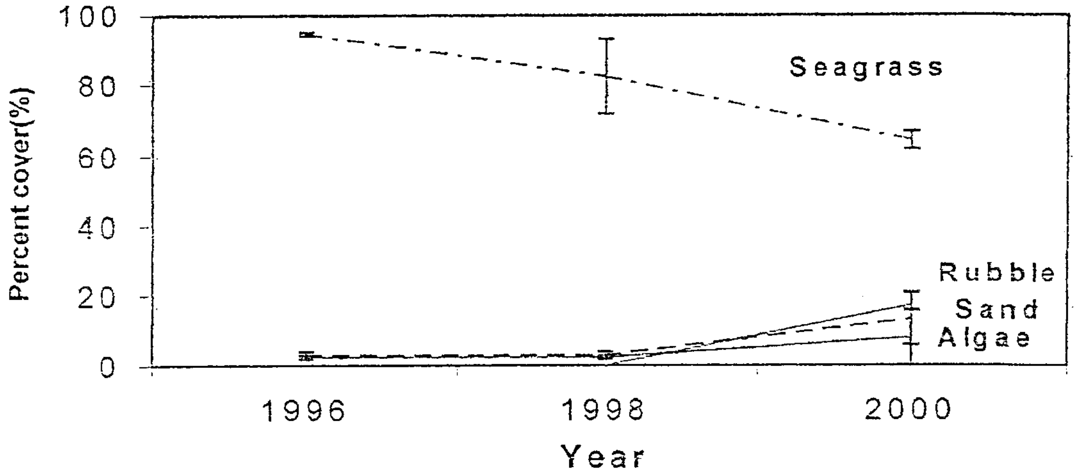
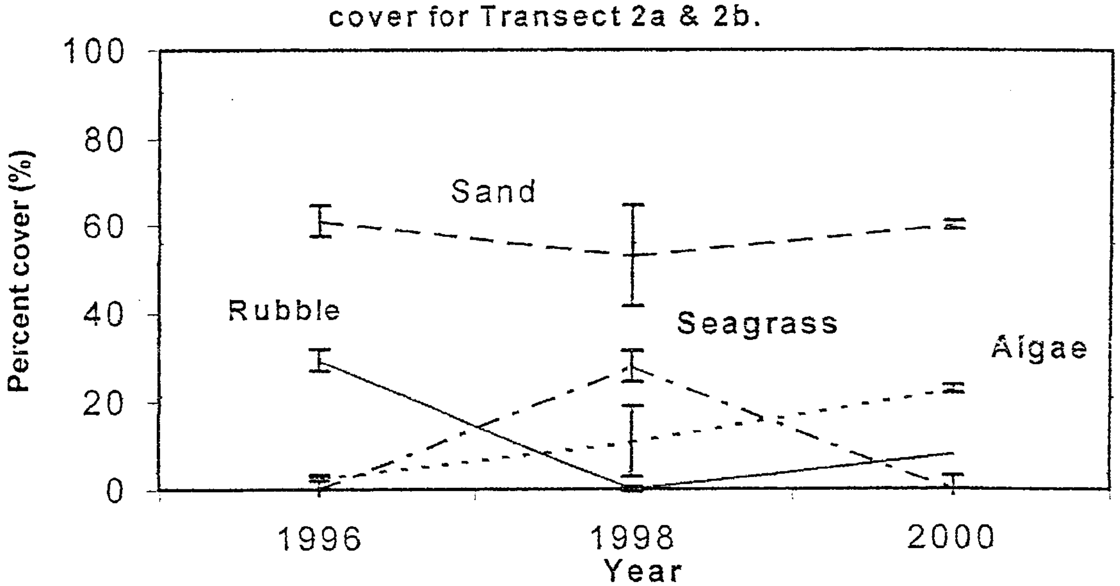
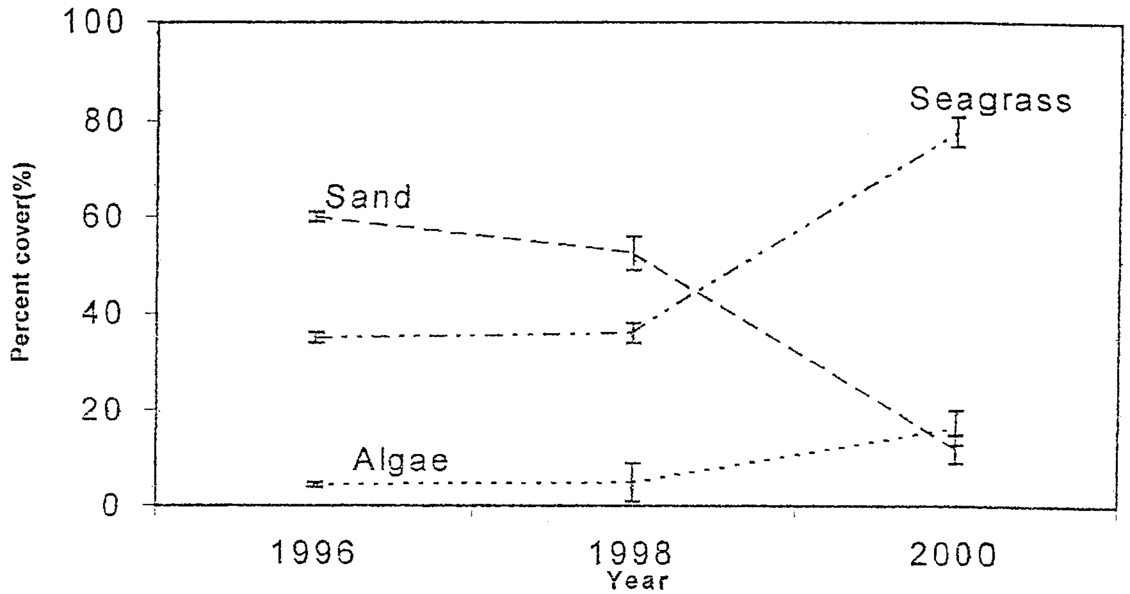


Figure 7. Great Bay, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 2 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 2a & 2b.



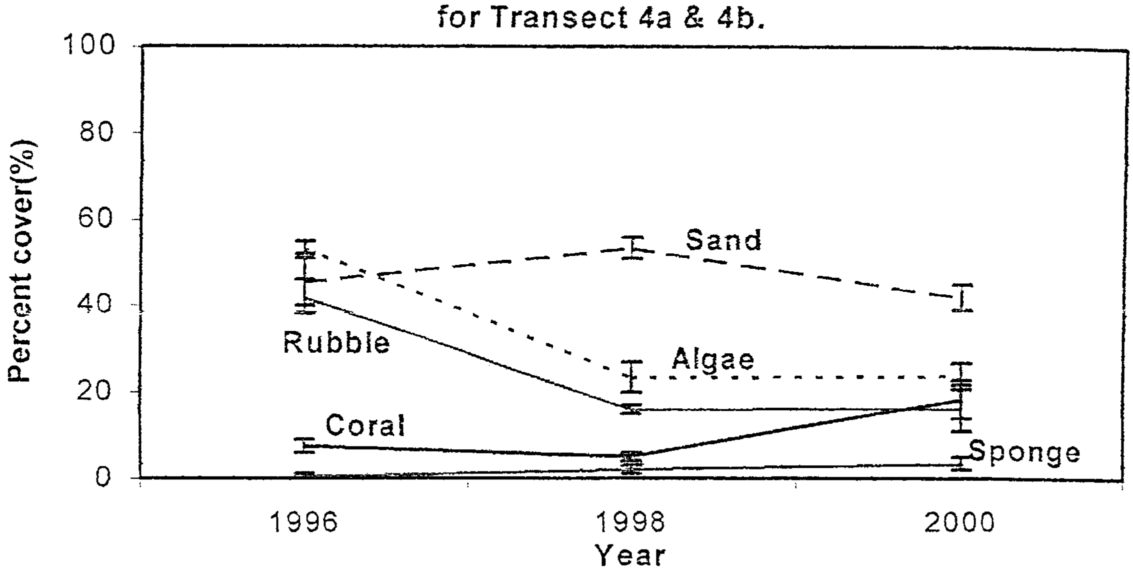
*Note: coral and gorgonians <1%, therefore not illustrated

Figure 8. Great Bay, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 3 among 1996,1998 and 2000. Vertical lines represent range percent cover for Transect 3a & 3b.



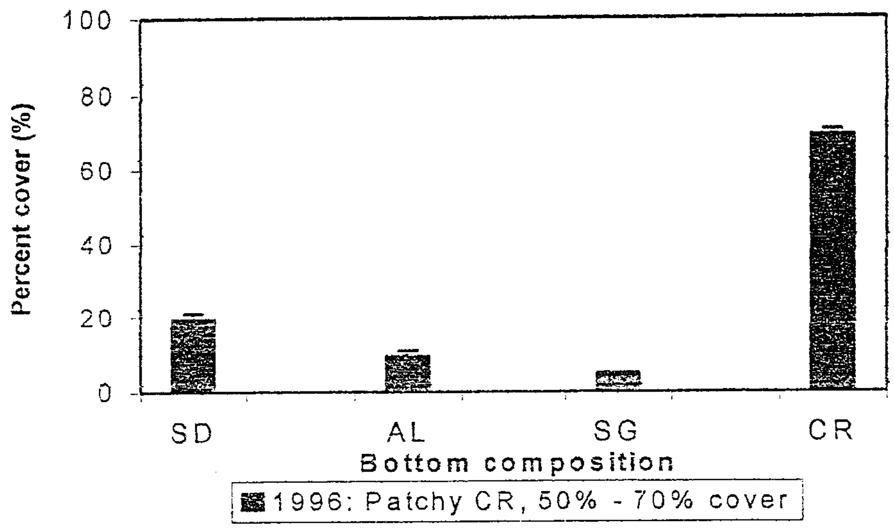
*Note: Sponge and rubble <1%, therefore not illustrated

Figure 9. Great Bay, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 4 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 4a & 4b.



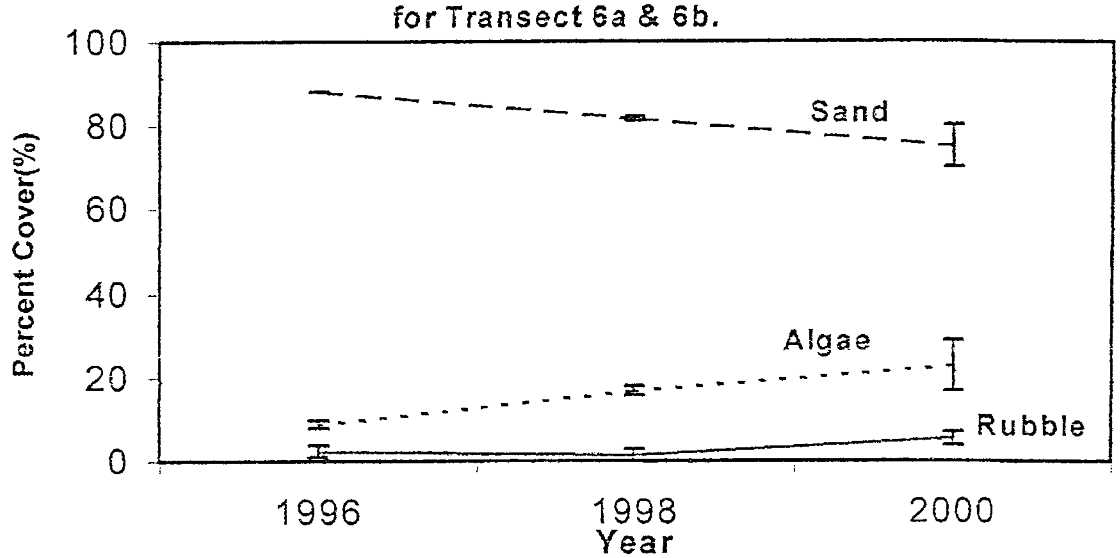
*Note. Gorgonian and rock <1%, therefore not illustrated

Figure 10. Jersey Bay, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 5 in 1996. Vertical lines represent range percent cover for Transect 5a & 5b.



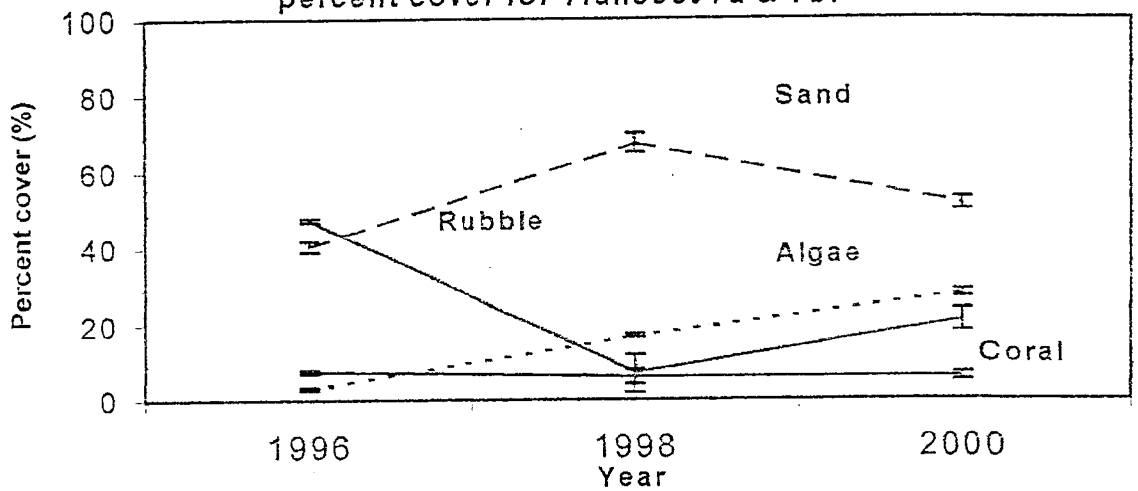
*Note. Transect 5 was not resurveyed in 1998 & 2000 because it could not be relocated.

Figure 11. Great Bay, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 6 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 6a & 6b.



*Note. Coral and sponge <1%, therefore not illustrated

Figure 12. Great Bay, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 7among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 7a & 7b.



*Note. Coral and bedrock <1%, therefore not illustrated

Figure 13. Christmas Cove, Great St. James, US Virgin Islands: Change in years percent benthic cover in Transect 8 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 8a & 8b.

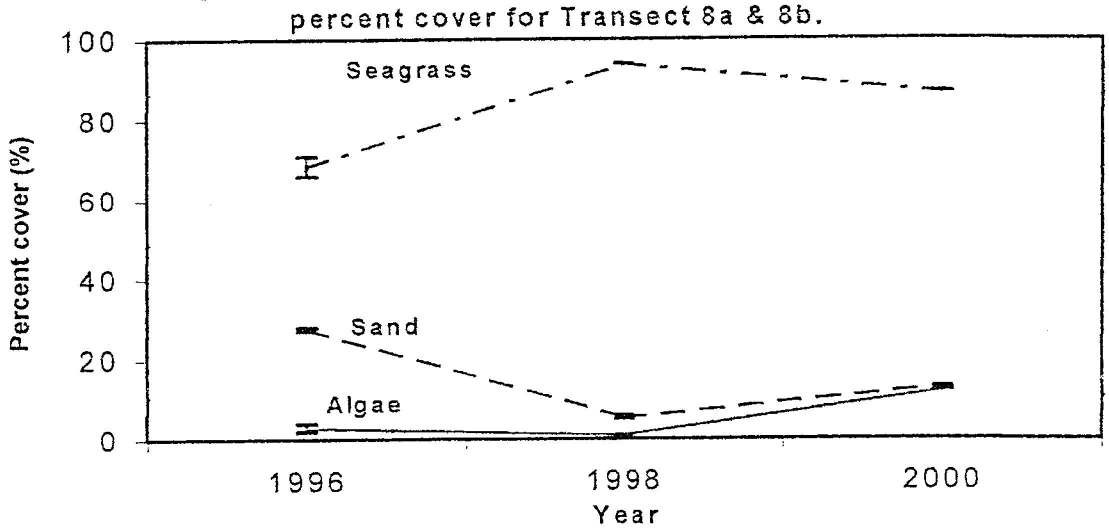
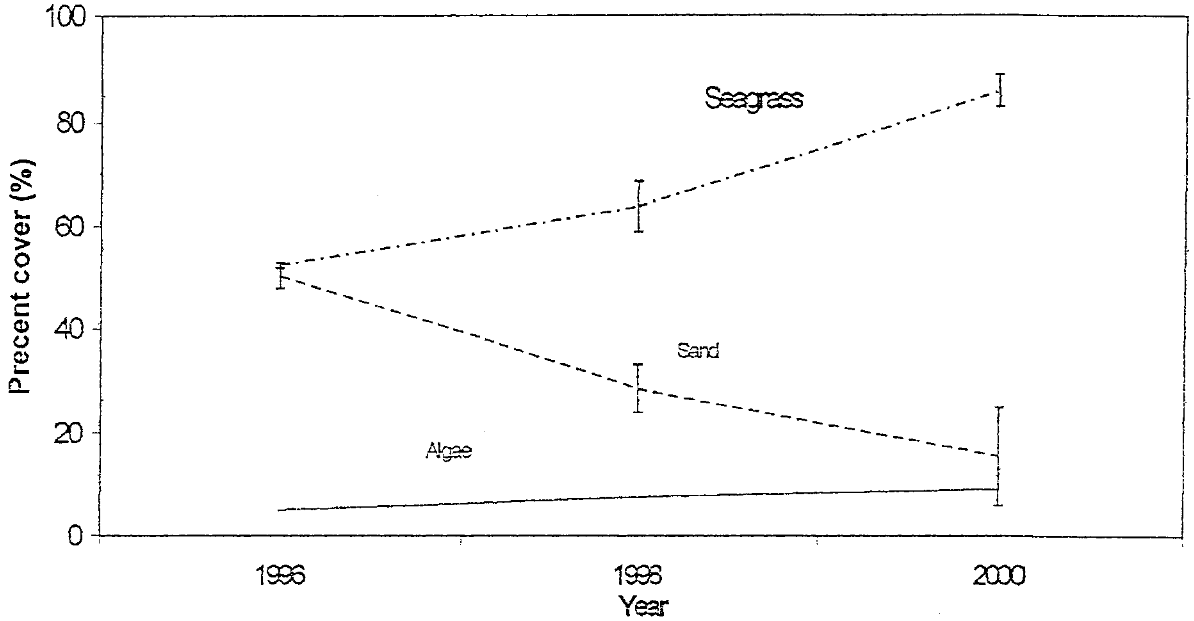
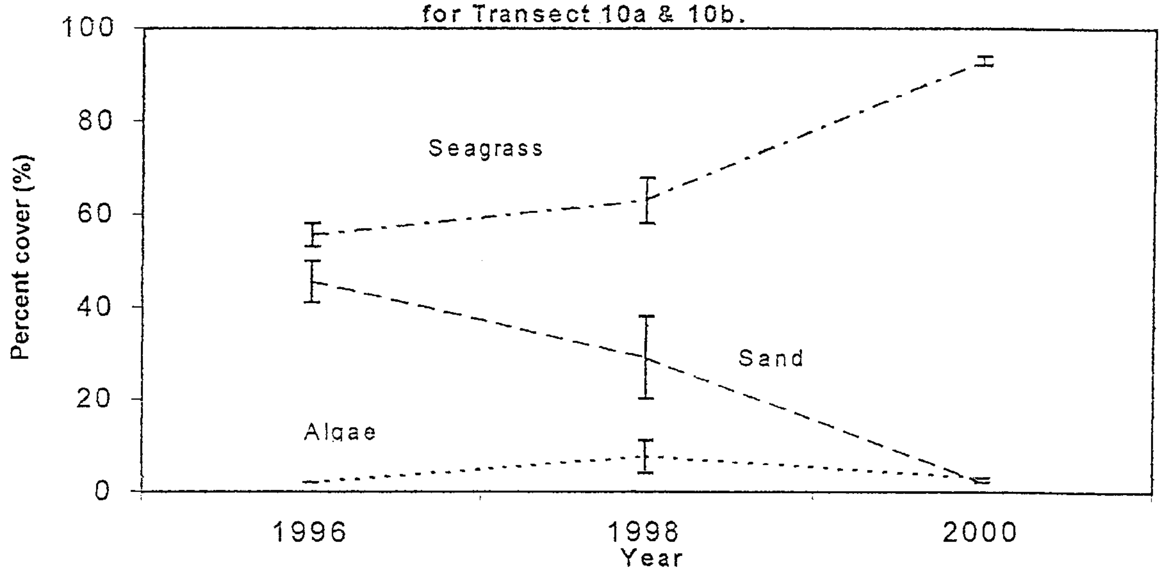


Figure 14. Christmas Cove, Great St.James, US Virgin Islands: Change in years percent benthic cover in Transect 9 among 1996, 1998 and 2000. Vertical lines represent range of percent cover for Transect 9a & 9b.



*note: Coral <2.5%, therefore not illustrated

Figure 15. Christmas Cove, Great St. James, US Virgin Islands: Change in years percent benthic cover in Transect 10 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 10a & 10b.



*Note. Coral <2%, therefore not illustrated

Figure 16. Inner Mangrove Lagoon, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 11 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 11a & 11b.

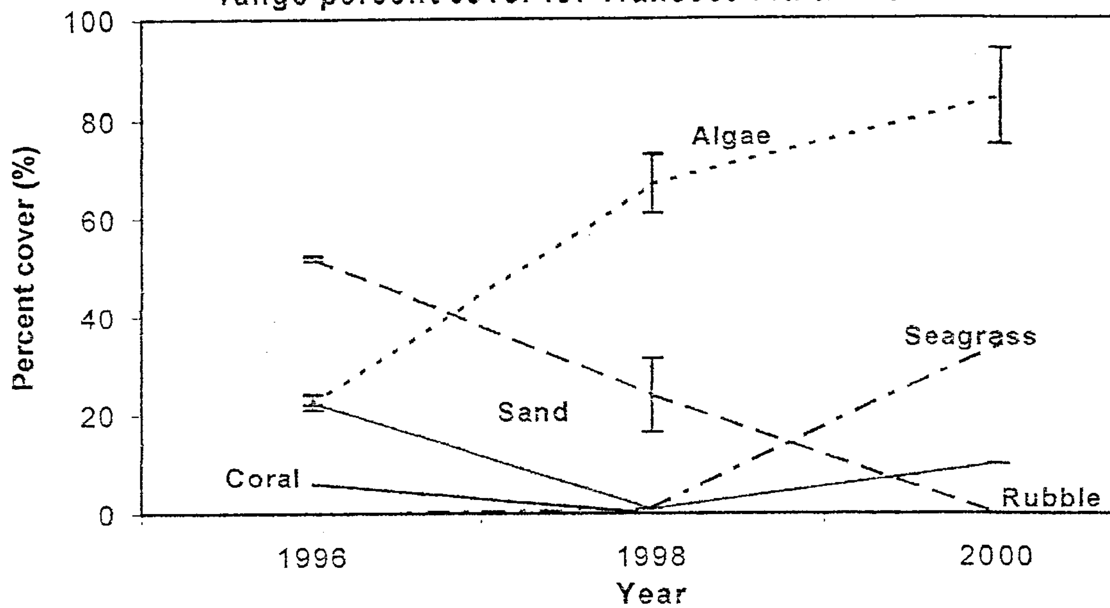
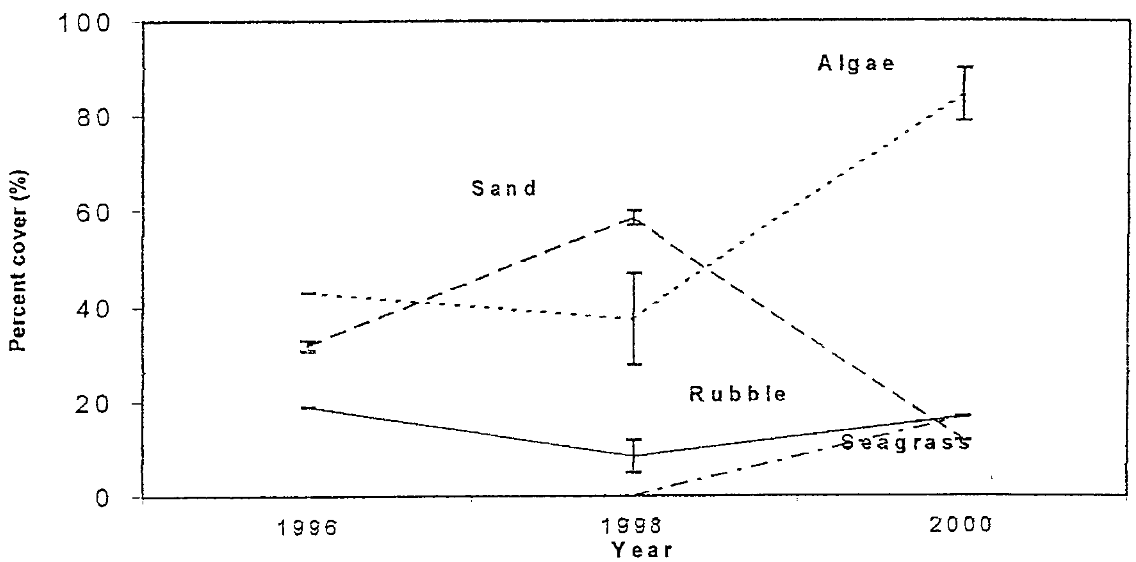
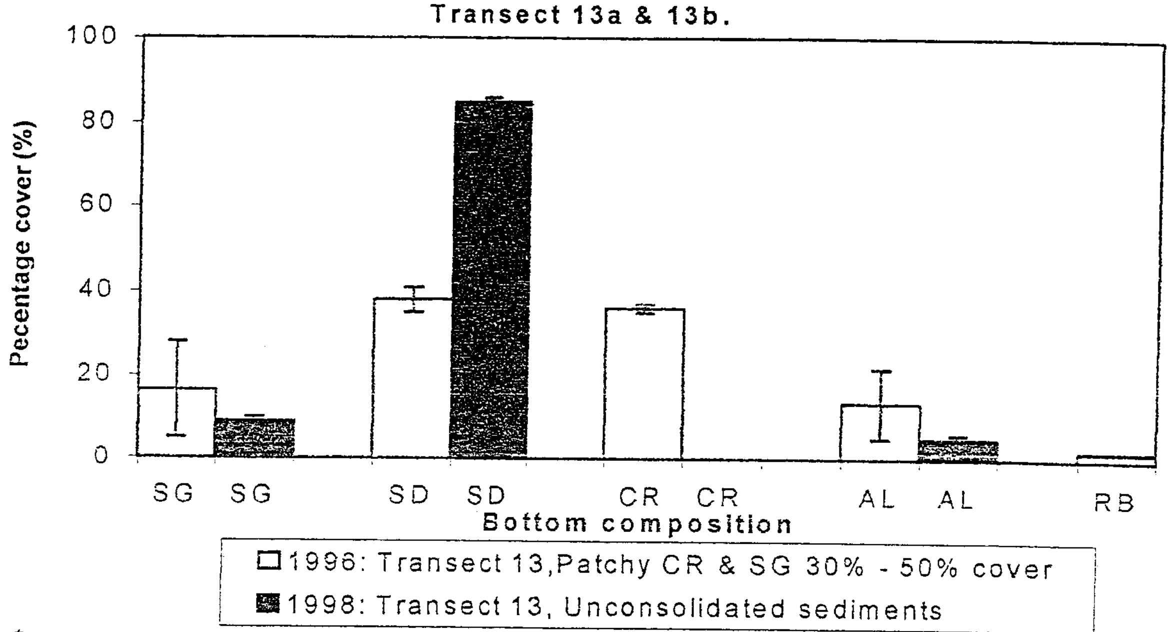


Figure 17. Inner Mangroove Lagoon, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 12 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 12a & 12b.



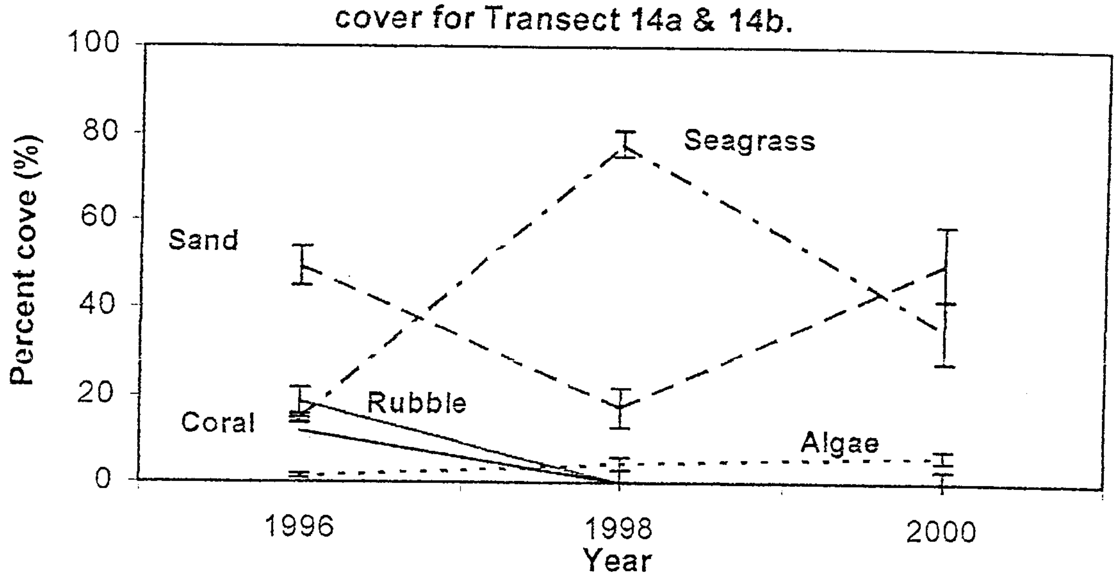
*Note: Coral <5%, therefore not illustrated

Figure 18. Great Bay, St. Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 13 between 1996 and 1998. Vertical lines represent range percent cover for Transect 13a & 13b.



*Note. Transect 13 was not relocated in 2000 after storm damage 1998 & 1999.

Figure 19. Christmas Cove, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 14 among 1996,1998 and 2000. Vertical lines represent range percent cover for Transect 14a & 14b.



*Note. Gorgonian and sponge <2.5% therefore not illustrated

Figure 20. Christmas Cove, St.Thomas, US Virgin Islands: Change in years percent benthic cover in Transect 15 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 15a & 15b.

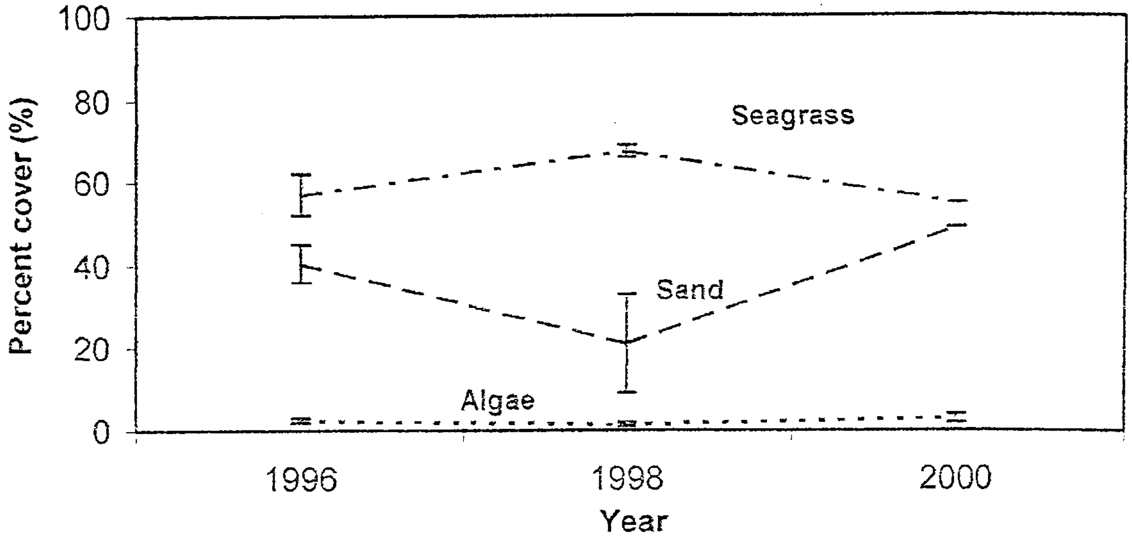
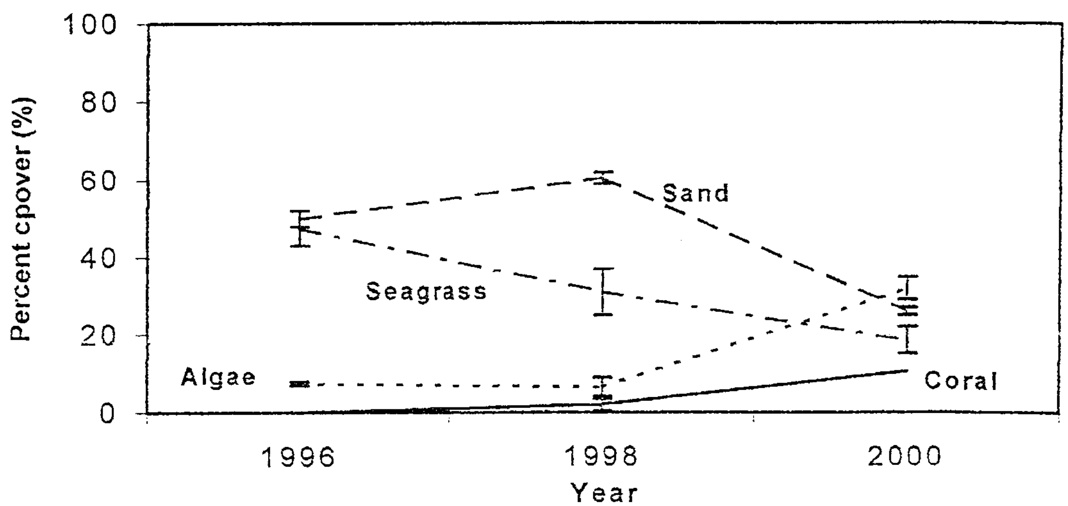


Figure 21. Christmas Cove, Great St. James, US Virgin Islands: Change in years percent benthic cover in Transect 16 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 16a & 16b.



*Note: Gorgonia, sponge and rubble<2.5%, therefore not illustrated

Figure 22. Cow and Calf Rocks, US Virgin Islands: Change in years percent benthic cover in Transect 17 among 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 17a & 17b.

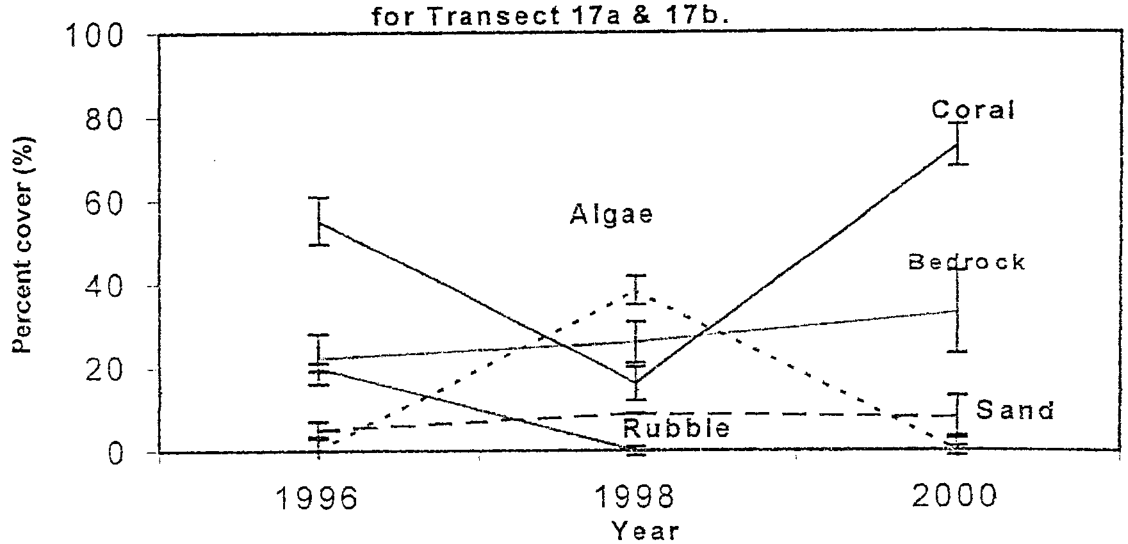
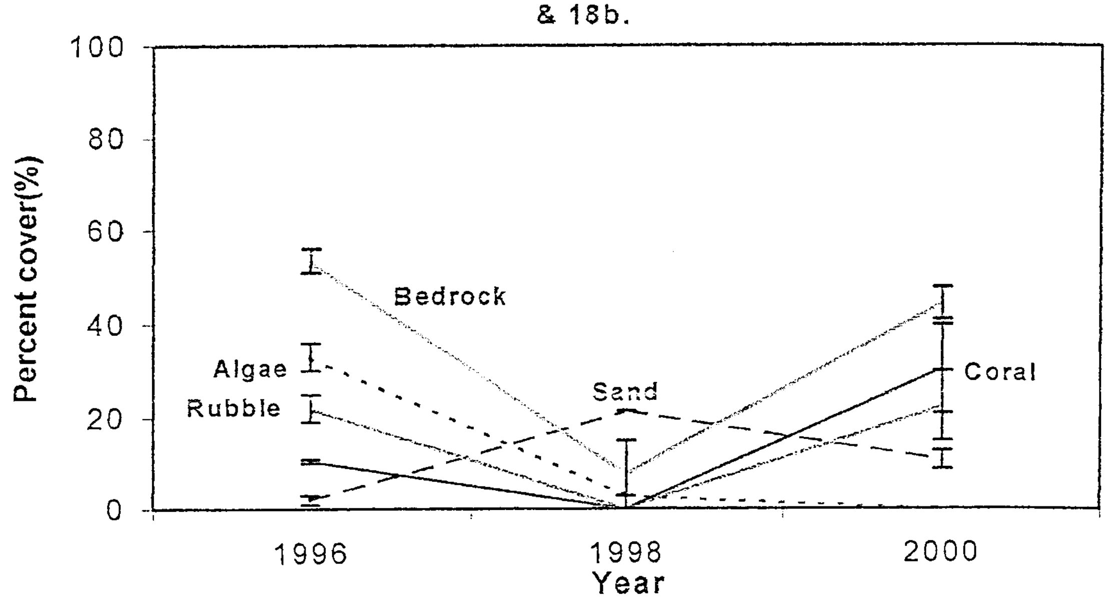
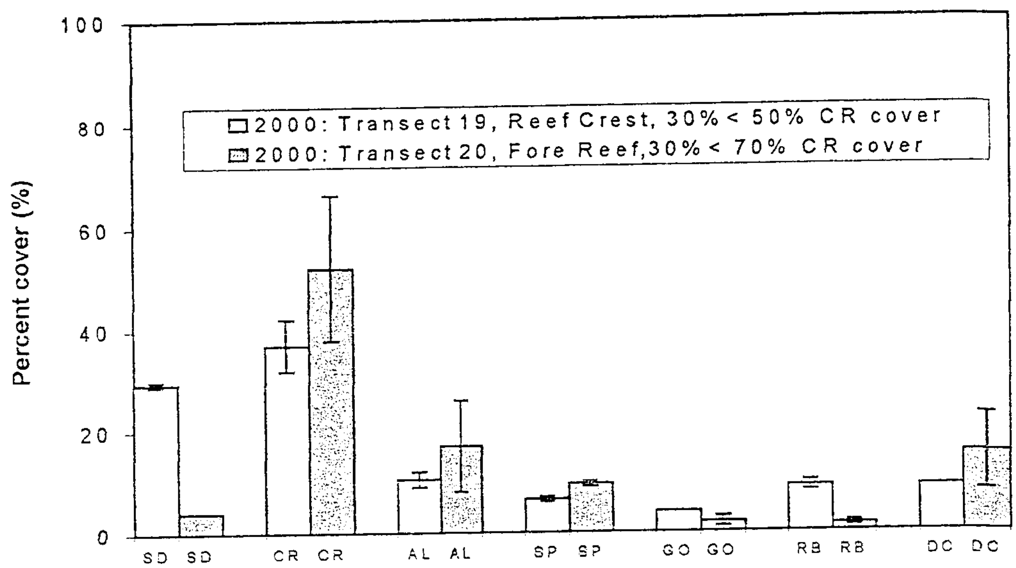


Figure 23. Cow and Calf Rocks, US Virgin Islands: Change in percent benthic cover, Transect 18, 1996, 1998 and 2000. Vertical lines represent range percent cover for Transect 18a & 18b.



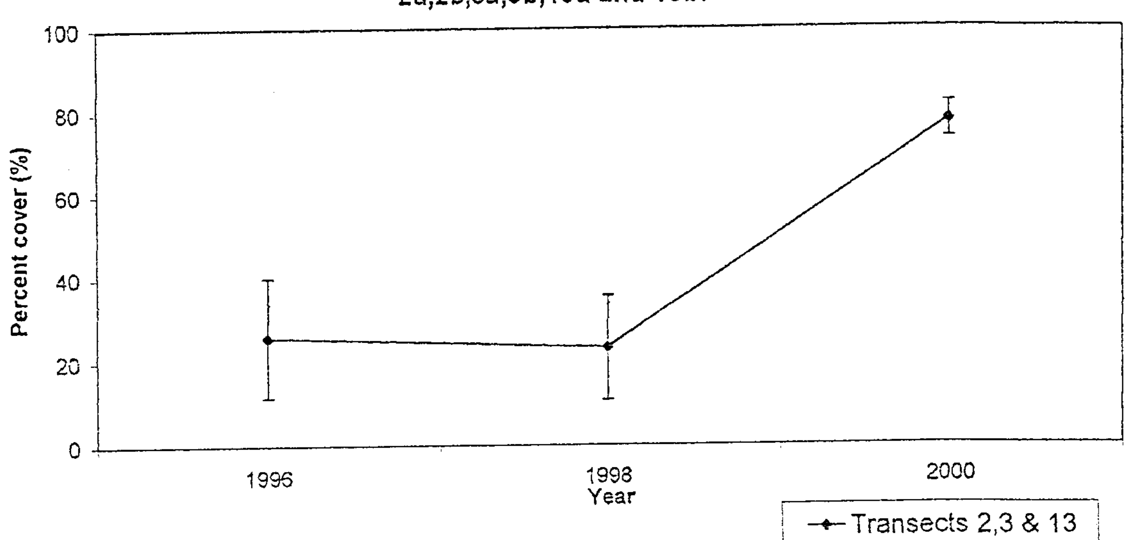
*Note. Gorgonian <1%, therefore not illustrated

Figure 24. Great Bay, St.Thomas, US Virgin Isalnds: Change in years percent benthic cover in Transect 19 and 20 for 2000. Vertical lines represent range percent cover for Transect 19a & 19b and 20a & 20b.



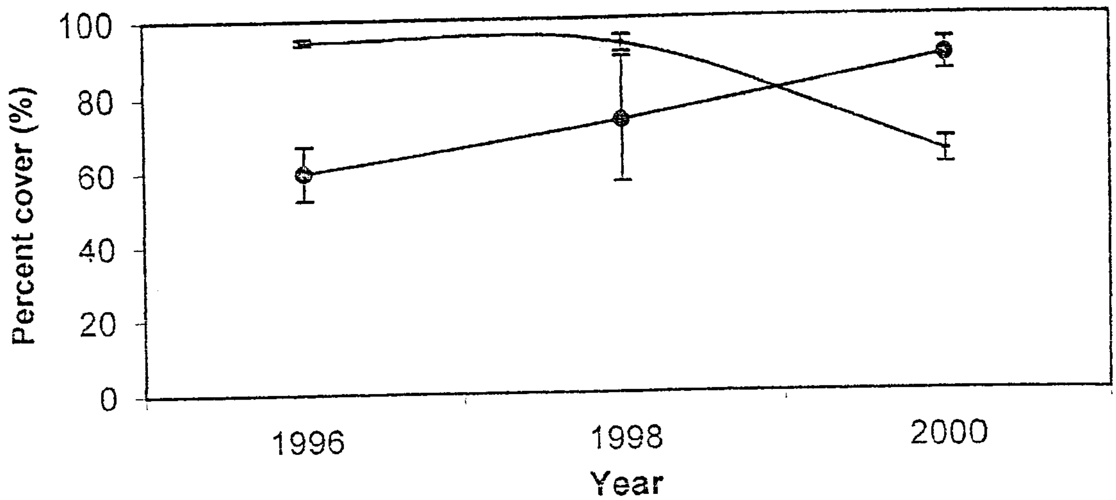
*Note. Transects 19 & 20 were established in 2000

Figure 25. Seagrass transects in Great Bay, St.Thomas, US Virgin Islands: Change in years percent seagrass cover in Transects 2, 3 & 13 among 1996,1998 and 200. Vertical lines represent standard deviation in Transects 2a,2b,3a,3b,13a and 13b.



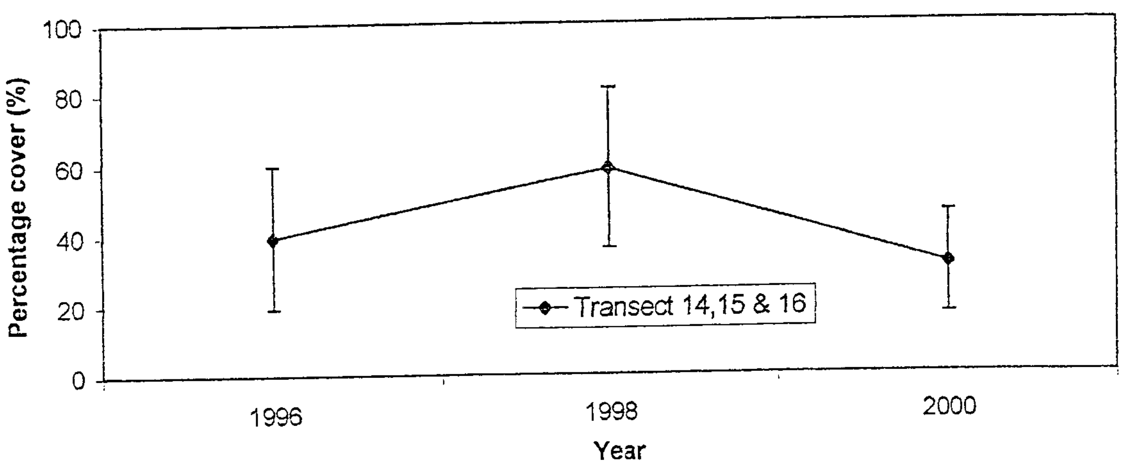
* Note. Percentage cover values are means(±SD) generated from Transects 2,3 & 13 among 1996, 1998 and 2000.

Figure 26. Seagrass Transects in Great St. James, US Virgin Islands: Change in Percent Cover of Seagrass Between Years for Christmas Cove (Transects 8, 9 & 10) and Bay Ass Bay (Transect 1)



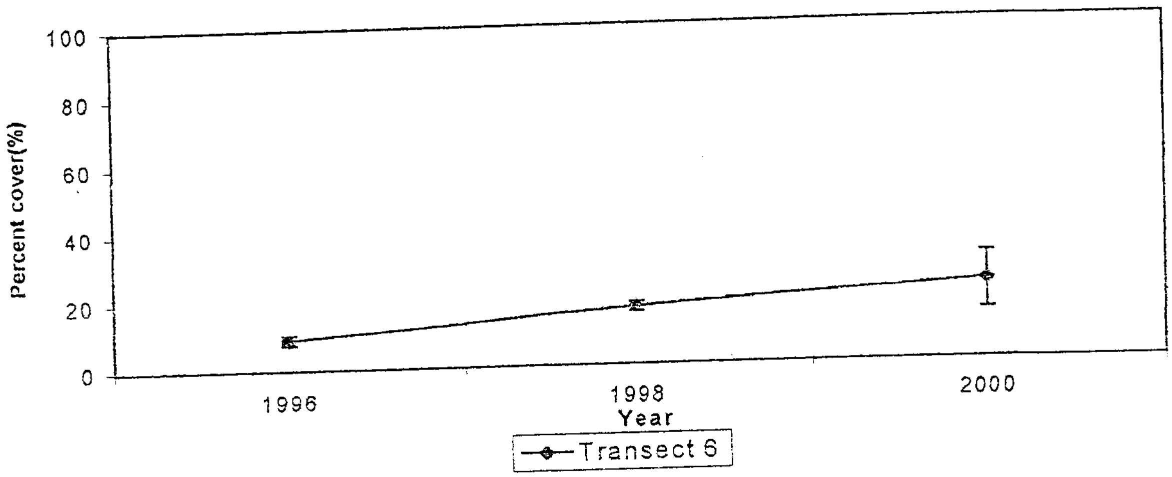
* Note. Percentage cover values are means(±SD) generated from Transects 8, 9,10 and Transect 1 among 1996, 1998 and 2000. Vertical lines represent standard deviation in Transect 8a,8b,9a,9b,10a and 10b.

Figure 27. Seagrass Transects in Great St. James, US Virgin Islands: Change in Percent Cover of Seagrass Between Years For Christmas Cove (Transects 14,15 and 16).



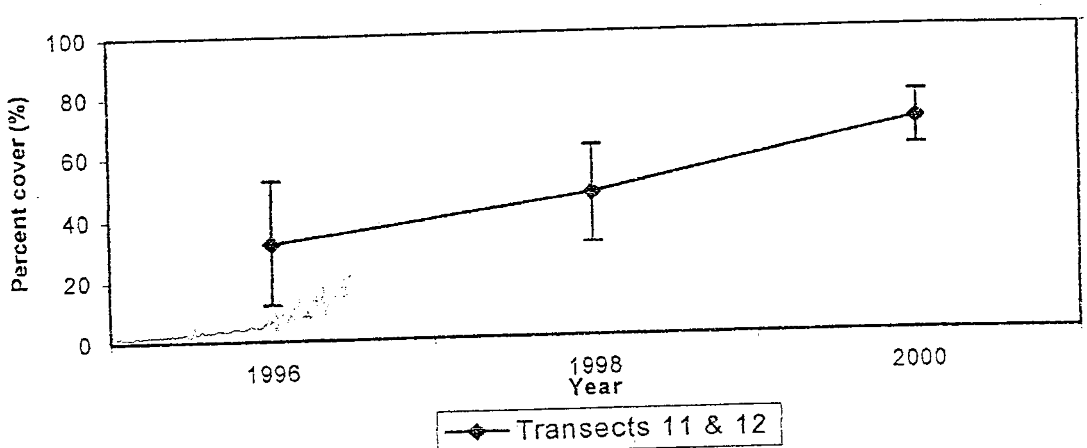
*Notes. Percentage cover values are means (±SD) generated from Transects 14, 15 & 16 among 1996, 1998 and 2000. Vertical lines represent standard deviation in Transects 14a, 14b, 15a, 15b, 16a & 16b.

Figure 28. Algae transects in Great Bay, St.Thomas, US Virgin Islands: Change in years percent algae cover in Transects 6 among 1996,1998 and 2000. Vertical lines represent standard deviation in Transect 6a and 6b.



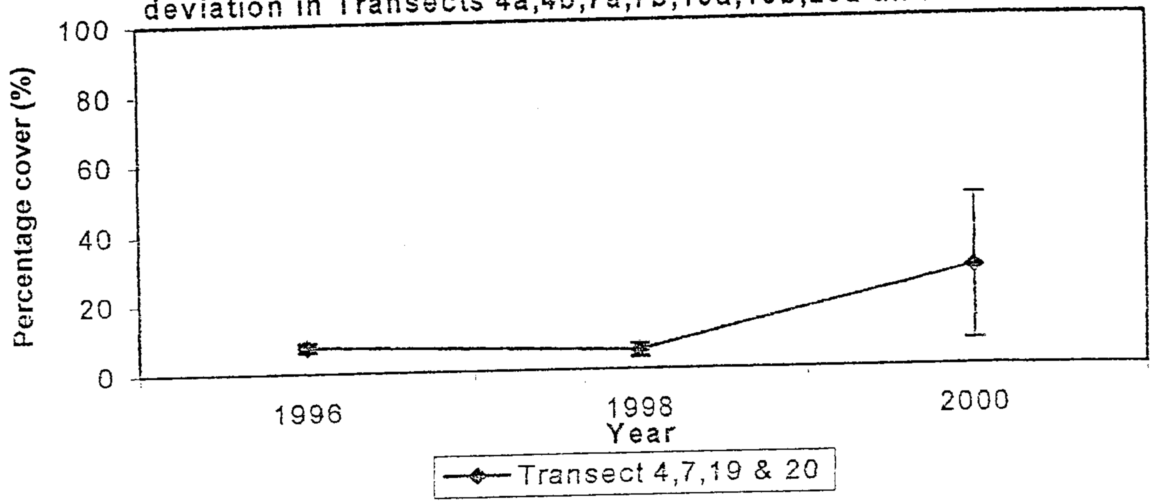
*Note. Percentage cover values are means(±SD) generated from Transects 6 1996, 1998 and 2000.

Figure 29. Algae transects in Inner Mangrove Lagoon, St.Thomas, US Virgin Islands: Change in years percent algae cover in Transects 11 & 12 among 1996,1998 and 2000. Vertical lines represent standard deviation in Transects 11a,11b,12a and 12b.



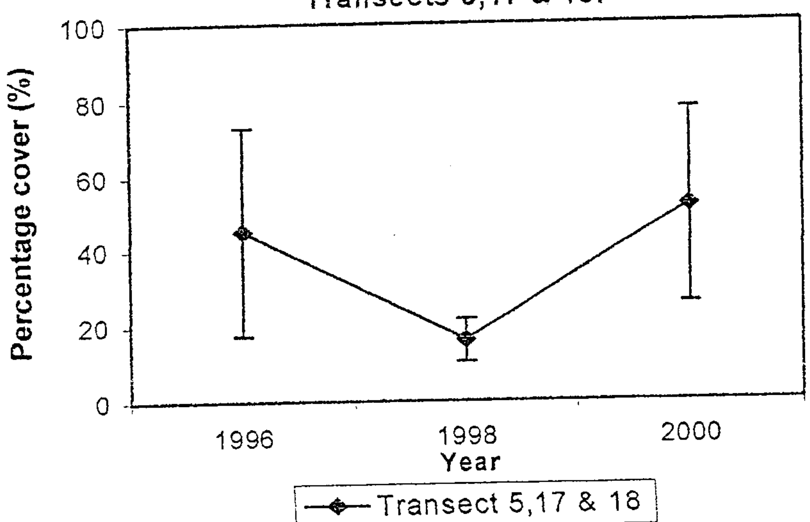
Note. Percentage cover values are means(±SD) generated from Transects 11 & 12 among 1996, 1998 and 2000.

Figure 30. Coral transects in Great Bay, St. Thomas, US Virgin Islands: Change in years percent coral cover in Transects 4,7,19 & 20, Vertical lines represent standard deviation in Transects 4a,4b,7a,7b,19a,19b,20a and 20b.



*Note. Percentage cover values are means(±SD) generated from Transects 4,7,19 & 20 among 1996, 1998 and 2000.

Figure 31. Coral transects in Jersey Bay,St.Thomas, US Virgin Islands: Transect 5 in Jersey Bay and Transects 17 & 18 at Cow & Calf Rocks. Change in years percent coral cover in Transects 5,17 & 18.



*Note. Percentage cover values are means(±SD) generated from Transects 5,17& 18 among 1996, 1998 and 2000. Vertical lines represent standard deviation in Transects 5a,5b,17a,17b,18a and 18b.

Figure 32. Bareass Bay, Great St.James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 1, 1996, 1998 and 2000.

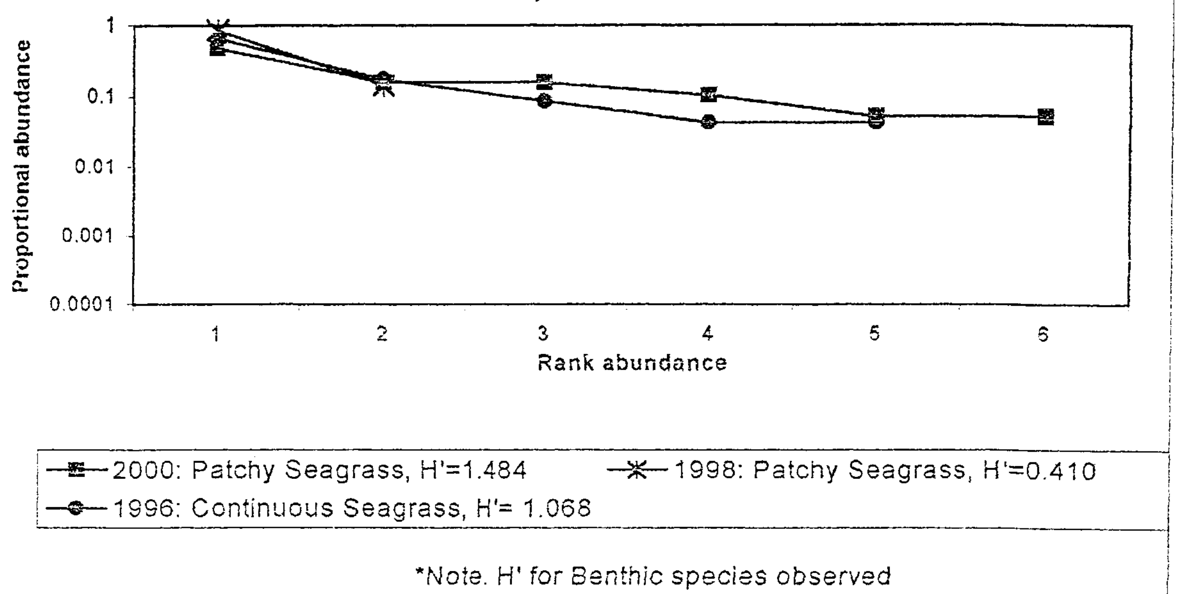


Figure 33. Great Bay, St. Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 2, 1996, 1998 and 2000

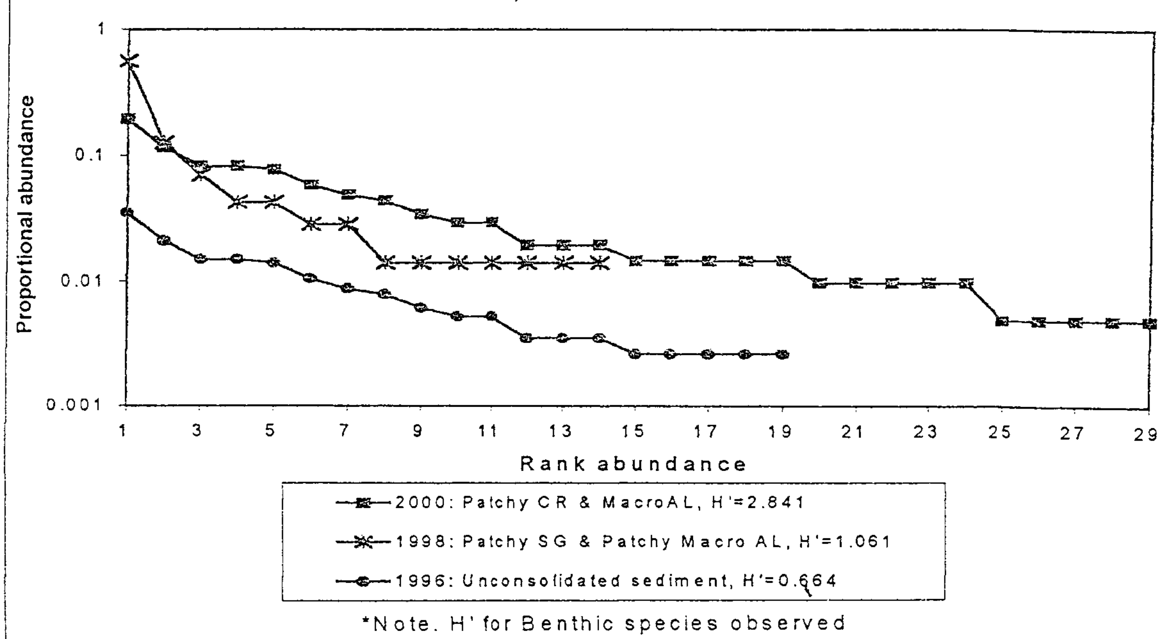
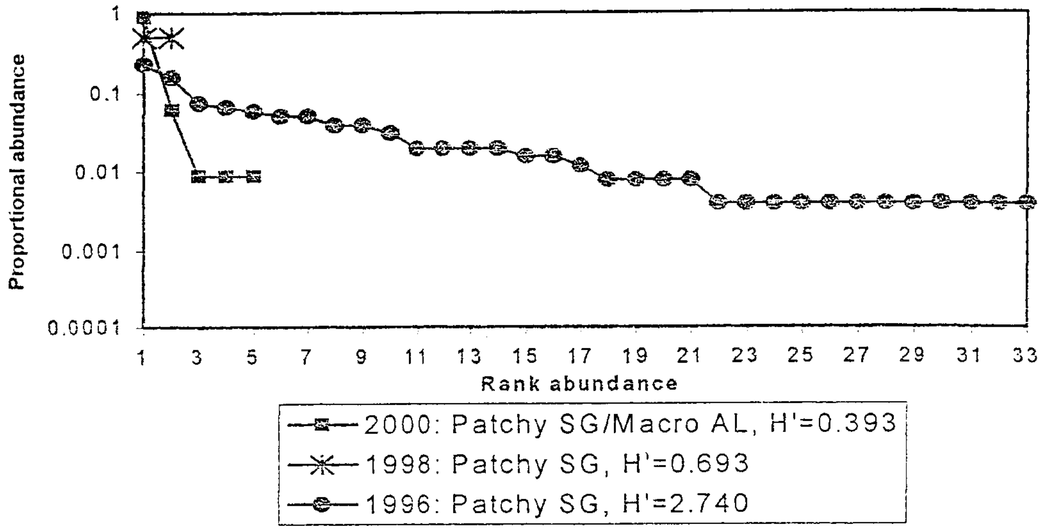
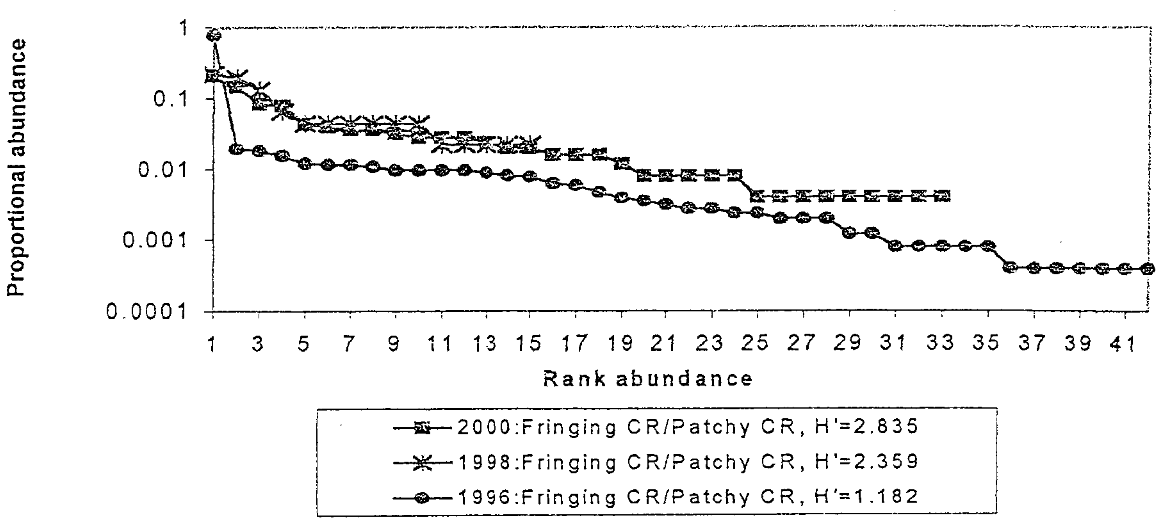


Figure 34. Great Bay, St.Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abunance for Transect 3, 1996, 1998 and 2000



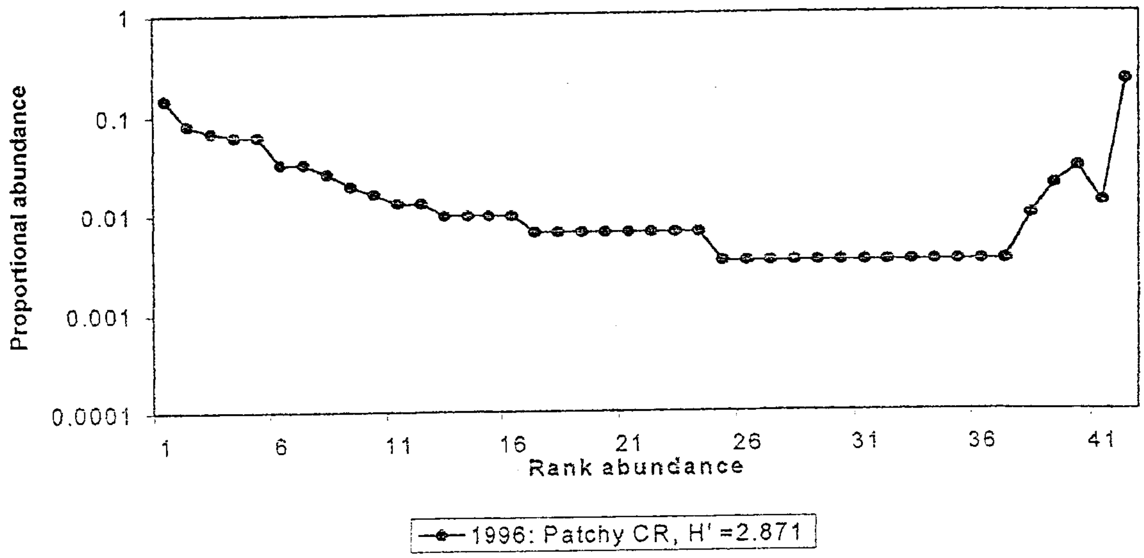
*Note. H' for Benthic species observed

Figure 35. Great Bay, St. Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 4, 1996, 1998 and 2000



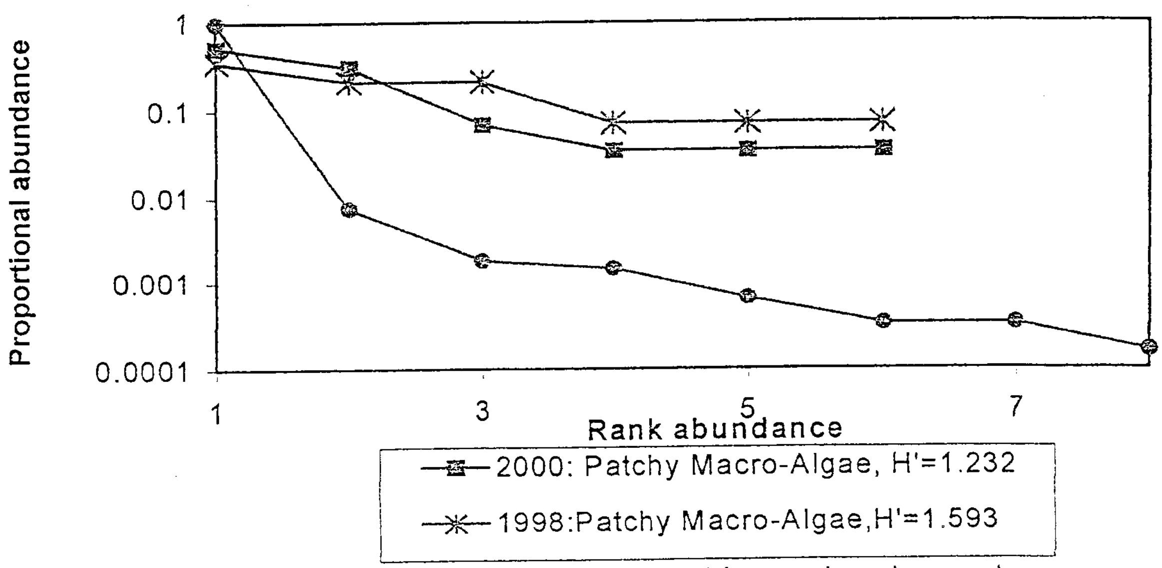
*Note. H' for Benthic species observed

Figure 36. Jersey Bay, St.Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 5 in 1996



*Note. Transect 5 was not resurveyed in 1998 & 2000 because it was lost due to storm damage.
H' for Benthic species observed

Figure 37. Great Bay, St. Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 6 in 1996, 1998 and 2000



*Note. H' for Benthic species observed

Figure 38. Great Bay, St.Thomas, US Virgin Islands :Fish species Rank-Abundance and Proportional Abundance for Transect 7 in 1996, 1998 and 2000

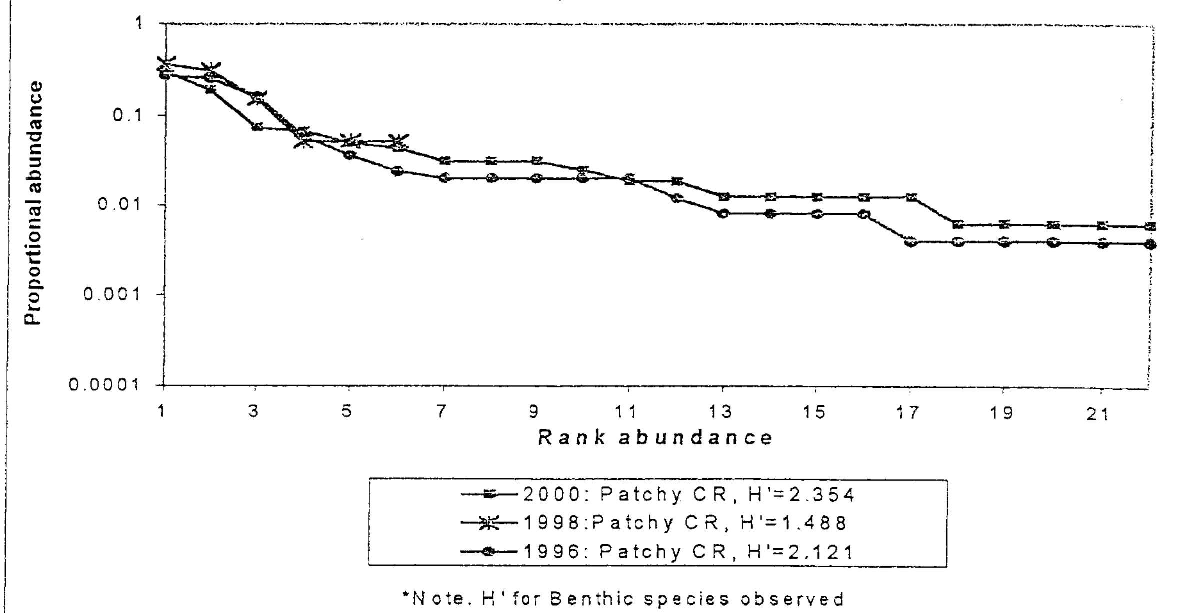


Figure 39. Christmas Cove, Great St.James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 8 in 1996, 1998 and 2000

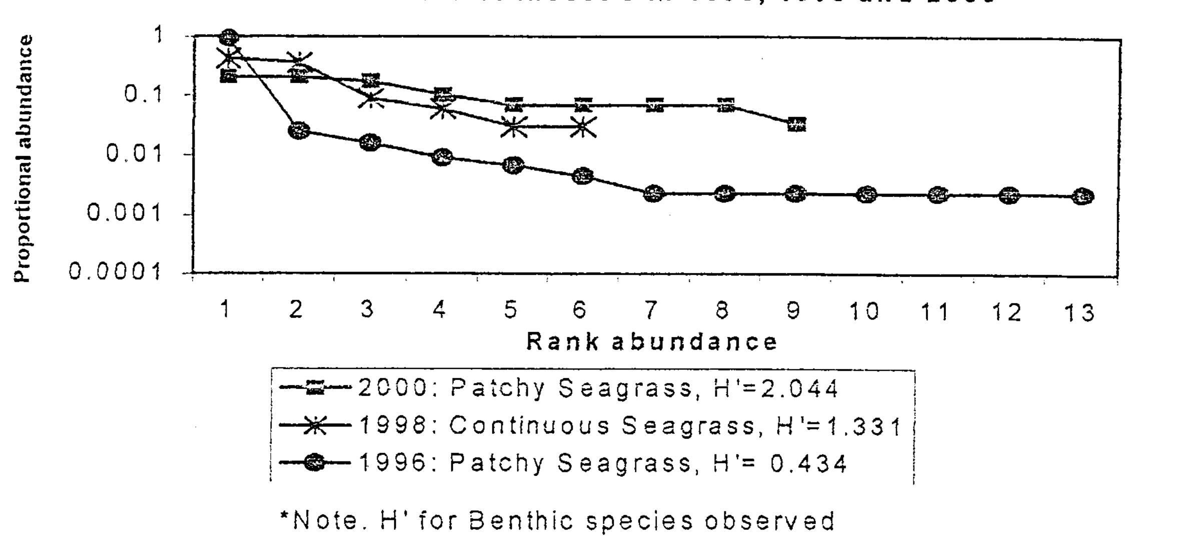


Figure 40. Christmas Cove, Great St.James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 9 in 1996, 1998 and 2000

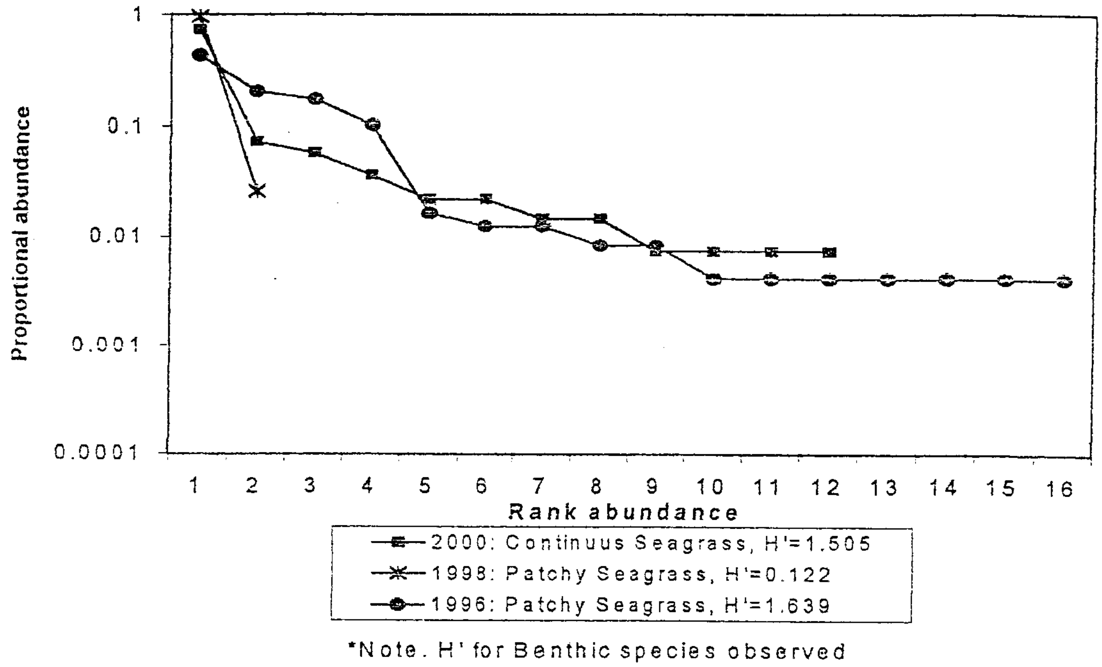


Figure 41. Christmas Cove, Great St. James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 10 in 1996, 1998 and 2000

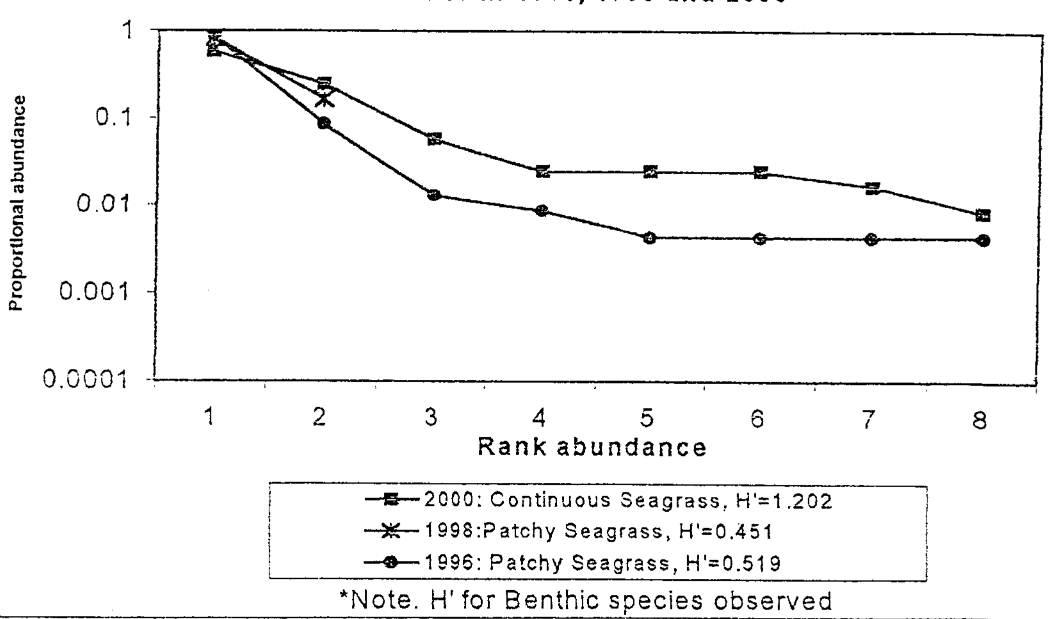
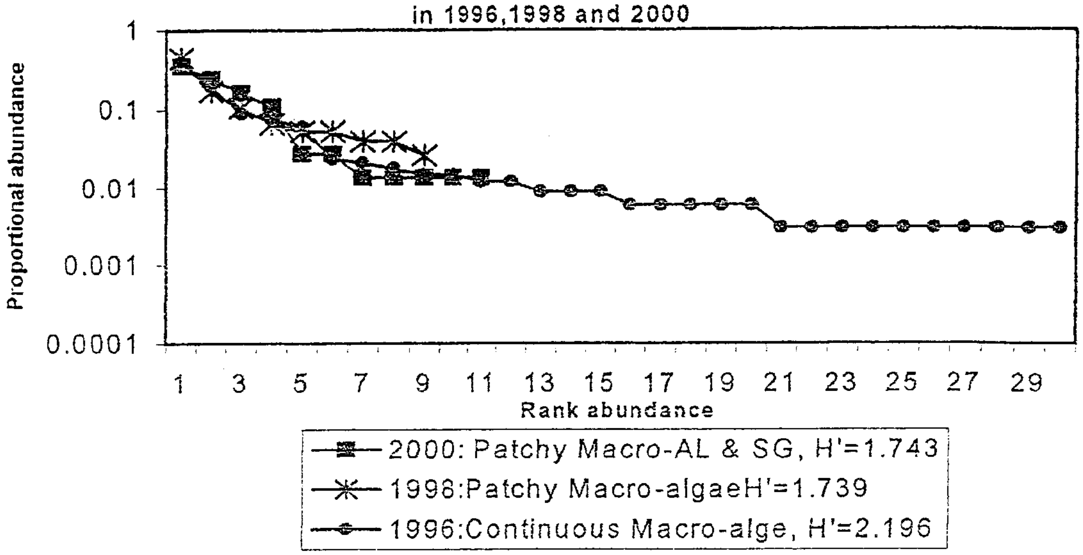
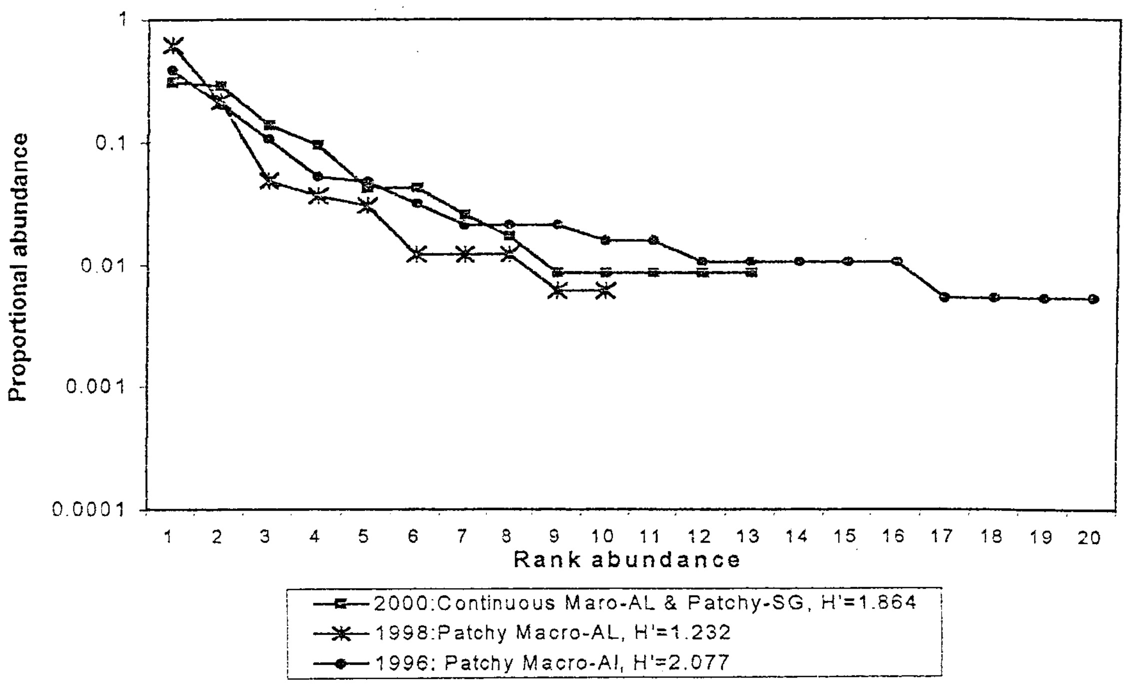


Figure 42. Inner Mangrove Lagoon, St.Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 11 in 1996,1998 and 2000



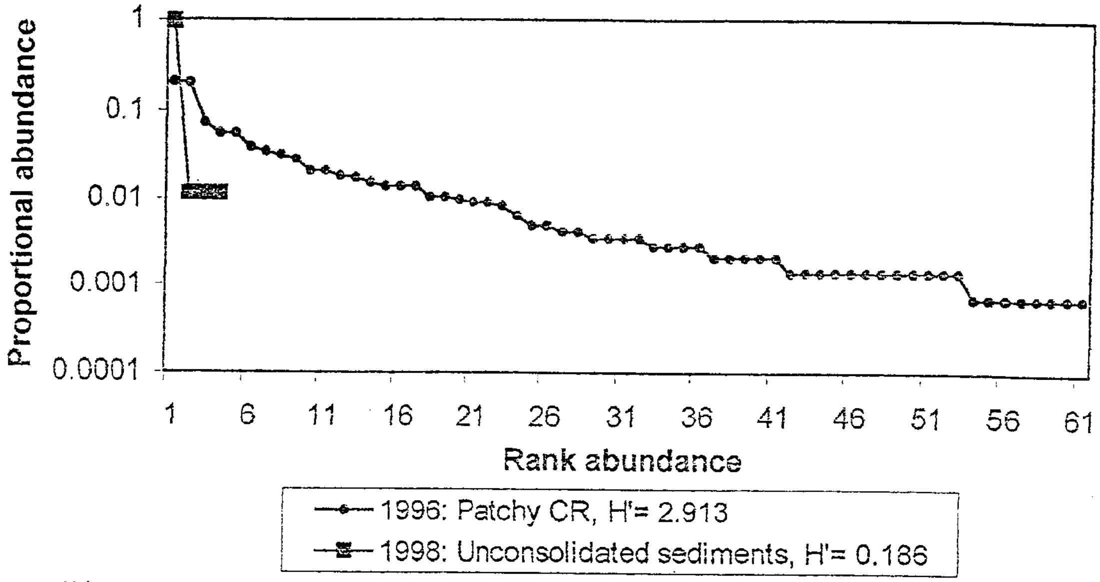
*Note. H' for Benthic species observed

Figure 43. Inner Mangroove Lagoon, St. Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 12 in 1996, 1998 and 2000



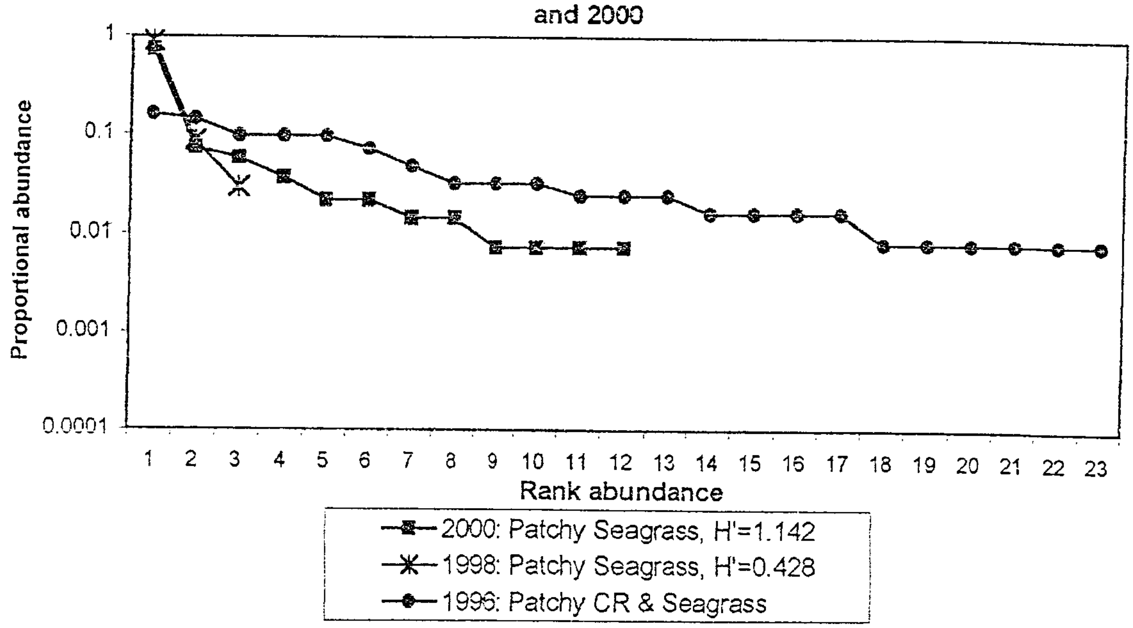
*Note. H' for Benthic species observed

Figure 44. Great Bay, St.Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 13 in 1996 and 1998.



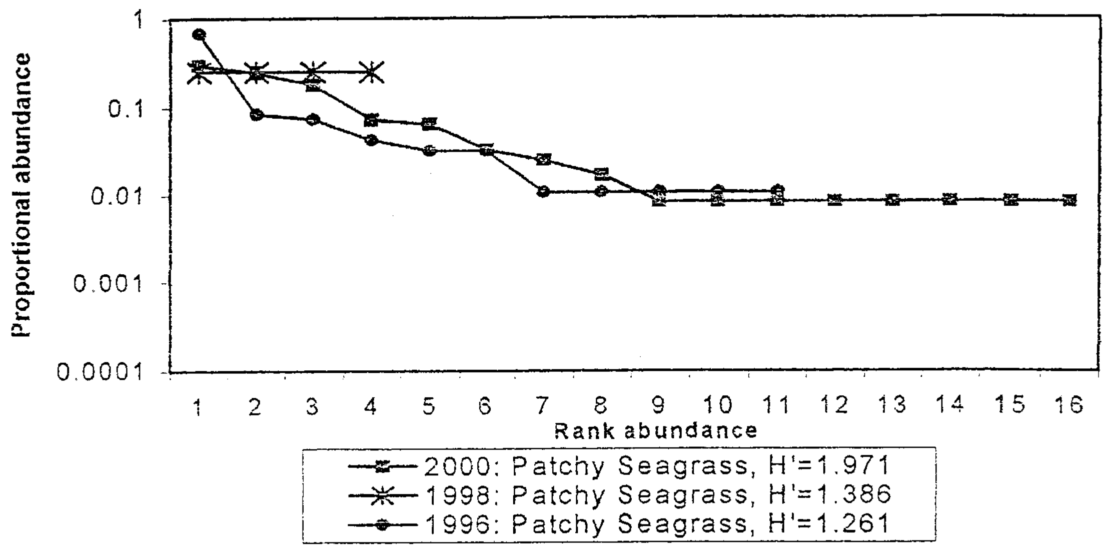
*Note. Transect 13 was not relocated in 2000 after storm damage 1998 & 1999.
H' for Benthic species observed

Figure 45. Christmas Cove, Great St. James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 14 in 1996,1998 and 2000



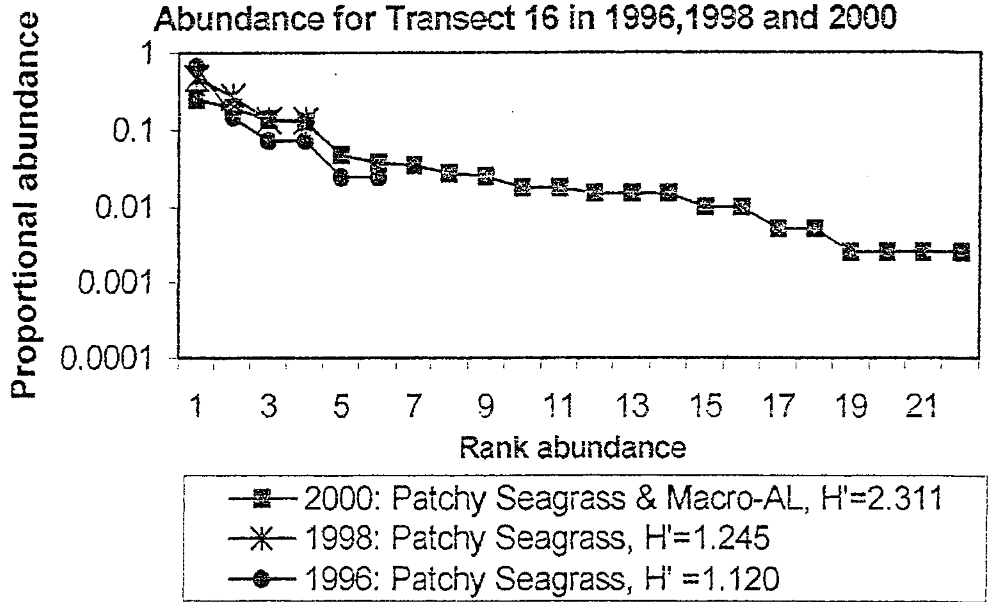
*Note. H' for Benthic species observed

Figure 46. Christmas Cove, Great St. James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 15 in 1996,1998 and 2000



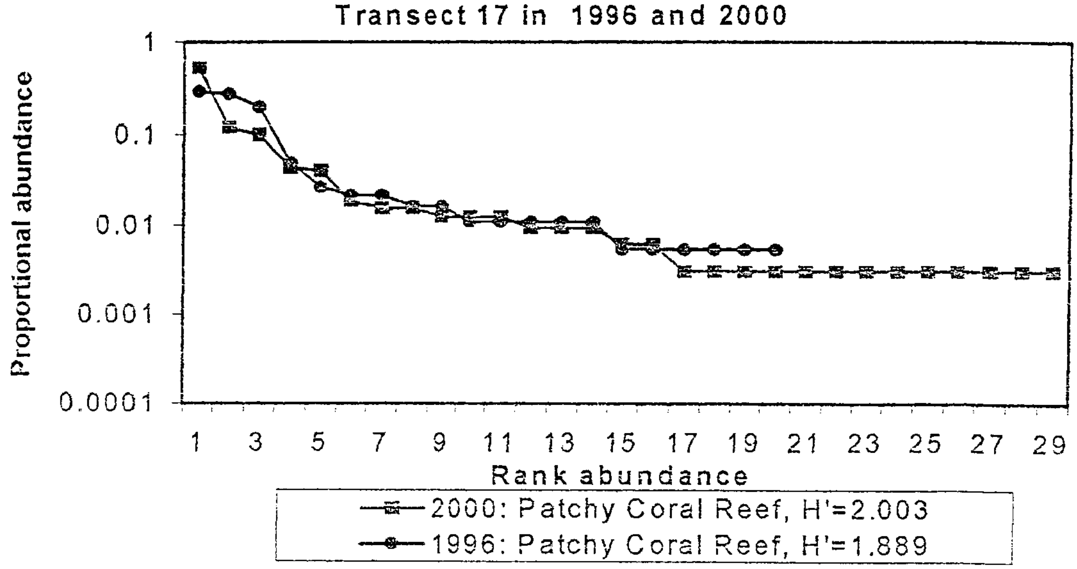
*Note. H' for Benthic species observed

Figure 47. Christmas Cove, Great St.James, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 16 in 1996,1998 and 2000



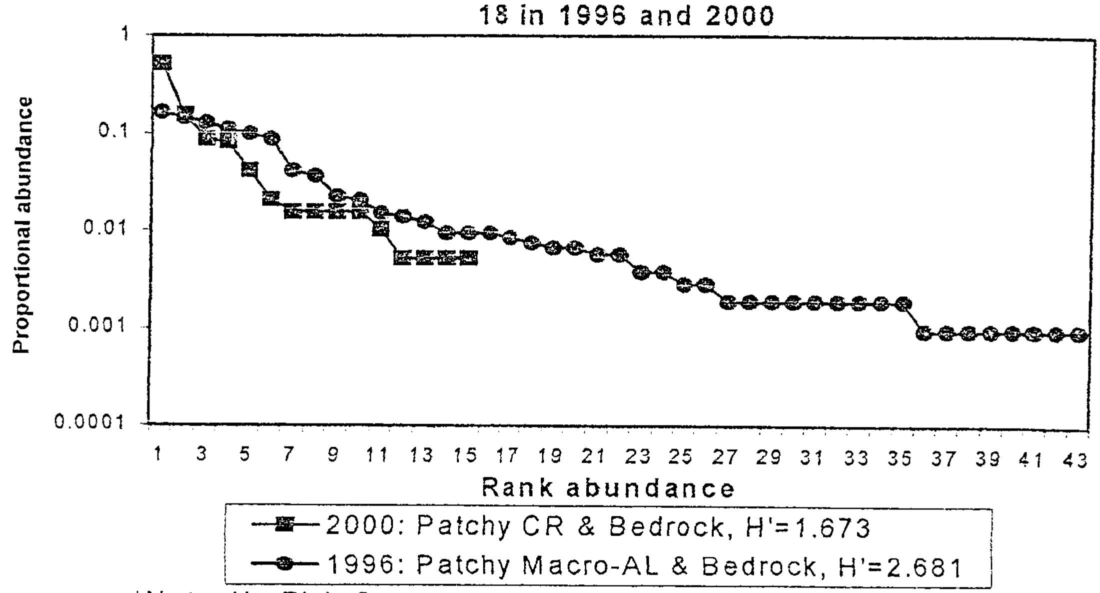
*Note. H' for Benthic species observed

Figure 48. Great Bay, St Thomas, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 17 in 1996 and 2000



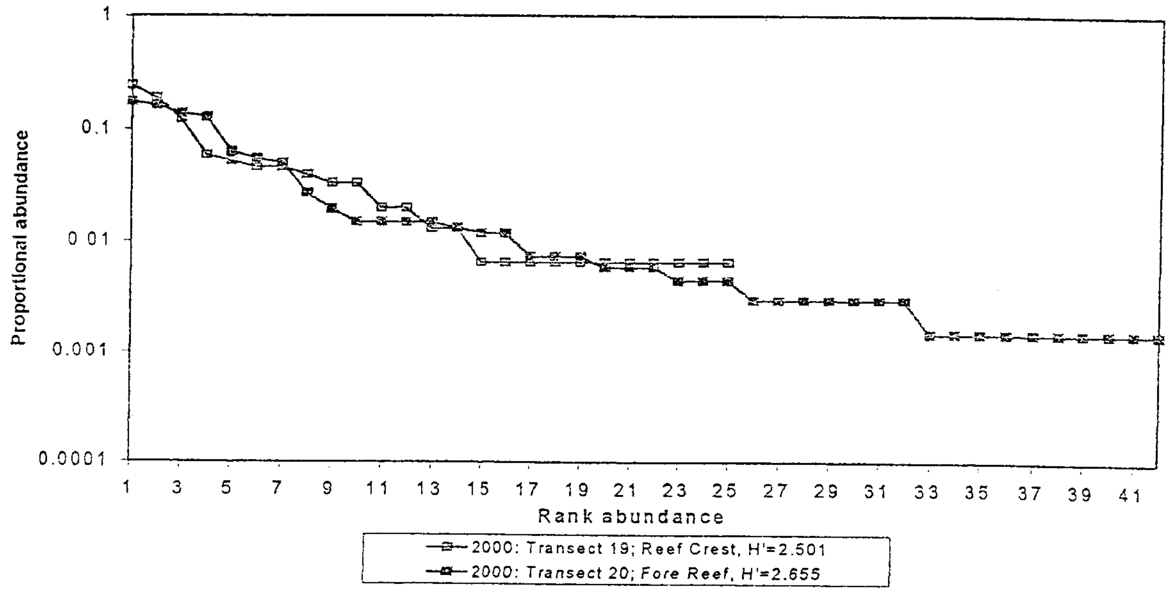
*Note. No Fish Censuses were performed on Transect 17 in 1998
H' for Benthic species observed

Figure 49. Cow & Calf Rocks, US Virgin Islands: Fish species Rank-Abundance and Proportional Abundance for Transect 18 in 1996 and 2000



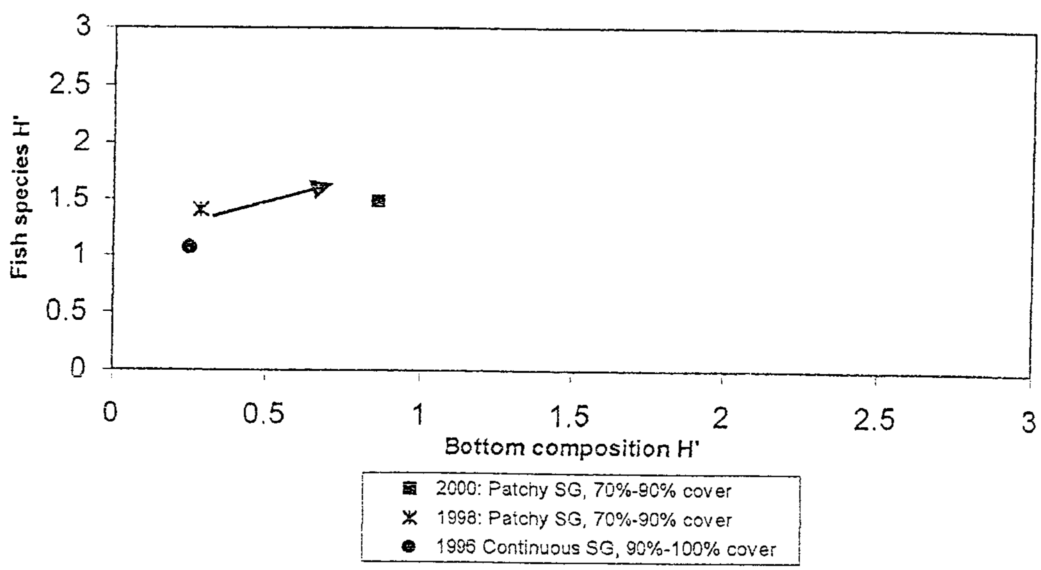
*Note. No Fish Censuses were performed on Transect 18 in 1998
H' for benthic species observed

Figure 50. Great Bay, St. Thomas, US Virgin Isalnds: Fish species Rank-Abundance and Proportional Abundance for Transects 19 and 20 in 2000



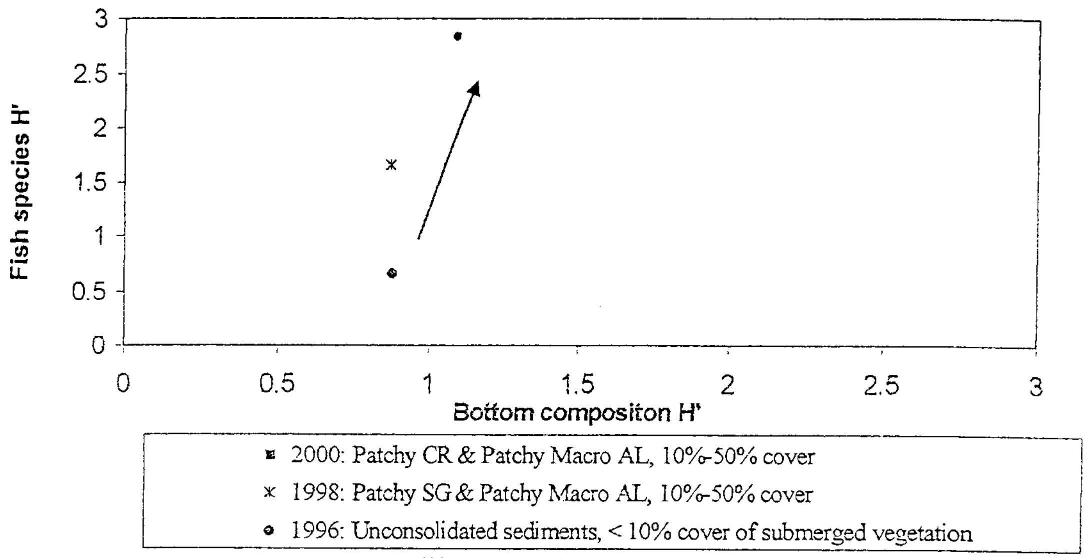
*Note. Transects 19 & 20 were established in 2000. H' for Benthic species

Figure 51. Bareass Bay, Great St. James, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 1 between 1996, 1998 and 2000



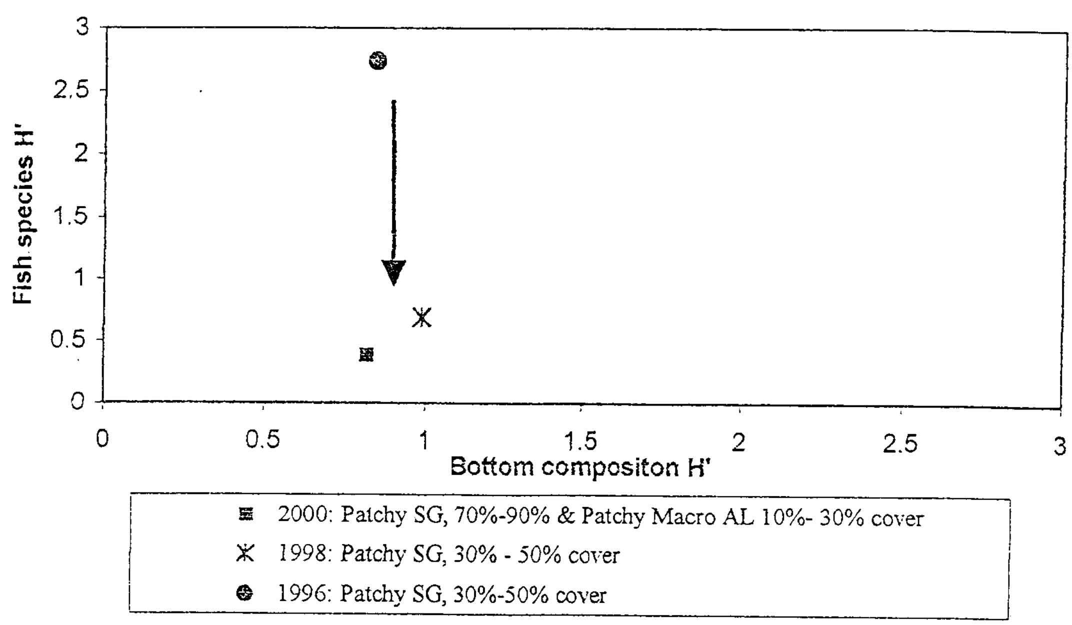
* Note. Arrow indicates change over time

Figure 52. Great Bay, St. Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 2 between 1996, 1998 and 2000



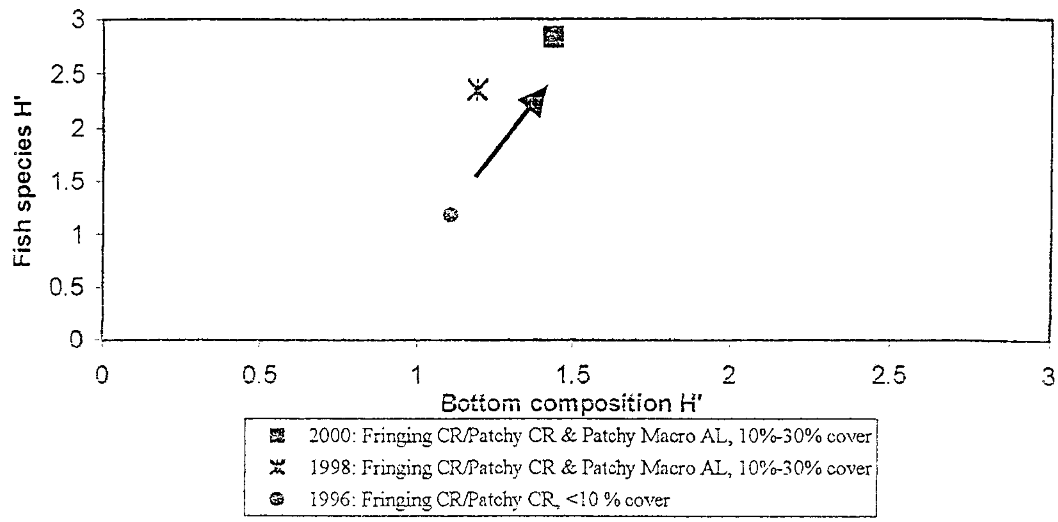
*Note. Arrow indicates change over time

Figure 53. Great Bay, St. Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 3 between 1996, 1998 and 2000



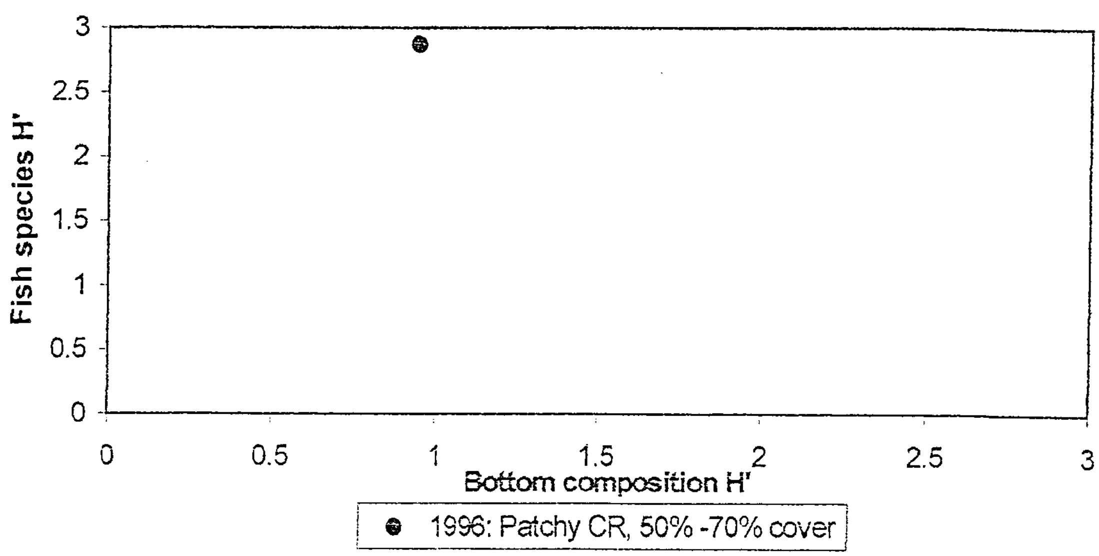
* Note. Arrow indicates change over time

Figure 54. Great Bay, St.Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species composition on Transect 4 between 1996, 1998 & 2000



*Note. Arrow indicates change over time

Figure 55. Jersey Bay, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 5 in 1996



*Note. Transect 5 was not resurveyed in 1998 & 2000 because it was lost due to storm damage

Figure 56. Great Bay, St. Thomas, US Virgin Isalnds: Comparison of H' for Bottom and Fish species on Transect 6 between 1996, 1998 and 2000

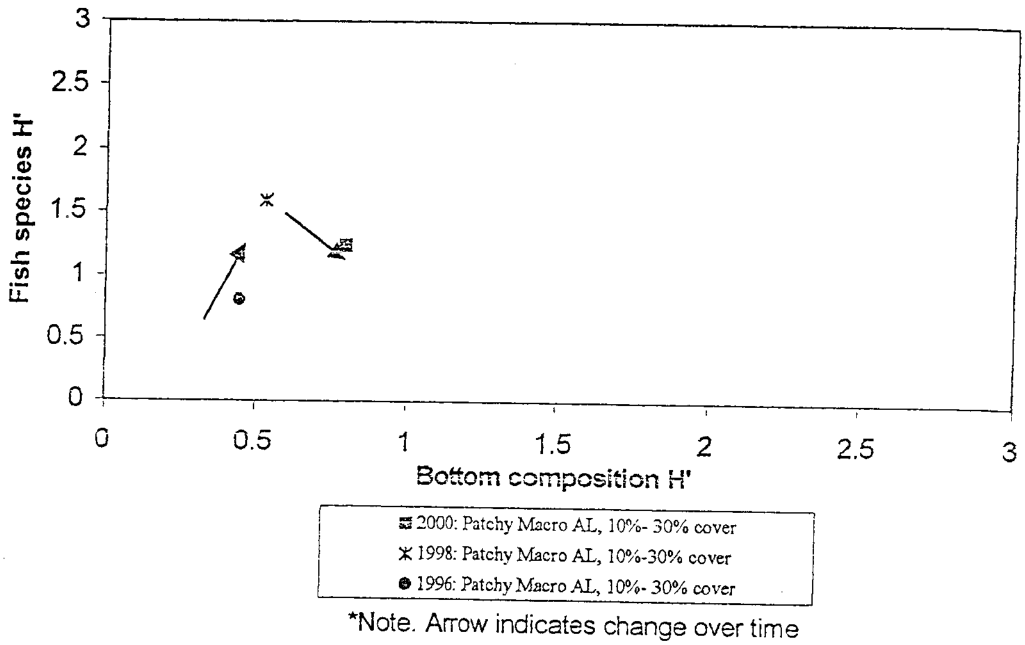


Figure 57. Great Bay, St. Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 7 between 1996, 1998 and 2000

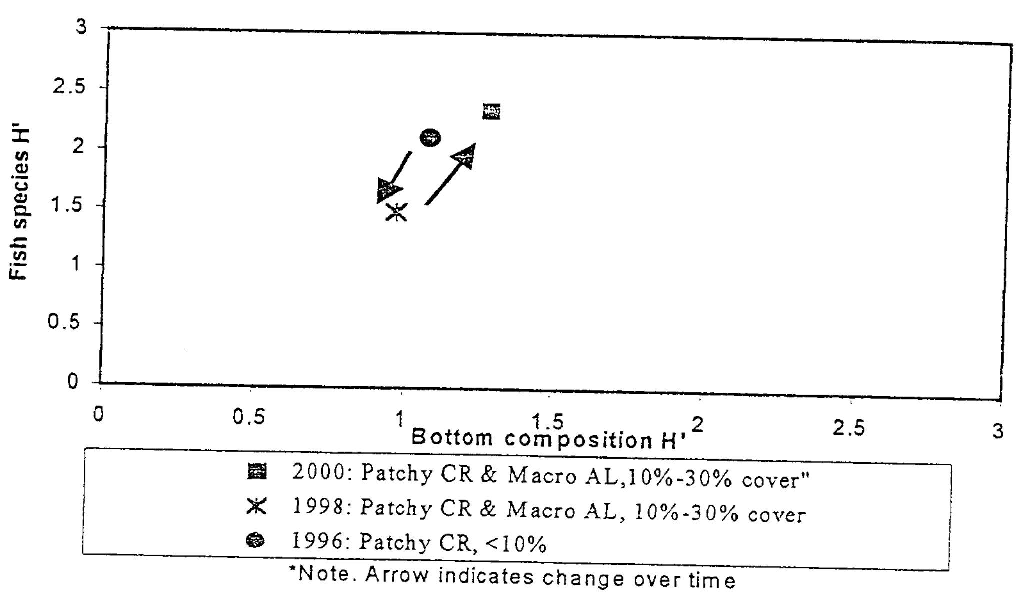
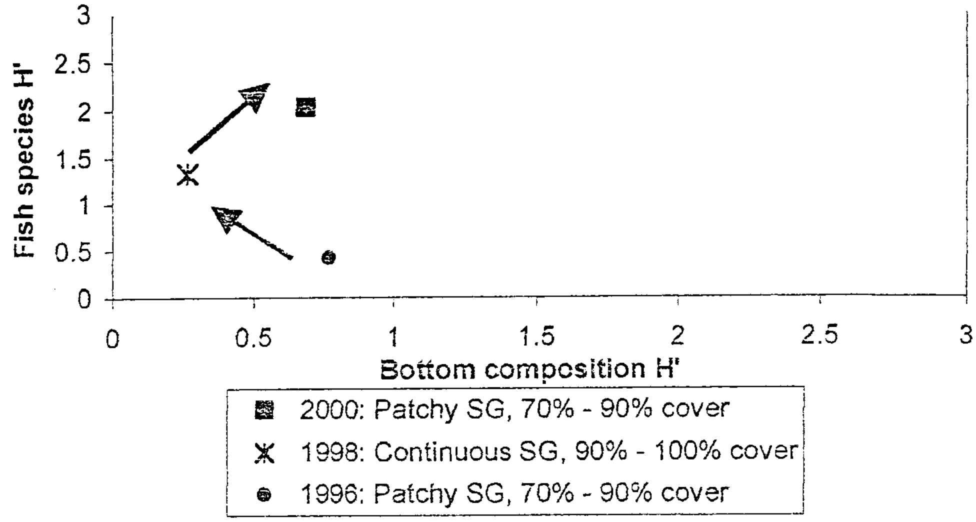
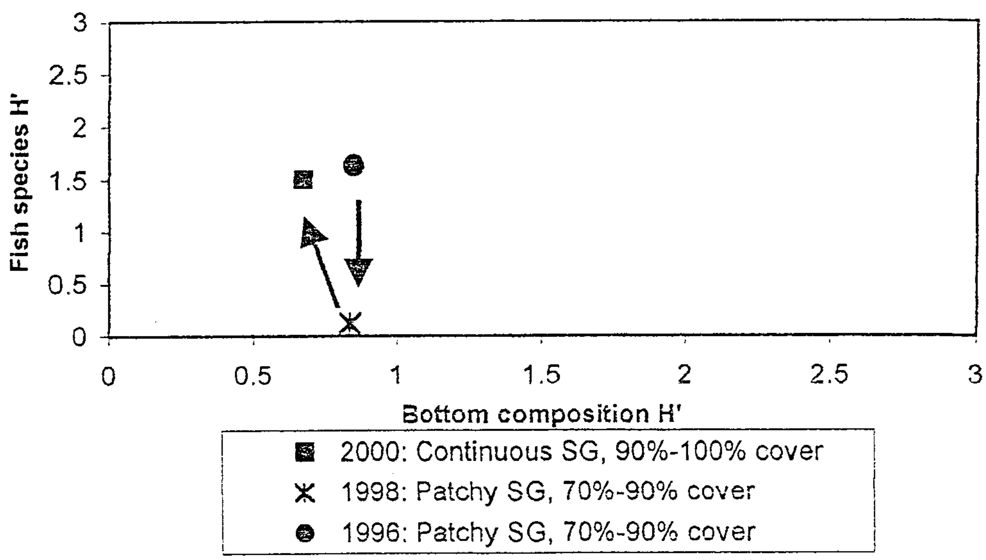


Figure 58. Christmas Cove, Great St. James, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 8 between 1996, 1998 and 2000



* Note. Arrow indicates change over

Figure 59. Christmas Cove, Great St.James, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 9 between 1996, 1998 and 2000



*Note. Arrow indicates change over time

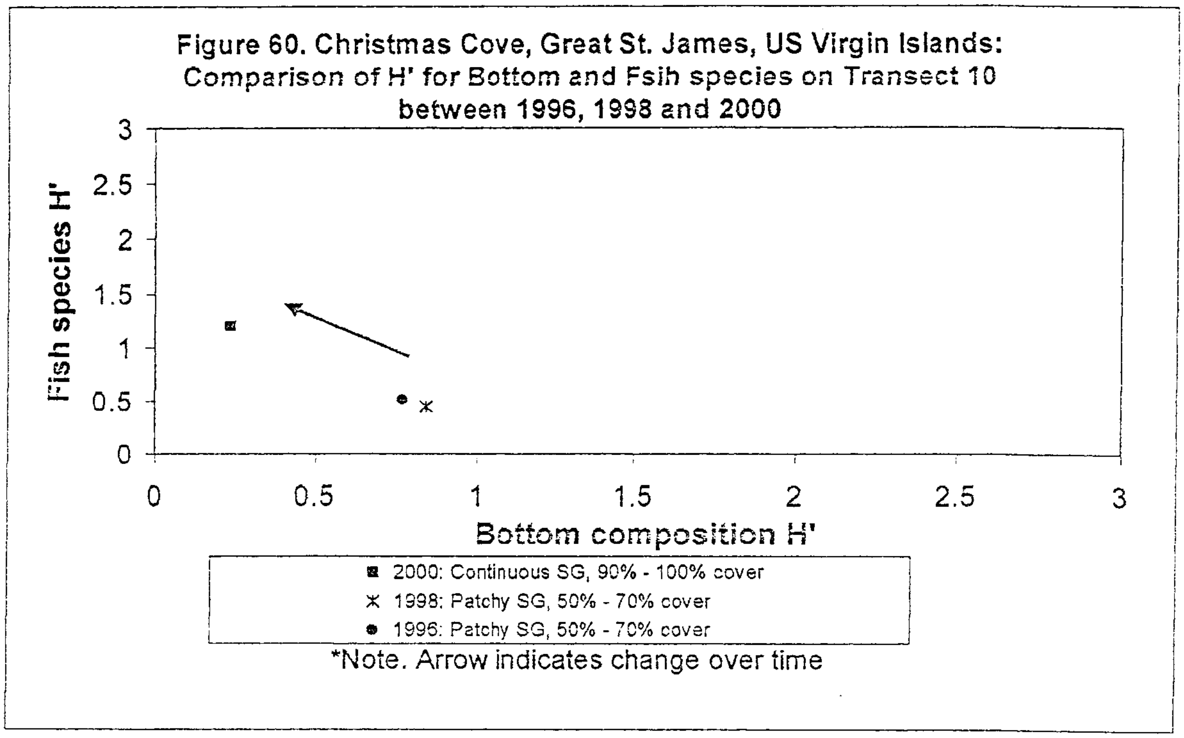


Figure 60. Christmas Cove, Great St. James, US Virgin Islands:
Comparison of H' for Bottom and Fsih species on Transect 10
between 1996, 1998 and 2000
Fish species H'
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
Bottom composition H'
2000: Continuous SG, 90% - 100% cover
1998: Patchy SG, 50% - 70% cover
1996: Patchy SG, 50% - 70% cover
*Note. Arrow indicates change over time

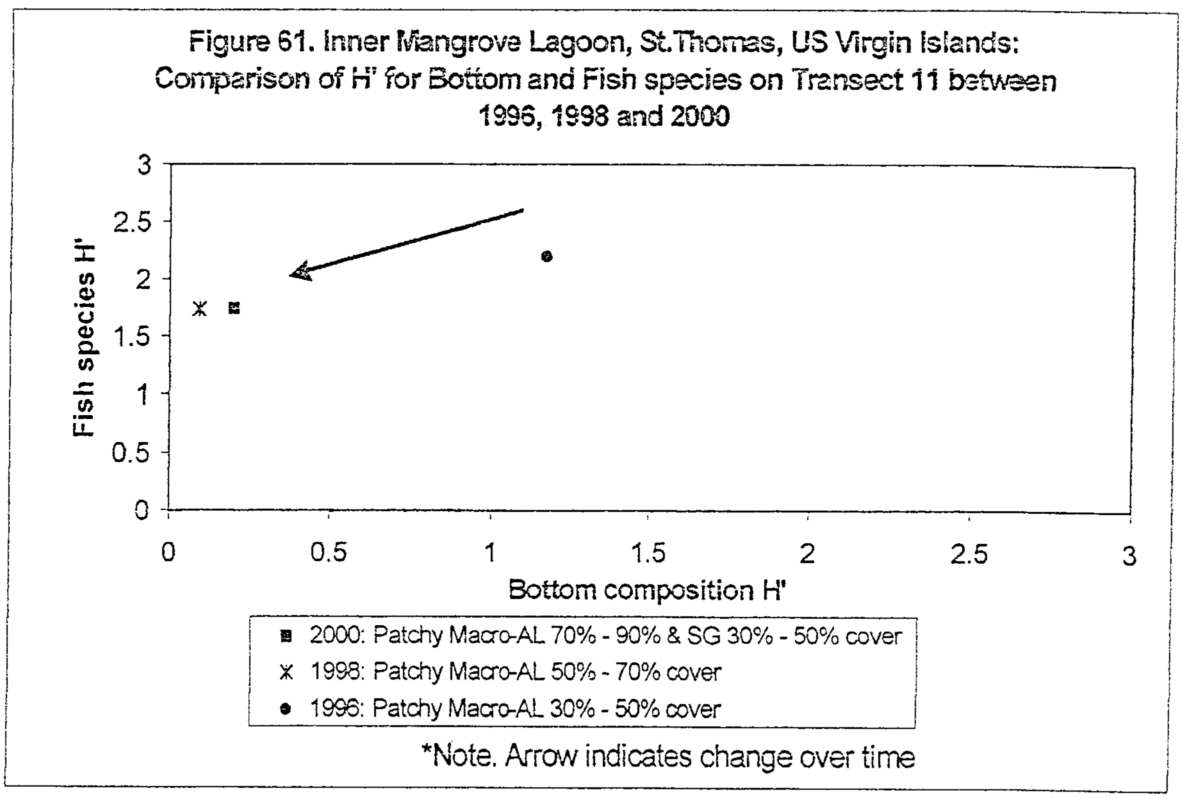
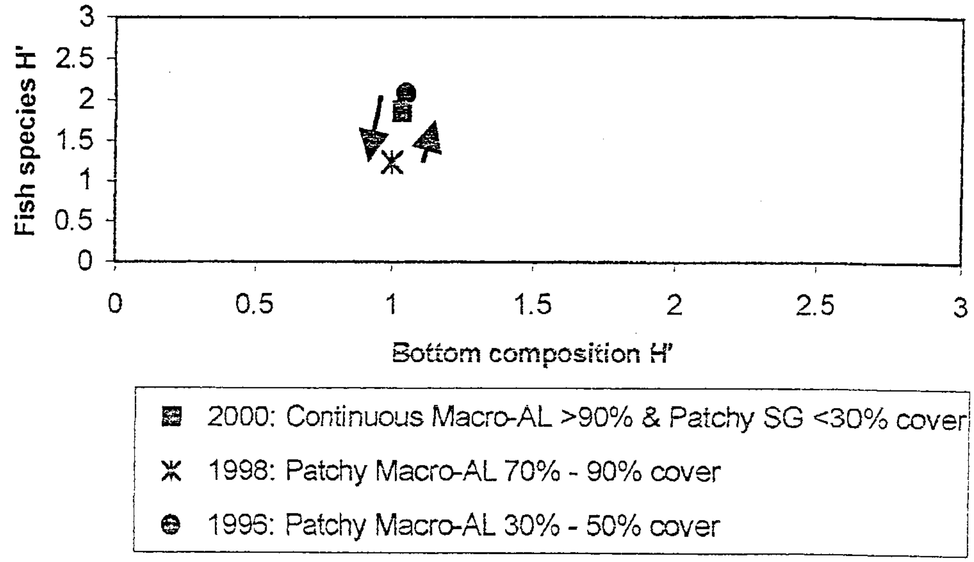


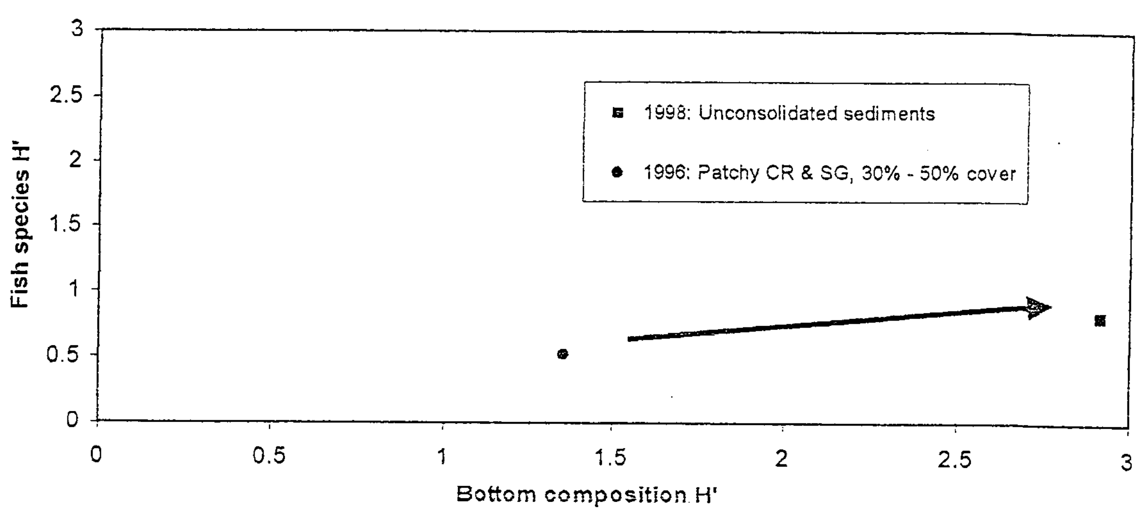
Figure 61. Inner Mangrove Lagoon, St.Thomas, US Virgin Islands:
Comparison of H' for Bottom and Fish species on Transect 11 between
1996, 1998 and 2000
Fish species H'
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
Bottom composition H'
2000: Patchy Macro-AL 70% - 90% & SG 30% - 50% cover
1998: Patchy Macro-AL 50% - 70% cover
1996: Patchy Macro-AL 30% - 50% cover
*Note. Arrow indicates change over time

Figure 62. Inner Mangrove Lagoon, St.Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 12 between 1996, 1998 and 2000



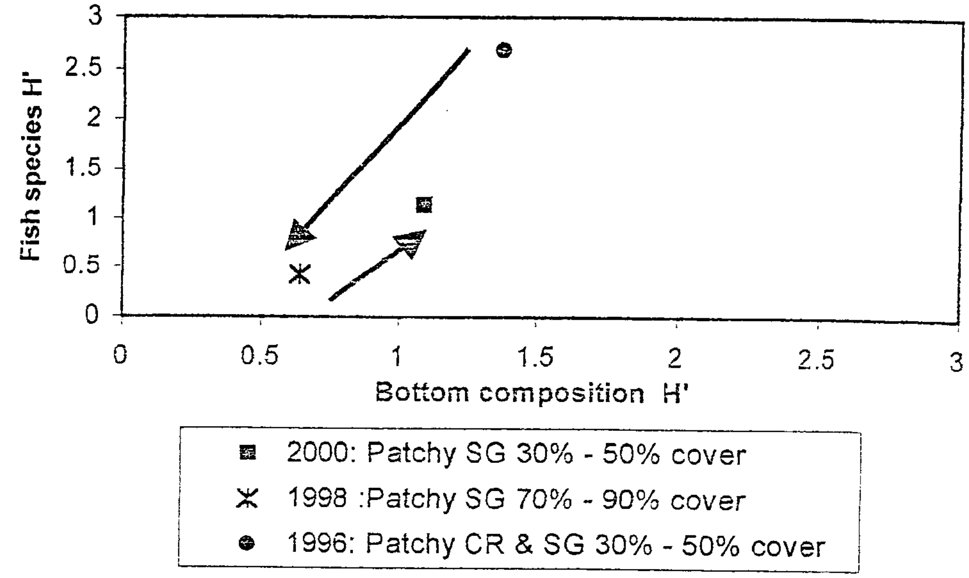
*Note. Arrow indicates change over time

Figure 63. Great Bay, St. Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 13 between 1996 and 1998.



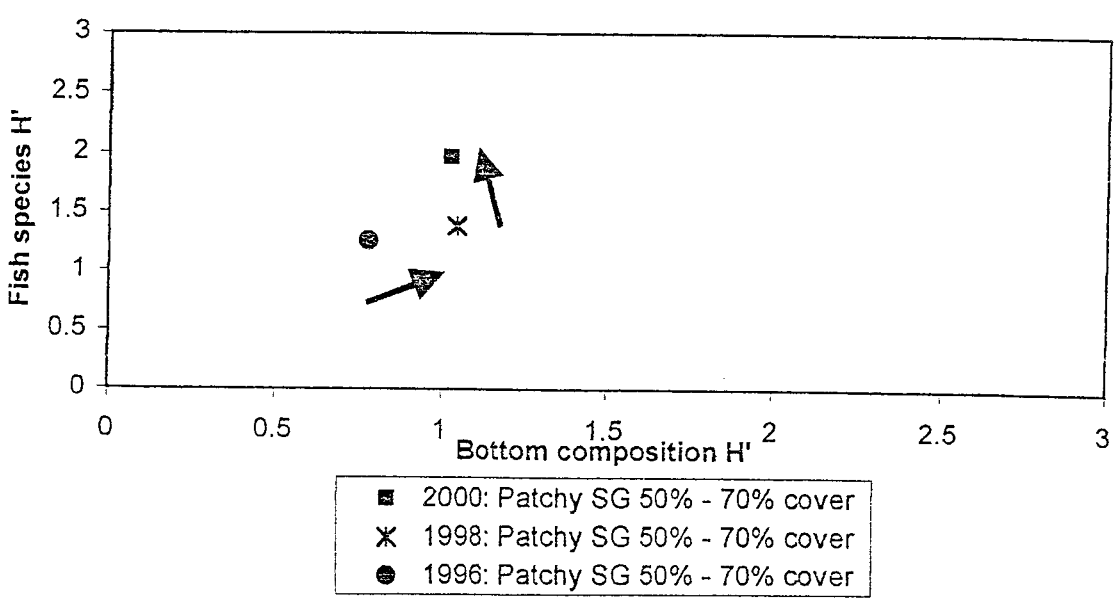
*Note. Arrow indicates change over time.
Transect 13 was not resurveyed in 2000 because it was not relocated after storm damage 1998 & 1999.

Figure 64. Christmas Cove, Great St.James, US Virgin Islands: Comparisonof H' for Bottom and Fish species on Transect 14 between 1996, 1998 and 2000



*Note. Arrow indicates change over time

Figure 65. Christmas Cove, Great St.James, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 15 between 1996, 1998 and 2000



*Note. Arrow indicates change over time

Figure 66. Christmas Cove, Great St. James, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 16 between 1996, 1998 and 2000

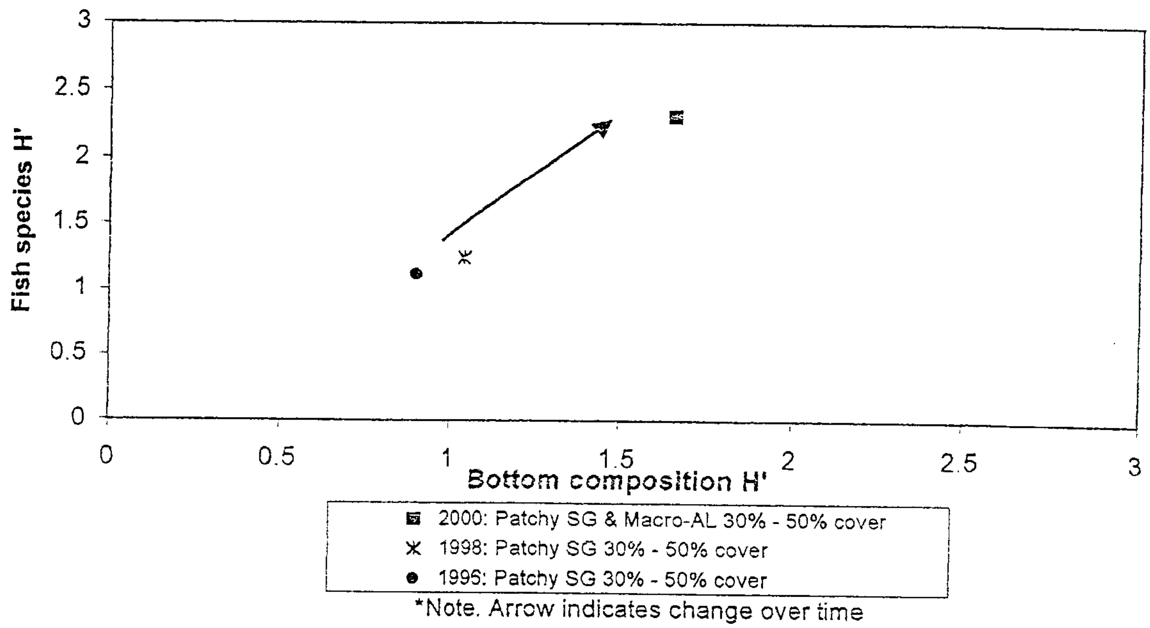


Figure 67. Cow & Calf Rocks, US Virgin Islands:Comparison of H' for Bottom and Fish species on Transect 17 between 1996, 1998 and 2000

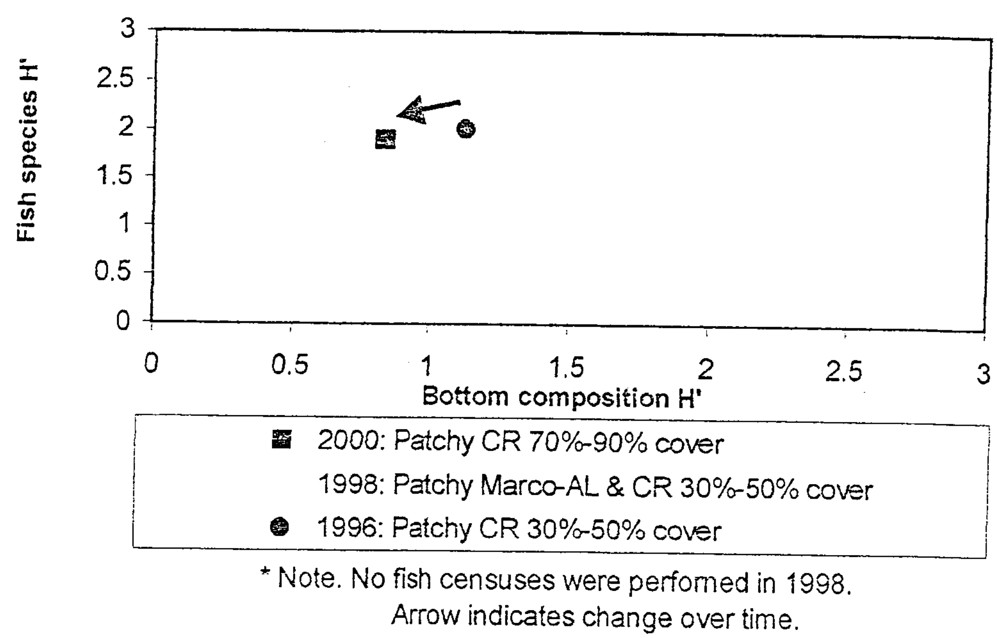
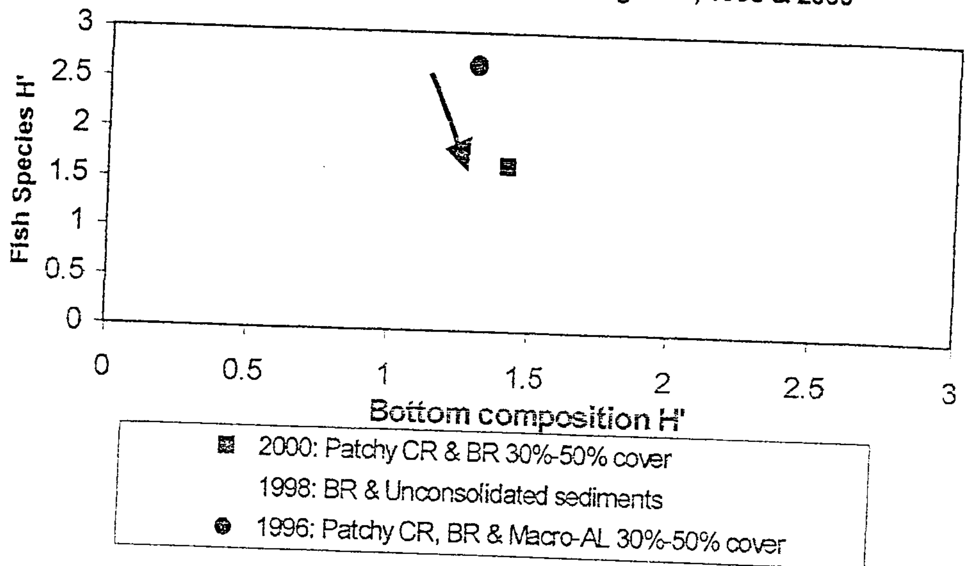
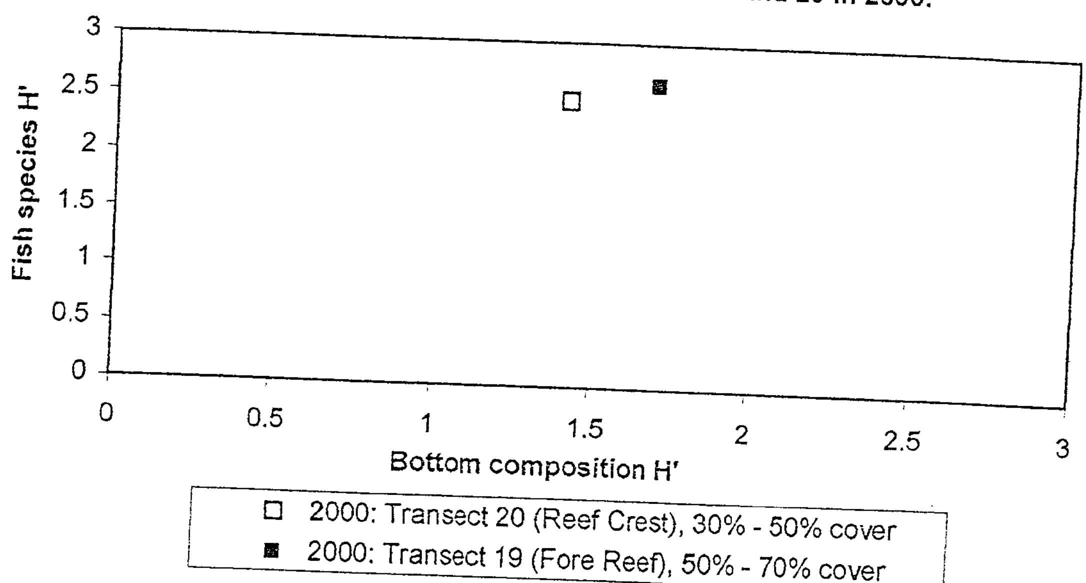


Figure 68. Cow & Calf Rocks, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 18 among 1996, 1998 & 2000



* Note. No fish censuses were perfomed in 1998
Arrow indicates change over time

Figure 69. Great Bay, St. Thomas, US Virgin Islands: Comparison of H' for Bottom and Fish species on Transect 19 and 20 in 2000.



*Note. Transect 19 and 20 were established in 2000.

Table 1. Benthic Species Percentage Cover By Transect Site, For Each Sampling Period (1996, 1998 and 2000).

Transect	Species	1996	1998	2000
1	*Syringodium filiforme*	57	60	32.5
	Thalassia testudinum	37.5	35	25
	Halodule wrightii			14
2	*Syringodium filiforme*		24.5	
	Schizothrix calcicola		6	
	Caulerpa racemosa		1.5	
	Penicillus capitatus		1	
	Dictyota cervicornis			13.5
	Halimeda monile	3		8.5
	Udotea flabellum	2		
	Halimeda tuna			1
	Lobophora variegata			1
	Padina sanctae-crucis			1
	Millepora complanata			1
	Millepora alcicornis			1
	Montastrea annularis	1		1.5
	Montastrea cavernosa	1		
	Siderastrea siderea			1
	Porites astreoides	1		2
	Diploria strigosa			1
	Favia fragum			2
3	*Syringodium filiforme*	35	36	71
	Thalassia testudinum			5
	Laurencia intricata			3.5
	Caulerpa lanuginosa			4
	Halimeda monile			6.5
	Penicillus capitatus			4
4	*Montastrea annularis*	7	4.5	14
	Agarcia agaricites	1	1	
	Porites branneri			
	Siderastrea siderea			
	Diploria labyrinthiformis			
	Chlorophyta	5	3	5.5
	Phaeophyta		20	18
	Rhodophyta		1	
5*1	*Montastrea annularis*	12.5		
	Montastrea cavernosa	13		

Table 1 (continued). Benthic Species Percentage Cover By Transect Site, For Each Sampling Period (1996, 1998 and 2000).

Transect	Species	1996	1998	2000
5[*1]	*Diploria labyrinthiformis*	13		
	Millepora complanata	15		
	Agarcia agaricites	16		
	Syringodium filiforme	5		
	Halimeda incrassata	5		
	Dictyota cervicornis	4.5		
6	Chlorophyta	5.5	4.5	15
	Phaeophyta	2		6
	Rhodophyta	2	4.5	
	Cyanophyta	2	8	1.5
7	*Porites divaricata*	1		
	Porites astreoides		1	1
	Montastrea annularis	4.5	5	1
	Montastrea cavernosa			1
	Siderastrea siderea	1		1
	Millepora complanata	1		
	Millepora alcicornis			1.5
	Favia fragum		1	1
	Diploria labyrinthiformis			1
8	*Syringodium filiforme*	25	52.5	40
	Thalassia testudinum	43.5	47.5	55
	Penicillus capitatus			5
9	*Syringodium filiforme*	38.5	51.5	29
	Thalassia testudinum	14	12.5	59
10	*Syringodium filiforme*	48.5	50	59.5
	Thalassia testudinum	7	13	33.5
11	*Syringodium filiforme*			19
	Thalassia testudinum		1	15
	Halimeda monile		32	15
	Penicillus capitatus	6.5	8.5	25.5
	Caulerpa mexicana		12.5	
	Dictyota cervicornis	3	9	16
	Halimeda incrassata	8.5	5.5	
	Halimeda tuna	9.5	5.5	
	Penicillus pyriformis			40

Table 1 (continued). Benthic Species Percentage Cover By Transect Site, For Each Sampling Period (1996, 1998 and 2000)

Transect	Species	1996	1998	2000
12	*Halodule wrightii*			12
	Halimeda monile	1		10
	Penicillus capitatus	2	1	16
	Caulerpa mexicana		2	
	Dictyota cervicornis		13	10
	Laurencia intricata	47	9	
	Halimeda incrassata		5	10
	Halimeda tuna			18
	Penicillus pyriformis	1	2.5	10
	Hypnea cervicornis		12	
	Halophila decipiens			14
13[*2]	*Agarcia agaricites*	16.5		
	Halimeda incrassata	3.5		
	Halimeda monile	3	3	
	Millepora complanata	5		
	Montastrea annularis	2		
	Penicillus capitatus	2		
	Porites porites	9.5		
	Siderastrea siderea	7		
	Syringodium filiforme	16.5	9	
	Udotea flabellum	5	2	
14	*Syringodium filiforme*	8	68	25.5
	Thalassia testudinum	6.5	10	25.5
	Halimeda monile			6
	Montastrea annularis	12		
15	*Syringodium filiforme*	50.5	63.5	21
	Thalassia testudinum	4	9.5	9.5
	Halimeda monile			15
	Halodule wrightii			17
	Laurencia intricata			17
16	*Syringodium filiforme*	44.5	27.5	18.5
	Thalassia testudinum	3	3.5	
	Halimeda incrassata	1	4	
	Halimeda monile	1		7
	Penicillus capitatus	3		3.5
	Laurencia intricata		1	1
	Porites porites			2

Table 1 (continued). Benthic Species Percentage Cover By Transect Site, For Each Sampling Period (1996, 1998 and 2000)				
Transect	Species	1996	1998	2000
16	*Porites astreoides*			1
	Agaricia agaricites			1
	Montastrea annularis		1	7
	Dendrogyra cylindrus			1
	Millepora complanata			1
	Diploria labyrinthiformis			2
	Amphimedon compressa			6
	Aplysina fulva			2
17	*Siderastrea siderea*			3.5
	Dichocoenia stokesii	2	3	6
	Millepora complanata	6	3	31.5
	Millepora alcicornis		4	
	Montastrea annularis	4		16
	Diploria labyrinthiformis	1	3	3.5
	Porites porites		1	2.5
	Porites astreoides	7		2.5
18	*Montastrea annularis*		1	11
	Porites porites		1	
	Diploria labyrinthiformis		0.5	11
	Porites astreoides			9
	Millepora alcicornis			14
	Dictyota cervicornis		9	
	Udotea flabellum		24	
19*3	*Agarcia agaricites*			5
	Cliona delitrix			0
	Dichocoenia stokesii			5
	Diploria labyrinthiformis			1
	Diploria strigosa			5
	Favia fragum			14
	Meandrina meandrites			0
	Millepora alcicornis			0
	Montastrea annularis			0
	Montastrea cavernosa			14
	Porites astreoides			5
	Siderastrea radians			5
	Siderastrea siderea			0

Table 1 (continued). Benthic Species Percentage Cover By Transect Site, For Each Sampling Period (1996, 1998 and 2000)				
Transect	**Transect**	**Transect**	**Transect**	**Transect**
20*3	*Agarcia agaricites*			6
	Dendrogyra cylindrus			1
	Diploria labyrinthiformis			1.5
	Diploria strigosa			2
	Eusmilia fastigiata			1
	Millepora alcicornis			4
	Millepora complanata			1
	Montastrea annularis			8.5
	Montastrea cavernosa			7.5
	Porites astreoides			10.5
	Porites divaricata			3.5
	Porites porites			5
	Siderastrea radians			1.5
	Siderastrea siderea			2

***Notes:**

1. Transect 5 was not resurveyed in 1998 and 2000 because it was not relocated after storm damage.
2. Transect 13 was not resurveyed in 2000 because it was not relocated after storm damage 1998 & 1999.
3. Transect 19 and 20 were established in 2000.

Table 2. Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

	TRANSECT NUMBER																													
Fish Species	**T1**			**T2**			**T3**			**T4**			**T5**			**T6**			**T7**			**T8**			**T9**			**T10**		
	96 (4)	98 (2)	00 (4)	96 (2)	98 (3)	00 (4)	96 (5)	98 (1)	00 (6)	96 (4)	98 (1)	00 (4)	96 (5)	98 (0)	00 (0)	96 (4)	98 (1)	00 (2)	96 (2)	98 (1)	00 (4)	96 (5)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (2)	98 (1)	00 (4)
Abu saxa				X						X																				
Aca bahi	X		X	X		X		X		X	X	X	X							X	X	X			X			X		
Aca chir				X	X	X				X	X	X	X								X	X	X		X			X		
Aca coer				X		X				X	X	X	X						X		X	X						X		
Aca spp.							X						X						X			X								
Acanthe spin																						X								
Acanthe spp																X														
Aet nari																								X						
Alu scho										X			X												X					
Apo spp.										X																				
Ast stel																												X		
Ath spp					X																							X		
Ath stip				X		X				X						X														
Aul macu																									X			X		
Bal vetu				X			X												X			X								
Ble spp																	X													
Bod rufu											X																			
Bot luna										X															X			X		
Bot ocel																														
Cal bajo																									X			X		
Cal cala					X	X					X						X	X				X								
Cal penn																														
Can macr										X																				
Can pull						X																								
Can rost							X																							
Car bart																														
Car hipp																														

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																													
	T1			T2			T3			T4			T5			T6			T7			T8			T9			T10		
	96 (4)	98 (2)	00 (4)	96 (2)	98 (3)	00 (4)	96 (5)	98 (1)	00 (6)	96 (4)	98 (1)	00 (4)	96 (5)	98 (0)	00 (0)	96 (4)	98 (1)	00 (2)	96 (2)	98 (1)	00 (4)	96 (5)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (2)	98 (1)	00 (4)
Car rube	X	X		X	X				X			X	X			X											X	X		
Car spp																														
Cen argi																														
Cha capi						X						X									X									X
Cha ocel									X																					
Cha spp																														
Cha stri											X	X																		
Chr cyan							X			X		X	X								X									
Chr inso																														
Chr mult										X		X																X		
Cle parr																														
Cli spp													X																	
Cor dicr																														
Cor glau				X		X	X			X		X						X	X			X			X					
Cor pers							X			X		X	X																	
Das amer	X								X																					
Dio spp																														
Ela bipi																														
Epi adsc												X	X																	
Epi crue							X																							
Epi gutt												X	X																	
Epi stri																														
Equ acum			X																											
Equ punc																														
Ger cine				X		X	X											X			X	X								
Gob geni												X	X																	

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																													
	T1			T2			T3			T4			T5			T6			T7			T8			T9			T10		
	96 (4)	98 (2)	00 (4)	96 (2)	98 (3)	00 (4)	96 (5)	98 (1)	00 (6)	96 (4)	98 (1)	00 (4)	96 (5)	98 (0)	00 (0)	96 (4)	98 (1)	00 (2)	96 (2)	98 (1)	00 (4)	96 (5)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (2)	98 (1)	00 (4)
Gob saep						X						X				X		X				X		X						
Gob sauc																														X
Gob spp					X																									
Gra lore										X			X																	
Hae auro																														
Hae carb													X																	
Hae flav												X	X								X									
Hae mela																														
Hae plum																														
Hae sciu																														
Hae spp.										X										X	X							X		
Hal bivi	X		X	X		X	X		X	X	X	X	X			X			X		X	X	X	X	X		X	X		
Hal cyan																X														
Hal garn						X	X			X		X							X		X	X								
Hal macu						X				X		X	X						X			X			X			X		
Hal pict										X	X						X													
Hal poey												X							X											
Hal radi																					X									
Hal spp																														
Hem bala																														
Hem bras																														
Hem mart	X						X		X									X				X			X		X	X		
Hem nova																														X
Hem sple													X			X											X	X		X
Hem spp																												X		
Het hali																X						X	X	X	X					

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	T1			T2			T3			T4			T5			T6			T7			T8			T9			T10		
	96 (4)	98 (2)	00 (4)	96 (2)	98 (3)	00 (4)	96 (5)	98 (1)	00 (6)	96 (4)	98 (1)	00 (4)	96 (5)	98 (0)	00 (0)	96 (4)	98 (1)	00 (2)	96 (2)	98 (1)	00 (4)	96 (5)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (2)	98 (1)	00 (4)
Hol adsc						X						X	X									X								
Hol cili					X																									
Hol rufu					X		X						X																	
Hol spp.										X																		X		
Hol tric													X						X											
Hyp puel				X	X	X																								
Hyp spp.				X			X			X									X									X		
log hele																														
Lab nuch																									X					
Lab spp																									X		X	X		X
Lac bica																								X			X			
Lac maxi													X															X		
Lac poly																														
Lac quad																						X								
Lac triq												X										X						X		
Lut anal								X					X																	
Lut apod																									X					
Lut cyan																														
Lut gris																														
Lut syna												X												X						
Mal gill																														
Mal macr							X															X								
Mal spp																						X								
Mal tria																														
Mic chry						X	X			X	X																	X		
Mon cili																												X		

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

	TRANSECT NUMBER																													
Fish Species	**T1**			**T2**			**T3**			**T4**			**T5**			**T6**			**T7**			**T8**			**T9**			**T10**		
	96 (4)	98 (2)	00 (4)	96 (2)	98 (3)	00 (4)	96 (5)	98 (1)	00 (6)	96 (4)	98 (1)	00 (4)	96 (5)	98 (0)	00 (0)	96 (4)	98 (1)	00 (2)	96 (2)	98 (1)	00 (4)	96 (5)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (2)	98 (1)	00 (4)
Mon tuck							X																							
Mul mari				X						X			X					X										X		
Myc tigr													X																	
Myr joco										X			X															X		
Ocy chry				X		X						X	X																	
Opi atla																														
Opi auri										X		X										X								
Opi macr							X																					X		
Opi whit					X																									
Pla arga																														
Pom arcu								X			X																			
Pom cili																														
Pom spp																														
Pse macu					X	X	X			X	X		X						X		X				X					
Sca coer																														
Sca croi						X	X			X		X							X		X							X		
Sca iser											X																			
Sca spp																				X										
Sca taen						X	X						X						X											
Sca vetu																														
Sco rega																									X					
Sel crum																														
Ser taba												X										X								
Ser tigr									X	X			X										X							
Ser tort					X																									
Spa atom																														

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																													
	T1			T2			T3			T4			T5			T6			T7			T8			T9			T10		
	96 (4)	98 (2)	00 (4)	96 (2)	98 (3)	00 (4)	96 (5)	98 (1)	00 (6)	96 (4)	98 (1)	00 (4)	96 (5)	98 (0)	00 (0)	96 (4)	98 (1)	00 (2)	96 (2)	98 (1)	00 (4)	96 (5)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (2)	98 (1)	00 (4)
Spa auro				X		X	X			X			X						X		X	X						X		
Spa chry						X	X					X	X						X											
Spa radi													X						X		X				X					
Spa rubr																					X	X								
Spa spp																														
Spa viri				X	X	X	X			X	X	X	X								X							X		
Spar auro																														
Sph barr	X																													
Sph spen							X			X			X									X								
Sph test																														
Ste dein				X		X				X											X							X		
Ste dors																														
Ste fusc						X	X			X																				
Ste leuc			X	X		X	X			X	X	X	X						X	X	X			X						
Ste part				X	X	X	X			X	X	X	X				X		X		X	X	X	X						
Ste plan						X	X			X		X	X						X											
Ste spp.					X		X	X											X			X								
Ste vari				X		X				X									X			X								X
Syn inte																	X				X				X					
Syn sau																														
Tha bifa				X		X	X			X	X	X	X									X						X		
Xyr mart																	X						X						X	
Xyr nova																														

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																									
	T11			T12			T13			T14			T15			T16			T17			T18			T19	T20
	96 (4)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (1)	00 (0)	96 (5)	98 (1)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (2)	00 (4)	96 (3)	98 (0)	00 (4)	96 (4)	98 (2)	00 (4)	00 (4)	00 (5)
Abu saxa	X														X			X	X			X				X
Aca bahi	X						X			X				X	X			X			X	X		X		X
Aca chir	X	X	X	X																		X				X
Aca coer					X		X			X			X		X				X		X	X		X	X	X
Aca spp.							X										X									
Acanthe spin																										
Acanthe spp																										
Aet nari					X																					
Alu scho																										
Apo spp.																										
Ast stel																										
Ath spp																										
Ath stip																										
Aul macu							X															X				
Bal vetu																			X			X			X	
Ble spp		X																								
Bod rufu				X																						X
Bot luna	X																									
Bot ocel																		X								
Cal bajo																										X
Cal cala	X	X		X			X															X				
Cal penn	X	X																								
Can macr	X																				X					
Can pull													X													
Can rost							X																			X

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																							
	T11			T12			T13			T14			T15			T16			T17			T18			T19	T20
	96 (4)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (1)	00 (0)	96 (5)	98 (1)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (2)	00 (4)	96 (3)	98 (0)	00 (4)	96 (4)	98 (2)	00 (4)	00 (4)	00 (5)
Car bart	X																									
Car hipp										X	X															
Car rube												X	X		X			X			X	X		X		
Car spp														X												
Cen argi																										X
Cha capi			X		X										X						X					
Cha ocel	X			X																	X					
Cha spp																			X			X				
Cha stri		X																	X			X				
Chr cyan				X																						X
Chr inso																				X		X				
Chr mult										X									X							X
Cle parr							X																			X
Cli spp																										
Cor dicr																	X									
Cor glau	X						X			X			X			X									X	
Cor pers							X			X																X
Das amer																		X								
Dio spp		X																								
Ela bipi										X																
Epi adsc							X														X					X
Epi crue																										
Epi gutt															X							X				
Epi stri																										
Equ acum																										
Equ punc																										X

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	T11			T12			T13			T14			T15			T16			T17			T18			T19	T20
	96	98	00	96	98	00	96	98	00	96	98	00	96	98	00	96	98	00	96	98	00	96	98	00	00	00
	(4)	(2)	(4)	(3)	(1)	(4)	(3)	(1)	(0)	(5)	(1)	(4)	(3)	(1)	(4)	(3)	(2)	(4)	(3)	(0)	(4)	(4)	(2)	(4)	(4)	(5)
Ger cine	X			X			X					X	X		X	X										
Gob geni																										X
Gob saep												X														
Gob sauc																										
Gob spp	X	X					X																			
Gra lore							X																			
Hae auro	X																									
Hae carb							X																			
Hae flav	X						X			X								X								X
Hae mela																										X
Hae plum							X															X				
Hae sciu	X		X	X																						
Hae spp.	X																									
Hal bivi	X	X	X	X	X		X					X	X		X	X	X	X				X		X	X	
Hal cyan												X														
Hal garn							X											X				X		X	X	X
Hal macu	X		X				X							X								X		X	X	
Hal pict										X	X	X										X				
Hal poey	X	X					X															X			X	
Hal radi																						X		X		
Hal spp	X																									
Hem balo										X																
Hem bras																X										
Hem mart	X						X			X			X		X											
Hem nova							X			X							X									
Hem sple	X						X			X							X									

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																									
	T11			T12			T13			T14			T15			T16			T17			T18			T19	T20
	96 (4)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (1)	00 (0)	96 (5)	98 (1)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (2)	00 (4)	96 (3)	98 (0)	00 (4)	96 (4)	98 (2)	00 (4)	00 (4)	00 (5)
Hem spp																										
Het hali							X	X		X																
Hol adsc											X							X				X		X		X
Hol cili							X																			X
Hol rufu																										X
Hol spp.																						X				
Hol tric																						X			X	
Hyp puel							X																			X
Hyp spp.							X																		X	
log hele										X						X										
Lab nuch																										
Lab spp										X																
Lac bica												X														
Lac maxi							X																			X
Lac poly																						X				
Lac quad																										
Lac triq							X											X								
Lut anal							X									X										
Lut apod				X																						
Lut cyan																										X
Lut gris	X		X	X	X		X																			X
Lut syna				X			X									X										
Mal gill	X						X																			
Mal macr	X						X																			
Mal spp																										
Mal tria																						X				

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																									
	T11			T12			T13			T14			T15			T16			T17			T18			T19	T20
	96 (4)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (1)	00 (0)	96 (5)	98 (1)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (2)	00 (4)	96 (3)	98 (0)	00 (4)	96 (4)	98 (2)	00 (4)	00 (4)	00 (5)
Mic chry	X																	X	X		X	X				X
Mon cili																										
Mon tuck																										
Mul mari				X			X			X								X	X							X
Myc tigr																										
Myr joco																										X
Ocy chry	X		X	X		X	X										X	X				X				X
Opi atla																					X	X				
Opi auri																		X			X			X		
Opi macr							X			X																
Opi whit								X														X				
Pla arga													X													
Pom arcu							X												X			X				
Pom cili							X																			
Pom spp																			X							
Pse macu							X			X											X	X			X	
Sca coer																		X								
Sca croi	X		X			X	X											X				X		X	X	X
Sca iser																										
Sca spp																						X				
Sca taen				X						X																X
Sca vetu							X															X			X	X
Sco rega												X						X				X				
Sel crum																						X				
Ser taba																									X	X
Ser tigr							X	X														X		X		

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

Fish Species	TRANSECT NUMBER																								
	T11			T12			T13			T14			T15			T16			T17			T18			T19	T20
	96 (4)	98 (2)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (1)	00 (0)	96 (5)	98 (1)	00 (4)	96 (3)	98 (1)	00 (4)	96 (3)	98 (2)	00 (4)	96 (3)	98 (0)	00 (4)	96 (4)	98 (2)	00 (4)	00 (4)	00 (5)
Ser tort																										
Spa atom																						X				
Spa auro	X						X			X												X		X	X	X
Spa chry							X																		X	
Spa radi	X					X	X															X			X	
Spa rubr	X																					X				
Spa spp																						X				
Spa viri	X	X			X		X	X														X		X	X	X
Spar auro																								X		
Sph barr						X																X				
Sph spen							X									X										
Sph test						X																				
Ste dein						X																				X
Ste dors					X																					
Ste fusc	X					X	X															X				X
Ste leuc	X		X			X				X															X	X
Ste part		X			X		X			X												X		X	X	X
Ste plan							X											X							X	X
Ste spp.	X						X																		X	
Ste vari	X																	X							X	
Syn inte												X						X				X			X	
Syn sau	X									X																
Tha bifa	X		X				X			X	X	X					X					X		X	X	X
Xyr mart																										
Xyr nova																										

Table 2 (continued). Fish Species Observed and Number of Censuses Carried Out (in parentheses) For Each Transect and Year.

*Notes:

1. Transect 5 was not resurveyed in 1998 & 2000 because it was not relocated after storm damage.
2. Transect 13 was not resurveyed in 2000 because it was not relocated after storm damage 1998 & 1999.
3. No fish censuses were performed in 1998 on Transect 17 and 18.
4. Transects 19 and 20 were established in 2000.

Table 3. Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period

Transect	Fish species	Sampling periods 1996		1998		2000	
		Density*1 (Fish/m²)	FL (cm)	Density*1 (Fish/m²)	FL (cm)	Density*1 (Fish/m²)	FL (cm)
1	*Acanthurus bahianus*	0.085	15			0.011	11
	Astrapogon stellatus					0.006	0.5
	Caranx ruber	0.028	17.5	0.006	14		
	Dasyatis americana	0.006	1000				
	Equetus acuminatus					0.006	4
	Halichoeres bivittatus	0.011	10			0.068	5
	Hemipteronotus martinicensis	0.011	3				
	Sphyraena barracuda	0.006	120				
	Stegastes leucostictus					0.017	1.25
2	*Abudefduf saxatilis*	0.023	9.5				
	Acanthurus bahianus	0.011	18.5			0.096	6
	Acanthurus chirurgus	0.057	13.5	0.051	7.5	0.091	4.9
	Acanthurus coeruleus	0.017	7.5			0.011	3.5
	Atherinomorus stipes	0.057	1.5			0.226	1
	Atherinidae spp.			0.226	2		
	Balistes vetula	0.011	35				
	Calamus calamus			0.04	8	0.011	14
	Cantherhinus pullus					0.006	6
	Caranx ruber	0.062	34.5	0.011	7		
	Chaetodon capistratus					0.006	3
	Coryphoterus glaucofraenum	0.051	5.5			0.011	1.5
	Eupomacentrus partitus			0.006	3		
	Gerres cinereus	0.006	18			0.006	9
	Gobionellus saepepallens					0.017	1.5
	Gobiidae spp.			0.028	3		
	Halichoeres bivittatus	0.04	7.5			0.04	4
	Halichoeres garnoti					0.051	3.3
	Halichoeres maculipinna					0.017	4
	Holocentrus adscensionis					0.023	6.5
	Holocanthus ciliaris			0.011	3		
	Holocentrus rufus			0.006	8		
	Hypoplectrus puella	0.011	6	0.006	4	0.011	3.8
	Hypoplectrus spp.	0.006	9				
	Microspathodon chyrsurus					0.006	3.5
	Mulloidichthys maritinicus	0.323	45				
	Ocyurus chrysurus	0.028	6			0.006	8
	Opistognathus whitehursti			0.006	5		
	Pseudupeneus maculatus			0.017	5	0.017	6.8
	Scarus croicensis					0.096	4
	Scarus taeniopterus					0.068	3.5
	Serranus tortugarum			0.006	8		
	Sparisoma aurofrenatum	0.023	25			0.057	5.5
	Sparisoma chrysopterum					0.068	8.5
	Sparisoma viride	0.017	11.5	0.017	6	0.017	2.3

Table 3 (continued). Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m²)	FL (cm)	Density(Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)
2	*Stegastes deincaeus*	0.006	2.5			0.023	5
	Stegastes fuscus					0.034	5
	Stegastes leucostictus	0.006	10			0.102	2.3
	Stegastes partitus	0.006	8	0.006	3	0.011	3.5
	Stegastes planifrons					0.034	2.3
	Stegastes spp.			0.023	3		
	Stegastes variabilis	0.04	7.5			0.023	3
	Thalassoma bifasciatum	0.068	11			0.017	3.8
3	*Acanthuridae spp.*	0.057	17.5				
	Acanthurus bahianus			1.006	8		
	Balistes vetula	0.006	40				
	Canthigaster rostrata	0.028	8				
	Caranx ruber					0.040	3
	Chaetodon ocellatus					0.006	3
	Chromis cyanea	0.096	10				
	Coryphoterus personatus	0.226	3.8				
	Coryphoterus glaucofraenum	0.017	3.5				
	Dasyastis americana					0.006	60
	Epinephelus cruentatus	0.006	26				
	Gerres cinereus	0.006	20				
	Halichoeres bivittatus	0.028	5.5			0.006	15
	Halichoeres garnoti	0.028	10.5				
	Hemipteronotus martinicensis	0.323	6			0.538	6.17
	Holocentrus rufus	0.006	12				
	Hypoplectrus spp.	0.017	11				
	Lutjanus analis			0.006	12		
	Malacoctenus macropus	0.006	4				
	Microspathodon chyrsurus	0.011	11				
	Monacanthus tuckeri	0.006	7				
	Opistognathus macrognathus	0.006	12				
	Pomaacanthus arcuatus			0.011	6		
	Pseudupeneus maculatus	0.017	52				
	Scarus croicensis	0.057	13.3				
	Scarus taeniopterus	0.079	13.3				
	Serranus tigrinus					0.011	3
	Sparisoma aurofrenatum	0.057	16				
	Sparisoma chrysopterum	0.011	17				
	Sparisoma viride	0.011	8				
	Sphoeroides spengleri	0.006	2				
	Stegastes fuscus	0.028	8.3				
	Stegastes leucostictus	0.028	10				
	Stegastes partitus	10.085	9				
	Stegastes planifrons	0.023	8				

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods 1996 Density (Fish/m^2)	1996 FL (cm)	1998 Density (Fish/m^2)	1998 FL (cm)	2000 Density (Fish/m^2)	2000 FL (cm)
3	*Stegastes spp.*	0.006	12	0.011	5		
	Thalassoma bifasciatum	0.006	12				
4	*Abudefduf saxatilis*	0.017	9				
	Acanthurus bahianus	0.158	14	0.011	2	0.051	5
	Acanthurus chirurgus	0.141	17.5	0.051	7	0.040	7.8
	Acanthurus coeruleus	0.091	12.5	0.011	2	0.057	3.4
	Aluterus schoepfii	0.006	10				
	Apogon spp.	0.085	10				
	Atherinomorus stipes	11.318	0.75				
	Bodianus rufus			0.017	5.5		
	Bothus lunatus	0.006	25			0.006	1
	Cantherines macroceros	0.006	3				
	Caranx ruber					0.119	17.8
	Chaetodon capistratus					0.023	5
	Chaetodon striatus			0.011	5	0.023	5
	Chaetondontidae spp.	0.045	12				
	Chromis cyanea	0.006	8			0.045	3.3
	Chromis multilineata	0.113	10			0.062	5.8
	Coryphoterus glaucofraenum	0.283	4			0.017	1.5
	Coryphoterus personatus	0.226	2.5			0.113	1
	Epinephelus adscensionis					0.006	7
	Epinephelus guttatus					0.006	7
	Gobionellus saepepallens					0.011	2
	Gobisoma genie					0.011	1.5
	Gramma loreto	0.011	5.5				
	Haemulidae spp.	0.028	20				
	Haemulon flavolineatum					0.006	10
	Halichoeres bivittatus	0.141	13.5	0.006	4	0.034	4.3
	Halichoeres garnoti	0.130	8.3			0.028	5
	Halichoeres maculipinna	0.175	10.7			0.006	5
	Halichoeres pictus	0.017	14	0.006	7		
	Halichoeres poeyi					0.006	5
	Holocentrus adscensionis					0.023	5.5
	Holocentrus spp.	0.119	7				
	Hypoplectrus spp.	0.011	11				
	Lactophrys triqueter					0.006	7
	Microspathodon chyrsurus	0.011	15	0.023	5		
	Mulloidichthys maritinicus	0.170	15				
	Myripristis jocobus	0.766	15				
	Ocyurus chrysurus					0.006	7
	Opistognathus aurifrons	0.057	9			0.051	6.5
	Pomacanthus arcuatus			0.011	5.5		
	Pseudupeneus maculatus	0.040	11.3	0.011	3		
	Scarus croicensis	0.141	10.1			0.028	5

Table 3 (continued). Density ($fish/m^2$) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density ($Fish/m^2$)	FL (cm)	Density ($Fish/m^2$)	FL (cm)	Density ($Fish/m^2$)	FL (cm)
4	*Scarus iserti*			0.006	6		
	Serranus tabacarius					0.006	4.5
	Serranus tigrinus	0.006	8				
	Sparisoma aurofrenatum	0.040	10				
	Sparisoma chrysopterum					0.011	7.5
	Sparisoma viride	0.034	20.3	0.011	6	0.011	7.5
	Sphoeroides spengleri	0.011	6.5				
	Stegastes deincaeus	0.068	6				
	Stegastes fuscus	0.051	6.3				
	Stegastes leucostictus	0.028	6.3	0.034	5	0.040	2.3
	Stegastes partitus	0.006	8	0.017	3	0.209	3.3
	Stegastes planifrons	0.034	7.5			0.011	3.3
	Stegastes variabilis	0.006	5.6				
	Thalassoma bifasciatum	0.170	8.2	0.006	2	0.300	3.5
5*2	*Acanthuridae spp.*	0.141	15				
	Acanthurus bahianus	0.017	11.5				
	Acanthurus chirurgus	0.255	11				
	Acanthurus coeruleus	0.108	9.3				
	Aluterus schoepfii	0.011	4				
	Caranx ruber	0.006	60				
	Chromis cyanea	0.045	7.5				
	Clinidae spp.	0.006	4				
	Coryphoterus personatus	0.057	2.5				
	Diodon hystrix	0.006	40				
	Epinephelus adscensionis	0.006	27				
	Epinephelus guttatus	0.006	15				
	Gobisoma genie	0.011	3				
	Gramma loreto	0.017	3.5				
	Haemulon carbonarium	0.006	25				
	Haemulon flavolineatum	0.023	18				
	Halichoeres bivittatus	0.057	3.2				
	Halichoeres cyanocephalus	0.017	5				
	Halichoeres maculipinna	0.034	8.3				
	Hemipteronotus spledens	0.006	9				
	Holocanthus tricolor	0.006	15				
	Holocentrus adscensionis	0.011	18.5				
	Holocentrus rufus	0.011	14.5				
	Lachnolaimus maximus	0.011	35				
	Lutjanus analis	0.011	30				
	Lutjanus synagris	0.006	25				
	Mulloidichthys martinicus	0.006	20				
	Mycteroperca tigris	0.006	45				
	Myripristis jocobus	0.006	20				
	Ocyurus chrysurus	0.011	17.5				
	Pseudupeneus maculatus	0.023	6				

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Species	Sampling period					
		1996		1998		2000	
		Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)
5*2	*Scarus taeniopterus*	0.119	11.5				
	Serranus tigrinus	0.011	8				
	Sparisoma aurofrenatum	0.017	15				
	Sparisoma chrysopterum	0.028	15				
	Sparisoma radians	0.006	3				
	Sparisoma viride	0.108	11.1				
	Sphoeroides spengleri	0.017	4				
	Stegastes leucostictus	0.034	7.75				
	Stegastes partitus	0.051	6				
	Stegastes planifrons	0.023	7.5				
	Thalassoma bifasciatum	0.373	11.3				
6	*Acanthemblemaria species*	0.011	5				
	Atherinomorus stipes	33.95	0.37				
	Blenniidae spp.			0.006	2		
	Calamus calamus			0.028	7	0.006	11.25
	Caranx ruber	0.051	7.5				
	Coryphoterus glaucofraenum					0.006	2
	Gerres cinereus					0.051	12.5
	Gobionellus saepepallens	0.255	5.1			0.011	2
	Halichoeres bivittatus	0.023	5				
	Halichoeres pictus			0.017	2		
	Hemipteronotus martinicensis					0.085	9.9
	Hemipteronotus spledens	0.006	6.5				
	Heteroconger halis	0.062	25				
	Lactophrys triqueter	0.011	10				
	Mulloidichthys maritinicus					0.006	3.5
	Stegastes partitus			0.006	4		
	Synodus intermedius			0.006	3		
	Xyrichtys martinicenis			0.017	4		
7	Acanthuridae species	0.226	13.5				
	Acanthurus bahianus			0.017	15.5	0.045	7.3
	Acanthurus chirurgus					0.028	5
	Acanthurus coeruleus	0.006	20			0.028	3.5
	Balistes vetula	0.006	30				
	Chaetodon capistratus					0.011	5
	Chaetondontidae species			0.006	6		
	Coryphoterus glaucofraenum	0.011	5				
	Gerres cinereus					0.028	4
	Haemulidae species			0.006	5	0.017	3
	Haemulon flavolineatum					0.006	7
	Halichoeres bivittatus	0.396	11.25			0.175	3.6
	Halichoeres garnoti	0.023	9			0.011	5

Table 3 (continued). Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods 1996 Density (Fish/m²)	1996 FL (cm)	1998 Density (Fish/m²)	1998 FL (cm)	2000 Density (Fish/m²)	2000 FL (cm)
7	*Halichoeres maculipinna*	0.085	11				
	Halichoeres poeyi	0.028	17				
	Halichoeres radiatus					0.011	6
	Holocanthus tricolor	0.006	13				
	Hypoplectrus species	0.006	15				
	Opistognathus aurifrons					0.023	2.5
	Pseudupeneus maculatus	0.006	30			0.017	5
	Scaridae species			0.006	8		
	Scarus croicensis	0.028	10			0.011	5
	Scarus taeniopterus	0.051	10				
	Sparisoma aurofrenatum	0.011	17.5			0.006	6
	Sparisoma chrysopterum	0.011	26				
	Sparisoma radians	0.006	12			0.006	6
	Sparisoma rubripinne					0.006	10
	Sparisoma viride					0.011	8.5
	Stegastes deincaeus					0.068	4
	Stegastes leucostictus	0.028	8	0.034	7.5	0.062	2.6
	Stegastes partitus	0.034	8.5			0.040	3
	Stegastes planifrons	0.011	3				
	Stegastes species	0.017	10				
	Stegastes variabilis	0.011	8				
	Synodus intermedius					0.006	6
	Thalassoma bifasciatum	0.17	11.5	0.040	10.5	0.283	2.9
8	*Acanthurus bahianus*	0.028	17.5				
	Acanthurus chirurgus	0.011	13.5	0.017	10		
	Acanthurus coeruleus	0.006	5				
	Acanthurus spinosa	0.006	2.5				
	Acanthurus spp.	0.017	4				
	Aetobatus narinari					0.011	76.1
	Balistes vetula	0.006	20				
	Calamus calamus	0.006	17.5				
	Coryphoterus glaucofraenum	0.006	4				
	Dasyastis americana	0.006	60				
	Gerres cinereus	0.006	30				
	Gobionellus saepepallens	0.006	3			5	5.0
	Halichoeres bivittatus	0.164	7.2	0.068	4	3	3.5
	Halichoeres garnoti	0.011	5				
	Halichoeres maculipinna	0.006	15				
	Hemipteronotus martinicensis	0.294	10.25			0.034	4.5
	Heteroconger halis	0.062	35	0.079	5	0.034	5.5
	Holocentrus adscensionis	0.006	10				
	Lactophrys quadricornis	0.006	25				
	Lactophrys triqueter	0.006	30				
	Lactophyrys bicaudualis					0.011	8.0
	Malacoctenus spp.	0.006	5				

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)
8	*Serranus tabacarius*	0.006	15				
	Serranus tigrinus			0.011	2		
	Sparisoma aurofrenatum	0.006	20				
	Sparisoma rubripinne	0.006	25				
	Sphoeroides spengleri	0.006	5				
	Stegastes partitus	0.006	8	0.0006	3	0.011	2.5
	Stegastes variabilis					0.006	4
	Stegastes leucostictus					0.011	2
	Stegastes spp.	0.011	6.5				
	Thalassoma bifasciatum	0.062	11..3				
	Xyrichtys martinicensis			0.006	8.9		
9	*Acanthurus bahianus*	0.023	3.5				
	Acanthurus chirurgus	0.017	3.3				
	Aluterus schoepfii	0.006	4				
	Atherinomorus stipes	0.283	15				
	Bothus lunatus	0.011	8.5				
	Caranx ruber					0.034	14.5
	Coryphoterus glaucofraenum	0.006	3				
	Halichoeres bivittatus	0.238	5.0			0.023	9
	Halichoeres maculipinna	0.017	5				
	Hemipteronotus martinicensis	0.594	8.8			6	5
	Hemipteronotus splendens					2	10
	Heteroconger halis	0.141	37.5				
	Labridae spp.	0.017	2			5.660	0.015
	Labrisomus nuchipinnis	0.006	3				
	Lactophyrys bicaudualis					0.011	12
	Lutjanus synagris	0.006	6				
	Pseudupeneus maculatus	0.011	5				
	Scomberomorus regalis	0.006	25				
	Sparisoma radians	0.006	3				
	Synodus intermedius	0.006	5				
10	*Acanthurus bahianus*	0.113	15				
	Acanthurus chirurgus	0.113	15				
	Acanthurus coeruleus	0.057	15				
	Apogon spp.	0.085	10				
	Atherinidae spp.			0.283	3		
	Atherinomorus stipes	11.32	0.75				
	Bothus lunatus	0.011	19.5				
	Caranx ruber	0.006	35				
	Chaetodon capistratus					0.017	2.5
	Chromis multilineata	0.113	10				
	Gobionellus saepepallens					0.017	3
	Gobiosoma saucrum					0.170	3.3
	Gramma loreto	0.011	5.5				

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)
10	*Haemulidae spp.*	0.040	17				
	Halichoeres bivittatus	0.085	8				
	Halichoeres maculipinna	0.057	9				
	Hemipteronotus martinicensis	1.149	10.3			7	3
	Hemipteronotus novacula					72	7.5
	Hemipteronotus splendens	0.017	13.5			0.006	10
	Hemipteronotus spp.	0.113	25				
	Holocentrus spp.	0.085	17				
	Hypoplectrus spp.	0.006	11				
	Labridae spp.	0.006	10			5.659	0.15
	Lactophyrys triqueter	0.006	24				
	Microspathodon chyrysurus	0.011	15				
	Monacanthus ciliatus	0.011	4.5				
	Mulloidichthys maritinicus	0.17	15				
	Myripristis jocobus	0.266	15				
	Opistognathus macrognathus	0.006	13				
	Scarus croicensis	0.011	12				
	Sepioteuthis sepioidea					0.011	5.5
	Sparisoma aurofrenatum	0.017	14				
	Sparisoma viride	0.011	30				
	Stegastes deincaeus	0.068	8				
	Stegastes variables					0.017	2.3
	Thalassoma bifasciatum	0.153	7.3				
	Xyrichtys martinicenis			0.057	4		
11	*Abudefduf saxatilis*	0.006	8				
	Acanthurus bahianus	0.028	10				
	Acanthurus chirugus	0.164	6.3	0.192	6	0.006	0.75
	Blenidae spp			0.017	2		
	Bothus lunatus	0.006	15				
	Calamus calamus	0.023	18.5	0.023	8		
	Calamus pennatula	0.028	27	0.023	13		
	Cantherines macroceros	0.006	40				
	Caranx barthomaei	0.017	21				
	Chaetodon capistratus					0.006	5
	Chaetodon ocellatus	0.011	6				
	Chaetodon striatus			0.017	4		
	Coryphoterus glaucofraenum	0.051	4.5				
	Diodontidae spp			0.011	4.5		
	Gerres cinereus	0.085	13				
	Gobbidae spp.	0.011	5	0.011	3		
	Haemulidae spp.	0.057	9.3				
	Haemulon aurolineatum	0.028	12				
	Haemulon flavolineatum	0.209	11				
	Haemulon plumieri	0.006	15				
	Haemulon sciurus	0.119	15.5				

Table 3 (continued). Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)
11	*Halichoeres bivittatus*	0.702	7.7	0.074	4	0.068	2.3
	Halichoeres maculipinna	0.034	8			0.006	5.5
	Halichoeres poeyi	0.006	9	0.011	2		
	Halichoeres spp.	0.011	12.5				
	Hemipteronotus martinicensis	0.141	10.3				
	Hemipteronotus spledens	0.034	24.5				
	Lutjanus griseus	0.034	11.9			0.006	15
	Malacoctenus gilli	0.017	4				
	Malacoctenus macropus	0.011	3.8				
	Microspathodon chyrsurus	0.006	6				
	Ocyurus chrysurus	0.011	6.5	0.017	4.5		
	Scarus croicensis	0.792	6.9			0.294	5
	Sparisoma aurofrenatum	0.170	5				
	Sparisoma radians	0.164	8				
	Sparisoma rubripinne	0.006	8				
	Sparisoma viride	0.006	20	0.028	3		
	Sphyraena barracuda	0.017	41				
	Stegastes fuscus	0.034	6.3				
	Stegastes leucostictus	0.062	4			0.034	3.5
	Stegastes spp.	0.040	8				
	Stegastes variabilis	0.011	6.5				
	Stegastes partitus			0.045	4		
	Synodus saurus	0.006	20				
	Thalassoma bifasciatum	0.062	7			0.006	2
12	*Acanthurus coeruleus*			0.006	3		
	Aetobatus narinari			0.011	60		
	Atherinomorus stipes	0.006	16	0.566	2		
	Calamus calamus	0.023	6.5				
	Chaetodon capistratus			0.011	3		
	Chaetodon ocellatus	0.017	7				
	Diodontidae spp			0.006	3		
	Gerres cinereus	0.187	10.3				
	Haemulon melanurum	0.006	16				
	Haemulon sciurus	0.006	6	0.198	5		
	Halichoeres bivittatus	0.079	11	0.034	5		
	Lutjanus apodus	0.006	6.5				
	Lutjanus griseus	0.017	6.3	0.045	10		
	Lutjanus synagris	0.017	8				
	Mulloidichthys maritinicus	0.006	7.3				
	Ocyurus chrysurus			0.011	4	0.079	3.7
	Scarus croicensis					0.102	35.4
	Sparisoma radians					0.198	0.5
	Sparisoma viride			0.011	0.5		
	Sphoeroides testudineus					0.006	3
	Sphyraena barracuda					0.034	21.1

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)
12	*Stegastes deincaeus*					0.147	3.3
	Stegastes dorsipunicans			0.011	3		
	Stegastes fuscus					0.011	8.3
	Stegastes leucostictus					0.045	4.5
	Stegastes partitus			0.028	4		
13[*3]	*Acanthuridae spp.*	0.283	16.1				
	Acanthurus bahianus	0.028	10				
	Acanthurus chirurgus	0.085	11				
	Acanthurus coeruleus	0.147	14.1				
	Aulostomus maculatus	0.023	38.5				
	Bodianus rufus	0.006	20				
	Calamus calamus	0.079	27				
	Canthigaster rostrata	0.011	11				
	Caranx ruber	0.006	25				
	Chaetodon ocellatus	0.034	7.3				
	Chromis cyanea	0.453	9.67				
	Clepticus parrae	0.011	20				
	Coryphoterus personatus	1.641	2.77				
	Coryphoterus glaucofraenum	0.040	3.37				
	Epinephelus adscensionis	0.017	28.75				
	Gerres cinereus	0.023	20				
	Gobiidae spp.	0.011	5				
	Gramma loreto	0.006	12				
	Haemulon carbonarium	0.113	25				
	Haemulon flavolineatum	0.023	22				
	Haemulon plumieri	0.453	25				
	Halichoeres bivittatus	0.317	5.3				
	Halichoeres garnoti	0.011	15				
	Halichoeres maculipinna	0.085	9.15				
	Halichoeres poeyi	0.051	8.67				
	Hemipteronotus martinicensis	0.170	8.25				
	Hemipteronotus novacula	0.017	7				
	Hemipteronotus spledens	0.006	6				
	Heteroconger halis	1.700	29	0.962	10		
	Holocanthus ciliaris	0.011	30				
	Holocanthus tricolor	0.011	19				
	Hypoplectrus puella	0.017	10				
	Hypoplectrus spp.	0.011	11				
	Lachnolaimus maximus	0.006	25				
	Lactophrys triqueter	0.170	25				
	Lutjanus analis	0.113	30				
	Lutjanus griseus	0.028	18				
	Lutjanus synagris	0.113	20				
	Malacoctenus gilli	0.017	4				
	Malacoctenus macropus	0.011	3.8				

Table 3 (continued). Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)
13*3	*Mulloidichthys martinicus*	0.124	27.5				
	Ocyurus chrysurus	0.006	2				
	Opistognathus macrognathus	0.017	12				
	Opistognathus whitehursti			0.011	3		
	Pomacanthus arcuatus	0.011	35				
	Pomacanthus ciliaris	0.011	37.5				
	Pseudupeneus maculatus	0.011	16				
	Scarus croicensis	0.594	16.15				
	Scarus taeniopterus	0.260	16.67				
	Scarus vetula	0.023	32				
	Serranus tigrinus	0.011	8	0.011	2		
	Sparisoma aurofrenatum	0.232	19.4				
	Sparisoma chrysopterum	0.006	12				
	Sparisoma radians	0.141	8				
	Sparisoma viride	0.068	11.38	0.011	1		
	Sphoeroides spengleri	0.028	7				
	Sphyraena barracuda	0.006	35				
	Stegastes fuscus	0.034	8.67				
	Stegastes partitus	0.040	5.77				
	Stegastes planifrons	0.074	10.75				
	Stegastes spp.	0.028	6.25				
	Thalassoma bifasciatum	0.074	7.25				
14	*Acanthurus bahianus*	0.051	5.3				
	Acanthurus coeruleus	0.006	10				
	Caranx hippos			0.006	8	0.023	10
	Caranx ruber					0.017	13.3
	Chromis multilineata	0.011	12				
	Coryphoterus personatus	0.113	3.5				
	Coryphoterus glaucofraenum	0.068	3.6				
	Elagatis bipinnulata	0.011	65				
	Gerres cinereus					0.006	12
	Gobionellus saepepallens					0.0017	2.5
	Haemulon flavolineatum	0.006	20				
	Haemulon melanurum					0.566	4
	Halichoeres bivittatus					0.124	5.5
	Halichoeres cyanocephalus					0.045	5
	Halichoeres pictus	0.011	5	0.028	8.5	0.028	5
	Hemipteronotus martinicensis	0.011	6				
	Hemipteronotus novacula	0.011	8.5				
	Hemipteronotus spledens	0.017	8.3				
	Hemiramphus baloa	0.017	25				
	Heteroconger halis	0.023	14				
	Holocentrus adscensionis			0.006	5		
	Ioglossus helenae	0.017	2.5				
	Labridae spp.	0.006	3				

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods 1996 Density (Fish/m^2)	1996 FL (cm)	1998 Density (Fish/m^2)	1998 FL (cm)	2000 Density (Fish/m^2)	2000 FL (cm)
14	*Lactophyrys bicaudualis*					0.006	12
	Lutjanus synagris					0.006	10
	Mulloidichthys maritinicus	0.068	17.5				
	Opistognathus macrognathus	0.006	10				
	Pseudupeneus maculatus	0.006	20				
	Scarus taeniopterus	0.006	15				
	Scomberomorus regalis					0.006	32.5
	Sparisoma aurofrenatum	0.023	17.5				
	Stegastes variabilis					0.011	2.8
	Stegastes leucostictus	0.034	7.5				
	Stegastes partitus	0.023	6				
	Synodus intermedius					0.028	5
	Synodus saurus	0.006	6				
	Thalassoma bifasciatum	0.102	10.8	0.170	6	0.011	7
15	*Abudefduf saxatilis*					0.045	10.8
	Acanthurus bahianus			0.006	8	0.006	10
	Acanthurus coeruleus	0.400	4			0.017	8.8
	Cantherhinus pullus	0.023	5				
	Carangidae spp.			0.006	10		
	Caranx ruber	0.006	20			0.187	15.5
	Chaetodon capistratus					0.051	3.0
	Coryphoterus glaucofraenum	0.017	2.3				
	Epinephelus guttatus					0.006	26
	Gerres cinereus	0.017	16			0.006	9
	Halichoeres bivittatus	0.045	3.3			0.006	4.0
	Halichoeres maculipinna			0.006	4.5		
	Hemipteronotus martinicensis	0.345	13			0.204	7.8
	Platybelone argaslus	0.006	28				
16	*Abudefduf saxatilis*					0.108	14
	Acanthuridae spp.			0.023	5		
	Acanthurus bahianus					0.023	10
	Bothus ocellatus					0.006	30
	Caranx ruber					0.034	55
	Coryphoterus dicrus			0.011	6		
	Coryphoterus glaucofraenum	0.017	3.6				
	Dasyatis americana					0.011	1.8
	Gerres cinereus	0.006	22				
	Haemulon flavolineatum					0.085	7.5
	Haemulon melanurum					0.566	4
	Halichoeres bivittatus	0.017	5	0.040	7	0.023	6.5
	Halichoeres garnoti					0.062	6.3
	Hemipteronotus spledens			0.011	5		
	Hemipteronotus novacula					0.057	5
	Hemiramphus brasiliensis	0.153	25				

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)
16	*Holocentrus adscensionis*					0.006	10.5
	Ioglossus helenae	0.006	3				
	Lactophrys triqueter					0.040	6.6
	Lutjanus synagris	0.006	17				
	Microspathodon chrysurus					0.011	4.5
	Mulloidichthys maritinicus					0.436	20
	Ocyurus chrysurus			0.028	8	0.289	13.5
	Opistognathus aurifrons					0.040	19.1
	Scarus coeruleus					0.311	19.2
	Scomberomorus regalis					0.006	32.5
	Sphoeroides spengleri	0.034	5				
	Stegastes planifrormis					0.006	10.5
	Stegastes variables					0.034	5.3
	Synodus intermedius					0.034	5.3
	Thalassoma bifasciatum					0.079	6
17[*4]	*Abudefduf saxatilis*	0.283	13				
	Acanthurus bahianus					0.198	6.9
	Acanthurus coeruleus	0.215	6.4			0.209	4.4
	Balistes vetula	0.006	25				
	Cantherines macrocerus					0.006	7
	Caranx ruber					0.017	10.5
	Chaetodon capistratus					0.023	4
	Chaetodon striatus	0.011	10				
	Chromis insolata	0.017	4				
	Epinephelus adscensionis					0.006	3.5
	Microspathodon chrysurus	0.006	10			0.028	10.5
	Mulloidichthys martinicus	0.006	20				
	Ocyurus chrysurus		22.5				
	Ophioblennius atlanticus					0.006	0.75
	Pomacanthidae spp.	0.006	20				
	Pseudupeneus maculatus					0.006	5.5
18[*4]	*Abudefduf saxatilis*	0.283	13				
	Acanthurus coeruleus	0.792	9.1			0.045	5.3
	Acanthurus bahianus	0.724	12.8			0.170	4.6
	Acanthurus chirurgus	0.600	15				
	Aulostomus maculatus	0.011	62.5				
	Balistes vetula	0.068	30.8				
	Calamus calamus	0.017	20				
	Caranx ruber	0.045	17			0.011	2.5
	Chaetodon ocellatus	0.045	11.2				
	Chaetodon striatus	0.045	14.5				
	Chromis insolata	0.017	4				
	Epinephelus guttatus	0.011	33.5				
	Haemulon plumieri	0.011	11				

Table 3 (continued). Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)
18*4	*Halichoeres bivittatus*	0.147	9			0.091	2.1
	Halichoeres garnoti	0.034	12.5			0.006	5
	Halichoeres maculipinna	0.141	7.5			0.017	2.8
	Halichoeres pictus	0.883	6.5				
	Halichoeres poeyi	0.057	10				
	Halichoeres radiatus	0.011	3.3			0.006	5
	Holocanthus tricolor	0.006	19				
	Holocentrus adscensionis	0.023	14.3			0.006	5.5
	Holocentrus rufus	0.006	20				
	Lactopophrys polygonia	0.006	20				
	Malacoctenus triangulatus	0.11	6				
	Microspathodon chyrsurus	0.057	11.6				
	Ocyurus chrysurus	0.147	22.8				
	Ophioblennius atlanticus	0.040	6				
	Opistognathus aurifrons					0.017	3.3
	Pomacanthidae spp	0.006	20				
	Pseudupeneus maculatus	0.040	17.5				
	Scarus croicensis	0.011	3			0.006	4
	Scarus taeniopterus	0.085	15.7				
	Scarus vetula	0.034	26.7				
	Scomberomorus regalis	0.006	32				
	Selar crumenophthalmus	0.990	9				
	Serranus tigrinus	0.017	11.5			0.017	3
	Sparida aurofrenatum					0.011	12
	Sparisoma aurofrenatum	0.102	12.8			0.011	6.5
	Sparisoma atomarium	0.011	7				
	Sparisoma chrysopterum	0.017	18.5				
	Sparisoma rubripinne	0.0074	27				
	Sparisoma spp.	0.006	30				
	Sparisoma viride	0.260	26.8			0.017	4.3
	Sphyraena barracuda	0.006	105				
	Stegastes fuscus	0.006	4				
	Stegastes partitus	0.243	5.3			0.096	1.3
	Stegastes spp.	0.006	4				
	Synodus intermedius	0.006	35				
	Thalassoma bifasciatum	0.962	9.3			0.572	2.8
19*5	*Acanthurus coeruleus*					0.028	6.3
	Balistes vetula					0.006	5
	Coryphoterus glaucofraenum					0.011	4.5
	Halichoeres bivittatus					0.006	6
	Halichoeres garnoti					0.108	5.5
	Halichoeres maculipinna					0.028	3
	Halichoeres poeyi					0.006	3.5
	Holocanthus tricolor					0.006	2.5
	Hypoplectrus species					0.006	4.5

Table 3 (continued). Density (fish/m²) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)	Density (Fish/m²)	FL (cm)
19*5	*Pseudupeneus maculatus*					0.006	3.5
	Scarus croicensis					0.006	3
	Scarus taeniopterus					0.040	2.5
	Serranus tabacarius					0.006	6
	Sparisoma aurofrenatum					0.017	8
	Sparisoma chrysopterum					0.164	5.5
	Sparisoma radians					0.011	4.5
	Sparisoma viride					0.006	3
	Stegastes leucostictus					0.051	5.5
	Stegastes partitus					0.006	6
	Stegastes planifrons					0.040	3.5
	Stegastes species					0.034	5.5
	Stegastes variabilis					0.017	4.5
	Synodus intermedius					0.006	3.5
	Thalassoma bifasciatum					0.209	6.8
20*5	*Abudefduf saxatilis*					0.011	5
	Acanthurus bahianus					0.028	5.5
	Acanthurus chirurgus					0.045	5.5
	Acanthurus coeruleus					0.074	4
	Bodianus rufus					0.011	22.5
	Calamus bajonado					0.023	20
	Canthigaster rostrata					0.006	4
	Caranx ruber					0.045	12.5
	Centropyge argi					0.006	5
	Chromis cyanea					0.532	4.0
	Chromis multilineata					0.668	4.1
	Clepticus parrae					0.051	7
	Coryphoterus personatus					0.622	1
	Dasyastis americana					0.006	5
	Equetus punctatus					0.006	6
	Gobisoma genie					0.017	7
	Haemulon flavolineatum					0.102	8
	Haemulon melanurum					0.028	4
	Halichoeres garnoti					0.057	3
	Holocanthus ciliaris					0.028	5
	Holocentrus adscensionis					0.011	6
	Hypoplectrus puella					0.017	7
	Lachnolaimus maximus					0.006	4
	Lutjanus apodus					0.017	15
	Lutjanus cyanopterus					0.006	12
	Microspathodon chyrsurus					0.11	5
	Mulloidichthys maritinicus					0.006	3
	Myripristis jocobus					0.300	5
	Ocyurus chrysurus					0.023	2
	Scarus croicensis					0.192	12

Table 3 (continued). Density (fish/m^2) and Mean Fork Length (FL) of Fish Species Observed on Each Transect Site for each Sampling Period.

Transect	Fish species	Sampling periods					
		1996		1998		2000	
		Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)	Density (Fish/m^2)	FL (cm)
20*5	*Scarus taeniopterus*					0.006	11
	Scarus vetula					0.006	10
	Serranus tabacarius					0.006	5
	Sparisoma aurofrenatum					0.034	6
	Sparisoma viride					0.034	8
	Stegastes deincaeus					0.011	4
	Stegastes fuscus					0.023	6
	Stegastes leucostictus					0.011	4.5
	Stegastes partitus					0.209	3.5
	Stegastes planifrons					0.057	3.5
	Thalassoma bifasciatum					0.130	4

*Notes:

1. Density is equal to the number of fish species divided by the sampled area, ~176.72 m^2.
2. Transect 5 was not resurveyed in 1998 & 2000 because it was not relocated after storm damage.
3. Transect 13 was not resurveyed in 2000 because it was not relocated after storm damage 1998 & 1999.
4. No fish censuses were performed in 1998 on Transect 17 and 18.
5. Transect 19 and 20 were established in 2000.

Table 4. Overall Density[*1] of Fish Species and Number of Fish per Area for Each Transect for the Three Sampling Periods (1996, 1998, and 2000).

	1996		1998		2000	
Transect No.	Density (Species of fish/m²)	Total Density (Fish/ m²)	Density (Species of fish/m²)	Total Density (Fish/ m²)	Density (Species of fish/m²)	Total Density (Fish/ m²)
1	0.034	0.147	0.006	0.006	0.028	0.108
2	0.119	0.866	0.091	0.424	0.170	1.132
3	0.187	1.280	0.023	0.028	0.028	0.639
4	0.221	2.98	0.085	0.204	0.023	1.370
5[*2]	0.238	1.726				
6	0.045	0.419	0.034	0.079	0.034	0.164
7	0.125	1.177	0.034	0.108	0.125	0.899
8	0.153	0.764	0.034	0.187	0.051	0.164
9	0.096	1.392	0.011	0.215	0.034	0.113
10	0.221	2.796	0.011	0.340	0.051	0.685
11	0.226	3.23	0.068	0.470	0.045	0.424
12	0.062	0.368	0.068	0.922	0.045	0.640
13[*3]	0.345	8.155	0.023	0.996		
14	0.136	0.640	0.023	0.175	0.079	0.843
15	0.0453	0.498	0.017	0.017	0.051	0.526
16	0.034	0.238	0.028	0.113	0.125	2.264
17[*4]	0.051	1.036			0.051	1.79
18[*4]	0.243	7.108			0.091	1.100
19[*5]					0.141	0.866
20[*5]					0.232	3.826

*Notes:

1. Density is equal to the number of fish divided by the sampled area, ~176.72 m².
2. Transect 5 was not resurveyed in 1998 & 2000 because it was not relocated after storm damage.
3. Transect 13 was not resurveyed in 2000 because it was not relocated after storm damage 1998 & 1999.
4. No fish censuses were performed in 1998 on Transect 17 and 18.
5. Transect 19 and 20 were established in 2000.

APPENDIX 1.
Habitat Classification Types and Codes for Data Recorded

Bottom type	Code
Algae	AL
Bedrock	BD
Coral Reef	CR
Gorgonian	GO
Hard Coral	HC
Limestone Hardbottom/Pavement	LS
Mangroves	MG
Mud	MD
Rock	RC
Rubble	RB
Sand	SD
Seagrass	SG
Soft Coral	SC
Sponge	SP

Based on NOAA (draft) and Devine (draft)

APPENDIX 2.
Transect Coordinates, Heading, and Depths

Transect No.	Transect Start Coordinates	heading (degrees)	Depth (m)		
			start	middle	end
1	18° 18.792'N; 64° 49.583'W	0	8	5	3
2	18° 19.407'N; 64° 50.371'W	60	9.3	5	3
3	18° 19.429'N; 64° 50.349'W	60	10	7	3.5
4	18° 19.406'N; 64° 50.165'W	90	10	5	1.5
5	18° 18.726'N; 64° 51.388'W	90	14	12	14
6	18° 19.234'N; 64° 50.349'W	60	15	8.3	5
7	18° 19.405'N; 64° 50.168'W	0	6	3.5	1.5
8	18° 18.375'N; 64° 50.800'W	120	8.5	5	3.5
9	18° 18.392'N; 64° 50.590'W	120	9	5.3	5
10	50m & 30° from transect #9	120	9	7	5
11	18° 18.316'N; 64° 52.450'W	350	2	2.6	1.5
12	18° 18.373'N; 64° 52.488'W	350	1	1.5	2
14	18° 18.794'N; 64° 49.936'W	120	6.6	6.6	6.6
15	18° 18.787'N; 64° 49.957'W	120	10	8	8.3
16	18° 18.753'N; 64° 49.970'W	120	11	10	8.5
17	18° 18.264'N; 64° 50.901'W	90	6.6	3.5	6.6
18	50m & 0° from transect #17	90	7	5	5
19	18° 19.252'N; 64° 50.137'W	120	7.5	6.4	7.5
20	18° 19.244'N; 64° 50.156'W	120	7.5	6.4	7.5

APPENDIX 3.

Coral species observed during Benthic survey, by Family, Common name, Scientific Name and Standardized Codes used for Data Processing.

Family name	Common Name	Scientific name	Code
Scleractinian corals:			
Agarciidae	Lettuce coral	*Agaricia agaricites*	Aga agar
Faviidae	Thin tube coral	*Cladocora debilis*	Cla debi
Meandrinidae	Pillar coral	*Dendrogyra cylindrus*	Den cyli
Faviidae	Elliptical star coral	*Dichocoenia stokesii*	Dic stok
Faviidae	Knobby brain coral	*Diploria clivosa*	Dip cliv
Faviidae	Grooved brain coral	*Diploria labrynthiformis*	Dip laby
Faviidae	Symmetrical brain coral	*Diploria strigosa*	Dip stri
Caryophilliidae	Smooth flower coral	*Eusmilia fastigiata*	Eus fast
Faviidae	Golf ball coral	*Favia fragum*	Fav frag
Faviidae	Maze coral	*Meandrina meandrites*	Mea mean
Faviidae	Mountainous star coral	*Montastrea annularis*	Mon annu
Faviidae	Large star coral	*Montastrea cavernosa*	Mon cave
Poitidae	Mustard hill coral	*Porites asteroides*	Por aster
Poitidae	Thin finger coral	*Porites divaricata*	Por diva
Poitidae	Branched finger coral	*Porites furcata*	Por furc
Poitidae	Club finger coral	*Porites porites*	Por pori
Siderastreidae	Lesser starlet coral	*Siderastrea radians*	Sid radi
Siderastreidae	Massive starlet coral	*Siderastrea siderea*	Sid side
Octocorals:			
Gorgoniidae	Common sea fan	*Gorgonia flabellum*	Gor flabg
Gorgoniidae	Venus sea fan	*Gorgonia ventalina*	Gor vent
Plexauridae	Knobby sea rods	*Eunicea sp.*	Euni spp
Plexauridae	Split pore sea rods	*Plexaurella sp.*	Plex spp
Plexauridae	Porous sea rods	*Pseudoplexaura sp.*	Pseu spp.
Hydrocorals:			
Milleporina	Branching fire coral	*Millepora alcicornis*	Mil alci
Milleporina	Blade fire coral	*Millepora complanata*	Mil comp

APPENDIX 4.

Seagrass and Algae species observed during Benthic Survey, Family, Common Name, Scientific Name and Standardized Codes Used for Data Processing.

Family name	Common Name	Scientific name	Code
Vascular (seagrasses)			
Hydrocharitaceae	Shoal grass	*Halodule wrightii*	Hal wrig
Hydrocharitaceae	Manatee grass	*Syringodium filliforme*	Syr fill
Hydrocharitaceae	Midrib grass	*Halophila decipiens*	Hal deci
Hydrocharitaceae	Turtle grass	*Thalassia testudinum*	Tha test
Phaeophyta – Brown algae			
Dictyotaceae	Y branched algae	*Dictyota cervicornis*	Dic cerv
Dictyotaceae	Encrusting fan leaf algae	*Lobophora variegata*	Lob vari
Dictyotaceae	White scroll algae	*Padina sanctae-crucis*	Pad sanc
Chlorophyta – Green algae			
Caulerpaceae	Flat green feather algae	*Caulepra mexicana*	Cau mexi
Udoteaceae	Three leaf algae	*Halimeda incrassta*	Hal incr
Udoteaceae	Green jointed-stalk algae	*Halimeda monile*	Hal moni
Udoteaceae	Watercress algae	*Halimeda opuntia*	Hal opun
Udoteaceae	Stalk lettuce leaf algae	*Halimeda tuna*	Hal tuna
Udoteaceae	Green net algae	*Microdictyon boergesnii*	Mic boer
Udoteaceae	Mermaid's shaving brush	*Penicilus capitatus*	Pen capi
Udoteaceae	Mermaid's fans	*Udotea flabellum*	Udo flab
Rhodophyta – Red algae			
Rhodomelaceae	----------------------------	*Laurencia intricata*	Lau intr
Cyanophyta – Blue-green algae			
Schizothrichaceae	----------------------------	*Schizothrix calcicola*	Sch calc

APPENDIX 5.
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b
5/9/1996														
5/10/1996														
5/13/1996														
5/16/1996			CT(1)	CT(1)										
5/21/1996							CT(1)	CT(1)						
5/23/1996	CT(1)	CT(1)												
5/29/1996														
5/30/1996													CT(1)	CT(1)
7/29/1996					CT(1)	CT(1)								
8/1/1996											CT(1)	CT(1)		
8/5/1996														
8/13/1996														
9/25/1996														
10/8/1996														
10/9/1996														
10/18/1996														
11/15/1996									CT(1)	CT(1)				
12/8/1996														
12/13/1996														
12/20/1996														
1/7/1997														
1/13/1997														
1/15/1997														
1/17/1997									FC(4)					
2/5/1997			FC(2)		FC(4)									
2/7/1997	FC(4)													
2/24/1997														
2/28/1997													FC(2)	

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b
3/18/1997														
3/19/1997					FC(1)									
3/21/1997														
4/17/1997														
4/20/1997														
4/21/1997														
5/28/1997											FC(4)			
6/6/1997														
6/13/1997							FC(4)							
9/22/1997														
12/13/1997														
6/5/1998														
6/6/1998														
6/9/1998														
6/10/1998														
6/11/1998														
6/12/1998														
6/13/1998	CT(1)													
6/16/1998														
6/17/1998														
6/18/1998														
6/23/1998	FC(1)		FC(1)				FC(1)				FC(1)			
6/30/1998					CT(1)	CT(1)								
7/1/1998			CT(1)											
7/7/1998				CT(1)									CT(1)	
7/8/1998											CT(1)			CT(1)

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	**1a**	**1b**	**2a**	**2b**	**3a**	**3b**	**4a**	**4b**	**5a**	**5b**	**6a**	**6b**	**7a**	**7b**
7/9/1998							CT(1)					CT(1)		
7/10/1998								CT(1)						
7/11/1998														
7/14/1998													FC(1)	
7/15/1998					FC(1)									
7/22/1998														
7/23/1998														
7/25/1998														
7/28/1998														
6/21/2000							CT(1)							
6/23/2000							FC(4)							
6/26/2000								CT(1)			CT(1) FC(2)			
6/27/2000												CT(1)	CT(1) FC(1)	
7/10/2000													FC(2)	CT(1)
7/12/2000					CT(1) FC(6)	CT(1)								
7/18/2000			CT(1) FC(3)	CT(1)										
7/19/2000			FC(1)											
7/20/2000													FC(3)	
7/26/2000			FC(2)											
8/2/2000														
8/3/2000														
8/8/2000														
8/9/2000														
8/10/2000														

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	**1a**	**1b**	**2a**	**2b**	**3a**	**3b**	**4a**	**4b**	**5a**	**5b**	**6a**	**6b**	**7a**	**7b**
1/3/2001														
1/4/2001														
1/12/2001														
1/12/2000														
1/14/2001														
1/14/2001														
1/16/2001	CT(1)	CT(1)												
1/16/2001	FC(4)													
1/19/2001														
1/19/2001														
1/20/2001														
1/20/2001														
1/21/2001														
1/21/2001														

***Note**. CT(#) - number of coral surveys on transect; FC(#) - number of fish censuses on transect.

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	**8a**	**8b**	**9a**	**9b**	**10a**	**10b**	**11a**	**11b**	**12a**	**12b**	**13a**	**13b**	**14a**	**14b**
5/9/1996							CT(1)	CT(1)						
5/10/1996	CT(1)	CT(1)												
5/13/1996			CT(1)	CT(1)										
5/16/1996														
5/21/1996					CT(1)	CT(1)								
5/23/1996														
5/29/1996									CT(1)	CT(1)				
5/30/1996														
7/29/1996														
8/1/1996														
8/5/1996											CT(1)	CT(1)		
8/13/1996														
9/25/1996													CT(1)	CT(1)
10/8/1996														
10/9/1996														
10/18/1996														
11/15/1996														
12/8/1996														
12/13/1996			FC(1)											
12/20/1996													FC(1)	
1/7/1997	FC(1)													
1/13/1997	FC(1)		FC(2)											
1/15/1997														
1/17/1997														
2/5/1997														
2/7/1997														
2/24/1997													FC(4)	
2/28/1997														

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	**8a**	**8b**	**9a**	**9b**	**10a**	**10b**	**11a**	**11b**	**12a**	**12b**	**13a**	**13b**	**14a**	**14b**
3/18/1997	FC(2)													
3/19/1997	FC(1)													
3/21/1997											FC(8)			
4/17/1997							FC(3)							
4/20/1997							FC(1)							
4/21/1997							FC(1)		FC(3)					
5/28/1997														
6/6/1997					FC(2)									
6/13/1997														
9/22/1997														
12/13/1997	FC(1)													
6/5/1998														
6/6/1998														
6/9/1998													FC(1)	
6/10/1998														
6/11/1998													CT(1)	CT(1)
6/12/1998	CT(1)	CT(1)												
6/13/1998					CT(1)									
6/16/1998			CT(1)											
6/17/1998				CT(1)										
6/18/1998					CT(1)	CT(1)								
6/23/1998	FC(1)		FC(1)		FC(1)		FC(1)				FC(1)			
6/30/1998														
7/1/1998														
7/7/1998														
7/8/1998														
7/9/1998														
7/10/1998														

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	**8a**	**8b**	**9a**	**9b**	**10a**	**10b**	**11a**	**11b**	**12a**	**12b**	**13a**	**13b**	**14a**	**14b**
7/11/1998											CT(1)	CT(1)		
7/14/1998														
7/15/1998														
7/22/1998							CT(1)	CT(1)	FC(1)					
7/23/1998									CT(1)	CT(1)				
7/25/1998														
7/28/1998														
6/21/2000														
6/23/2000														
6/26/2000														
6/27/2000														
7/10/2000														
7/12/2000														
7/18/2000														
7/19/2000														
7/20/2000														
7/26/2000														
8/2/2000														
8/3/2000														
8/8/2000														
8/9/2000														
8/10/2000														
1/3/2001	CT(1)	CT(1)												
1/3/2001	FC(4)													
1/4/2001			CT(1)	CT(1)	CT(1)	CT(1)								
1/4/2001			FC(4)		FC(4)									
1/12/2001														
1/12/2000														

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number													
Dates	**8a**	**8b**	**9a**	**9b**	**10a**	**10b**	**11a**	**11b**	**12a**	**12b**	**13a**	**13b**	**14a**	**14b**
1/14/2001														
1/14/2001														
1/16/2001														
1/16/2001														
1/19/2001														
1/19/2001														
1/20/2001														
1/20/2001														
1/21/2001													CT(1)	CT(1)
1/21/2001													FC(4)	

***Note**. CT(#) - number of coral surveys on transect; FC(#) - number of fish censuses on transect.

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number											
Dates	15a	15b	16a	16b	17a	17b	18a	18b	19a	19b	20a	20b
5/9/1996												
5/10/1996												
5/13/1996												
5/16/1996												
5/21/1996												
5/23/1996												
5/29/1996												
5/30/1996												
7/29/1996												
8/1/1996												
8/5/1996												
8/13/1996					CT(1)	CT(1)						
9/25/1996												
10/8/1996		CT(1)										
10/9/1996			CT(1)	CT(1)								
10/18/1996							CT(1)	CT(1)				
11/15/1996												
12/8/1996	CT(1)											
12/13/1996												
12/20/1996			FC(1)									
1/7/1997	FC(3)		FC(1)									
1/13/1997												
1/15/1997					FC(1)							
1/17/1997												
2/5/1997												
2/7/1997												
2/24/1997												
2/28/1997												

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number											
Dates	15a	15b	16a	16b	17a	17b	18a	18b	19a	19b	20a	20b
3/18/1997												
3/19/1997												
3/21/1997												
4/17/1997												
4/20/1997												
4/21/1997												
5/28/1997												
6/6/1997												
6/13/1997												
9/22/1997												
12/13/1997												
6/5/1998												
6/6/1998												
6/9/1998	FC(1)		FC(1)									
6/10/1998		CT(1)										
6/11/1998	CT(1)	CT(1)										
6/12/1998												
6/13/1998												
6/16/1998												
6/17/1998												
6/18/1998												
6/23/1998												
6/30/1998												
7/1/1998												
7/7/1998												
7/8/1998												
7/9/1998												
7/10/1998												

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number											
Dates	**15a**	**15b**	**16a**	**16b**	**17a**	**17b**	**18a**	**18b**	**19a**	**19b**	**20a**	**20b**
7/11/1998												
7/14/1998												
7/15/1998												
7/22/1998												
7/23/1998												
7/25/1998												
7/28/1998							CT(1)	CT(1)				
6/21/2000												
6/23/2000												
6/26/2000												
6/27/2000												
7/10/2000												
7/12/2000												
7/18/2000												
7/19/2000												
7/20/2000												
7/26/2000												
8/2/2000											CT(1)	CT(1)
8/3/2000											FC(3)	
8/8/2000									FC(4)	CT(1)		
8/9/2000									CT(1)			
8/10/2000											FC(2)	
1/3/2001												
1/3/2001												
1/4/2001												
1/4/2001												
1/12/2001									CT(1)	CT(1)		
1/12/2000									FC(4)	FC(4)		

APPENDIX 5. (continued)
Sampling Dates and Parameters Monitored by Transect Number

	Transect Number											
Dates	**15a**	**15b**	**16a**	**16b**	**17a**	**17b**	**18a**	**18b**	**19a**	**19b**	**20a**	**20b**
1/14/2001												
1/14/2001												
1/16/2001												
1/16/2001												
1/19/2001			CT(1)	CT(1)								
1/19/2001			FC(4)									
1/20/2001	CT(1)	CT(1)										
1/20/2001	FC(4)											
1/21/2001												

***Note**. CT(#) - number of coral surveys on transect; FC(#) - number of fish censuses on transect.

APPENDIX 6.

Fish survey data log sheet

Date: Water temperature & Depth: Time started:

Transect: Meter: Time ended:

Species name	Number	Min	Max	Mean

Short description of site:

Diagram of layout of benthic cover

Form by. Barry Volson

APPENDIX 7A.

List of Fish Species Observed During Fish Censes, **Alphabetical by Scientific Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	Common Name	Scientific name	Code
Pomacentridae	Sergeant major	*Abudefduf saxatilis*	Abu saxa
Clinidae	Spinyheaded blenny	*Acanthemblemaria spinosa*	Acanthe spin
Clinidae	Blenny	*Acanthemblemaria* spp.	Acanthe spp.
Acanthuridae	Surgeonfishes	Acanthuridae species	Aca spp.
Acanthuridae	Ocean surgeon	*Acanthurus bahianus*	Aca bahi
Acanthuridae	Doctorfish	*Acanthurus chirurgus*	Aca chir
Acanthuridae	Blue tang	*Acanthurus coeruleus*	Aca coer
Myliobatidae	Spotted eagle ray	*Aetobatus narinari*	Aet nari
Monacanthidae	Orange filefish	*Aluterus schoepfii*	Alu scho
Apogonidae	Cardinalfish	*Apogon* species	Apo spp
Apogonidae	Cardinalfish	*Astrapogon stellatus*	Ast stel
Atherinidae	Silversides	Atherinidae species	Ath spp
Atherinidae	Hardhead silversides	*Atherinomorus stipes*	Ath stip
Aulostomidae	Trumpetfish	*Aulostomus maculates*	Aul macu
Balistidae	Queen triggerfish	*Balistes vetula*	Bal vetu
Blenniidae	Combtooth blennies	Blenniidae species	Ble spp
Labridae	Spanish Hogfish	*Bodianus rufus*	Bod rufu
Bothidae	Peacock flounder	*Bothus lunatus*	Bot luna
Bothidae	Eyed flounder	*Bothus ocellatus*	Bot ocel
Sparidae	Jolthead porgy	*Calamus bajonado*	Cal bajo
Sparidae	Saucereye porgy	*Calamus calamus*	Cal cala
Sparidae	Pluma	*Calamus pennatula*	Cal penn
Monacanthidae	Orangespotted filefish	*Cantherhinus pullus*	Can pullu
Monacanthidae	Whitespotted filefish	*Cantherines macroceros*	Can macr
Tetraodontidae	Sharpnose puffer	*Canthigaster rostrata*	Can rost
Carangidae	Yellow jack	*Caranx bartholomaei*	Car bart
Carangidae	Crevalle jack	*Caranx hippos*	Car hipp
Carangidae	Bar jack	*Caranx ruber*	Car rube
Pomacanthidae	Cherubfish	*Centropyge argi*	Cen argi
Chaetondontidae	Foureye butterflyfish	*Chaetodon capistratus*	Cha capi
Chaetondontidae	Spotfin butterflyfish	*Chaetodon ocellatus*	Cha ocel
Chaetondontidae	Banded Butterflyfish	*Chaetodon striatus*	Cha stri
Chaetondontidae	Butterflyfishes	Chaetondontidae species	Cha spp
Pomacentridae	Blue chromis	*Chromis cyanea*	Chr cyan
Pomacentridae	Blue chromis	*Chromis insolata*	Chr inso
Pomacentridae	Brown chromis	*Chromis multilineata*	Chr mult
Labridae	Creole wrasse	*Clepticus parrae*	Cle parr
Clinidae	Blenny	Clinidae species	Cli spp
Gobiidae	Colon goby	*Coryphoterus dicrus*	Cor dicr

APPENDIX 7A (continued).

List of Fish Species Observed During Fish Censes, **Alphabetical by Scientific Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	Common Name	Scientific name	Code
Gobiidae	Masked/Glass goby	*Coryphoterus personatus*	Cor pers
Gobiidae	Bridled goby	*Coryphoterus glaucofraenum*	Cor glau
Dasytidae	Southern stingray	*Dasyastis americana*	Das amer
Diodontidae	Pufferfish	Diodontidae spp.	Dio spp
Carangidae	Rainbow runner	*Elagatis bipinnulata*	Ela bipi
Serranidae	Rock hind	*Epinephelus adscensionis*	Epi adsc
Serranidae	Graysby	*Epinephelus cruentatus*	Epi crue
Serranidae	Red hind	*Epinephelus guttatus*	Epi gutt
Serranidae	Nassau grouper	*Epinephelus striatus*	Epi stri
Sciaenidae	High hat	*Equetus acuminatus*	Equ acum
Sciaenidae	Spotted drum	*Equetus punctatus*	Equ punc
Gerreidae	Yellowfin mojarra	*Gerres cinereus*	Ger cine
Gobiidae	Gobies	Gobiidae species	Gob spp
Gobiidae	Dash goby	*Gobionellus saepepallens*	Gob saep
Gobiidae	Cleaning goby	*Gobisoma genie*	Gob geni
Grammitidae	Fairy basslet	*Gramma loreto*	Gra lore
Haemulidae	Grunts	Haemulidae species	Hae spp
Haemulidae	Tomtate	*Haemulon aurolineatum*	Hae auro
Haemulidae	Cesar grunt	Haemulon carbonarium	Hae carb
Haemulidae	French grunt	*Haemulon flavolineatum*	Hae flav
Haemulidae	Cottonwick	*Haemulon melanurum*	Hae mela
Haemulidae	White grunt	*Haemulon plumieri*	Hae plum
Haemulidae	Bluestriped grunt	*Haemulon sciurus*	Hae sciu
Labridae	Slippery dick	*Halichoeres bivittatus*	Hal bivi
Labridae	Yellowcheek wrasse	*Halichoeres cyanocephalus*	Hal cyan
Labridae	Yellowhead wrasse	*Halichoeres garnoti*	Hal garn
Labridae	Clown wrasse	*Halichoeres maculipinna*	Hal macu
Labridae	Rainbow wrasse	*Halichoeres pictus*	Hal pict
Labridae	Blackear wrasse	*Halichoeres poeyi*	Hal poey
Labridae	Puddingwife	*Halichoeres radiatus*	Hal radi
Labridae	Wrasse	*Halichoeres* spp	Hal spp
Labridae	Rosy razorfish	*Hemipteronotus martinicensis*	Hem mart
Labridae	Razorfish/Wrasse	*Hemipteronotus* species	Hem spp
Labridae	Green razorfish	*Hemipteronotus spledens*	Hem sple
Hemiramphidae	Balao	*Hemiramphus balao*	Hem bala
Hemiramphidae	Ballyhoo	*Hemiramphus brasiliensis*	Hem bras
Congridae	Brown garden eel	*Heteroconger halis*	Het hali
Pomacanthidae	Queen angelfish	*Holacanthus ciliaris*	Hol cili
Pomacanthidae	Rock beauty	*Holocanthus tricolor*	Hol tric
Holocentridae	Squirrelfishes	Holocentridae species	Hol spp.

APPENDIX 7A (continued).
List of Fish Species Observed During Fish Censes, **Alphabetical by Scientific Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	Common Name	Scientific name	Code
Holocentridae	Sqirrelfish	*Holocentrus adscensionis*	Hol adsc
Holocentridae	Longspine squrrelfish	*Holocentrus rufus*	Hol rufu
Serranidae	Barred hamlet	*Hypoplectrus puella*	Hyp puel
Serranidae	Hamlet	*Hypoplectrus* species	Hyp spp
Gobiidae	Hovering goby	*Ioglossus helenae*	Iog hele
Labrisomidae	Hairy blenny	*Labrisomus nuchipinnis*	Lab nuch
Labridae	Hogfish	*Lachnolaimus maximus*	Lac maxi
Ostraciidae	Spotted trunkfish	*Lactophrys bicaudalis*	Lac bica
Ostraciidae	Honeycomb cowfish	*Lactophrys polygonia*	Lac poly
Ostraciidae	Scrawled cowfish	*Lactophrys quadricornis*	Lac quad
Ostraciidae	Smooth trunkfish	*Lactophrys triqueter*	Lac triq
Lutjanidae	Mutton snapper	*Lutjanus analis*	Lut anal
Lutjanidae	Schoolmaster	*Lutjanus apodus*	Lut apod
Lutjanidae	Cubera snapper	*Lutjanus cyanopterus*	Lut cyan
Lutjanidae	Mutton snapper	*Lutjanus griseus*	Lut gris
Lutjanidae	Lane snapper	*Lutjanus synagris*	Lut syna
Clinidae	Blenny	*Malacoctenus gilli*	Mal gill
Clinidae	Rosy blenny	*Malacoctenus macropus*	Mal macr
Clinidae	Blenny	*Malacoctenus* species	Mal spp
Clinidae	Saddled Blenny	*Malacoctenus triangulates*	Mal tria
Pomacentridae	Yellowtail damselfish	*Microspathodon chyrsurus*	Mic chry
Monacanthidae	Fringed filefish	*Monacanthus ciliatus*	Mon cili
Balistidae	Slender filefish	*Monacanthus tuckeri*	Mon tuck
Mullidae	Yellow goatfish	*Mulloidichthys maritinicus*	Mul mart
Serranidae	Tiger grouper	*Mycteroperca tigris*	Myc tigr
Holocentridae	Blackbar soldier	*Myripristis jocobus*	Myr joco
Lutjanidae	Yellowtail snapper	*Ocyurus chrysurus*	Ocy chry
Blennidae	Redlip blenny	*Ophioblennius atlanticus*	Oph atla
Opistognathidae	Yellowhead jawfish	*Opistognathus aurifrons*	Opi auri
Opistognathidae	Banded jawfish	*Opistognathus macrognathus*	Opi macr
Opistognathidae	Dusky jawfish	*Opistognathus whitehursti*	Opi whit
Belonidae	Keeled needlefish	*Platybelone argalus*	Pla arga
Pomacanthidae	Angelfish	Pomacanthidae species	Pom spp
Pomacanthidae	Gray angelfish	*Pomacanthus arcuatus*	Pom arcu
Mullidae	Spotted goatfish	*Pseudupeneus maculatus*	Pse macu
Scaridae	Parrotfish	Scaridae species	Sca spp
Scaridae	Blue parrotfish	*Scarus coeruleus*	Sca coer
Scaridae	Stripped parrotfish	*Scarus croicensis*	Sca croi
Scaridae	Striped parrotfish	*Scarus iserti*	Sca iser
Scaridae	Princess parrotfish	*Scarus taeniopterus*	Sca taen

APPENDIX 7A (continued).

List of Fish Species Observed During Fish Censes, **Alphabetical by Scientific Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	Common Name	Scientific name	Code
Scaridae	Queen parrotfish	*Scarus vetula*	Sca vetu
Scombridae	Cero	*Scomberomorus regalis*	Sco rega
Carangidae	Bigeye scad	*Selar crumenophthalmus*	Sel crum
Serranidae	Tobaccofish	*Serranus tabacarius*	Ser taba
Serranidae	Harlequin bass	*Serranus tigrinus*	Ser tigr
Serranidae	Chalk bass	*Serranus tortugarum*	Ser tort
Scaridae	Greenblotch parrotfish	*Sparisoma atomarium*	Spa atom
Scaridae	Redband parrotfish	*Sparisoma aurofrenatum*	Spa auro
Scaridae	Redtail parrotfish	*Sparisoma chrysopterum*	Spa chry
Scaridae	Bucktooth parrotfish	*Sparisoma radians*	Spa radi
Scaridae	Redfin parrotfish	*Sparisoma rubripinne*	Spa rubr
Scaridae	Stoplight parrotfish	*Sparisoma viridre*	Spa viri
Scaridae	Parrotfish	*Sparisona* species	Spa spp
Tetraodontidae	Bandtail puffer	*Sphoeroides spengleri*	Sph spen
Tetraodontidae	Marbled puffer	*Sphoeroides testudineus*	Sph test
Sphyraenidae	Great barracuda	*Sphyraena barracuda*	Sph barr
Pomacentridae	Longfin damselfish	*Stegastes deincaeus*	Ste dien
Pomacentridae	Damselfish	*Stegastes dorsopunicans*	Ste dors
Pomacentridae	Dusky damselfish	*Stegastes fuscus*	Ste fusc
Pomacentridae	Beugregory	*Stegastes leucostictus*	Ste leuc
Pomacentridae	Bicolor damselfish	*Stegastes partitus*	Ste part
Pomacentridae	Threespot damselfish	*Stegastes planifrons*	Ste plan
Pomacentridae	Damselfish	*Stegastes* species	Ste spp
Pomacentridae	Cocoa damselfish	*Stegastes variabilis*	Ste vari
Synodontidae	Sand diver	*Synodus intermedius*	Syn inte
Synodontidae	Bluestriped lizardfish	*Synodus saurus*	Syn saur
Labridae	Bluehead wrasse	*Thalassopma bifasciatum*	Tha bifa
Labridae	Rosy razorfish	*Xyrichtys martinicenis*	Xyr mart
Labridae	Pearly razorfish	*Xyrichtys novacula*	Xyr nova

APPENDIX 7B.

List of Fish Species Observed During Fish Censes, **Alphabetical by Family Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	**Common Name**	**Scientific name**	**Code**
Acanthuridae	Surgeonfishes	Acanthuridae species	Aca spp.
Acanthuridae	Ocean surgeon	*Acanthurus bahianus*	Aca bahi
Acanthuridae	Doctorfish	*Acanthurus chirurgus*	Aca chir
Acanthuridae	Blue tang	*Acanthurus coeruleus*	Aca coer
Apogonidae	Cardinalfish	*Apogon* species	Apo spp
Apogonidae	Cardinalfish	*Astrapogon stellatus*	Ast stel
Atherinidae	Silversides	Atherinidae species	Ath spp
Atherinidae	Hardhead silversides	*Atherinomorus stipes*	Ath stip
Aulostomidae	Trumpetfish	*Aulostomus maculates*	Aul macu
Balistidae	Queen triggerfish	*Balistes vetula*	Bal vetu
Balistidae	Slender filefish	*Monacanthus tuckeri*	Mon tuck
Belonidae	Keeled needlefish	*Platybelone argalus*	Pla arga
Blennidae	Redlip blenny	*Ophioblennius atlanticus*	Oph atla
Blenniidae	Combtooth blennies	Blenniidae species	Ble spp
Bothidae	Peacock flounder	*Bothus lunatus*	Bot luna
Bothidae	Eyed flounder	*Bothus ocellatus*	Bot ocel
Carangidae	Yellow jack	*Caranx bartholomaei*	Car bart
Carangidae	Crevalle jack	*Caranx hippos*	Car hipp
Carangidae	Bar jack	*Caranx ruber*	Car rube
Carangidae	Rainbow runner	*Elagatis bipinnulata*	Ela bipi
Carangidae	Bigeye scad	*Selar crumenophthalmus*	Sel crum
Chaetondontidae	Foureye butterflyfish	*Chaetodon capistratus*	Cha capi
Chaetondontidae	Spotfin butterflyfish	*Chaetodon ocellatus*	Cha ocel
Chaetondontidae	Banded Butterflyfish	*Chaetodon striatus*	Cha stri
Chaetondontidae	Butterflyfishes	Chaetondontidae species	Cha spp
Clinidae	Spinyheaded blenny	*Acanthemblemaria spinosa*	Acanthe spin
Clinidae	Blenny	*Acanthemblemaria* spp.	Acanthe spp.
Clinidae	Blenny	Clinidae species	Cli spp
Clinidae	Blenny	*Malacoctenus gilli*	Mal gill
Clinidae	Rosy blenny	*Malacoctenus macropus*	Mal macr
Clinidae	Blenny	*Malacoctenus* species	Mal spp
Clinidae	Saddled Blenny	*Malacoctenus triangulates*	Mal tria
Congridae	Brown garden eel	*Heteroconger halis*	Het hali
Dasytidae	Southern stingray	*Dasyastis americana*	Das amer
Diodontidae	Pufferfish	Diodontidae spp.	Dio spp
Gerreidae	Yellowfin mojarra	*Gerres cinereus*	Ger cine
Gobiidae	Colon goby	*Coryphoterus dicrus*	Cor dicr
Gobiidae	Masked/Glass goby	*Coryphoterus personatus*	Cor pers
Gobiidae	Bridled goby	*Coryphoterus glaucofraenum*	Cor glau

APPENDIX 7B (continued).

List of Fish Species Observed During Fish Censes, **Alphabetical by Family Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	**Common Name**	**Scientific name**	**Code**
Gobiidae	Gobies	Gobiidae species	Gob spp
Gobiidae	Dash goby	*Gobionellus saepepallens*	Gob saep
Gobiidae	Cleaning goby	*Gobisoma genie*	Gob geni
Gobiidae	Hovering goby	*Ioglossus helenae*	Iog hele
Grammitidae	Fairy basslet	*Gramma loreto*	Gra lore
Haemulidae	Grunts	Haemulidae species	Hae spp
Haemulidae	Tomtate	*Haemulon aurolineatum*	Hae auro
Haemulidae	Cesar grunt	Haemulon carbonarium	Hae carb
Haemulidae	French grunt	*Haemulon flavolineatum*	Hae flav
Haemulidae	Cottonwick	*Haemulon melanurum*	Hae mela
Haemulidae	White grunt	*Haemulon plumieri*	Hae plum
Haemulidae	Bluestriped grunt	*Haemulon sciurus*	Hae sciu
Hemiramphidae	Balao	*Hemiramphus balao*	Hem bala
Hemiramphidae	Ballyhoo	*Hemiramphus brasiliensis*	Hem bras
Holocentridae	Squirrelfishes	Holocentridae species	Hol spp.
Holocentridae	Sqirrelfish	*Holocentrus adscensionis*	Hol adsc
Holocentridae	Longspine squrrelfish	*Holocentrus rufus*	Hol rufu
Holocentridae	Blackbar soldier	*Myripristis jocobus*	Myr joco
Labridae	Spanish Hogfish	*Bodianus rufus*	Bod rufu
Labridae	Creole wrasse	*Clepticus parrae*	Cle parr
Labridae	Slippery dick	*Halichoeres bivittatus*	Hal bivi
Labridae	Yellowcheek wrasse	*Halichoeres cyanocephalus*	Hal cyan
Labridae	Yellowhead wrasse	*Halichoeres garnoti*	Hal garn
Labridae	Clown wrasse	*Halichoeres maculipinna*	Hal macu
Labridae	Rainbow wrasse	*Halichoeres pictus*	Hal pict
Labridae	Blackear wrasse	*Halichoeres poeyi*	Hal poey
Labridae	Puddingwife	*Halichoeres radiatus*	Hal radi
Labridae	Wrasse	*Halichoeres* spp	Hal spp
Labridae	Rosy razorfish	*Hemipteronotus martinicensis*	Hem mart
Labridae	Razorfish/Wrasse	*Hemipteronotus* species	Hem spp
Labridae	Green razorfish	*Hemipteronotus spledens*	Hem sple
Labridae	Hogfish	*Lachnolaimus maximus*	Lac maxi
Labridae	Bluehead wrasse	*Thalassopma bifasciatum*	Tha bifa
Labridae	Rosy razorfish	*Xyrichtys martinicenis*	Xyr mart
Labridae	Pearly razorfish	*Xyrichtys novacula*	Xyr nova
Labrisomidae	Hairy blenny	*Labrisomus nuchipinnis*	Lab nuch
Lutjanidae	Mutton snapper	*Lutjanus analis*	Lut anal
Lutjanidae	Schoolmaster	*Lutjanus apodus*	Lut apod
Lutjanidae	Cubera snapper	*Lutjanus cyanopterus*	Lut cyan
Lutjanidae	Mutton snapper	*Lutjanus griseus*	Lut gris

APPENDIX 7B (continued).
List of Fish Species Observed During Fish Censes, **Alphabetical by Family Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

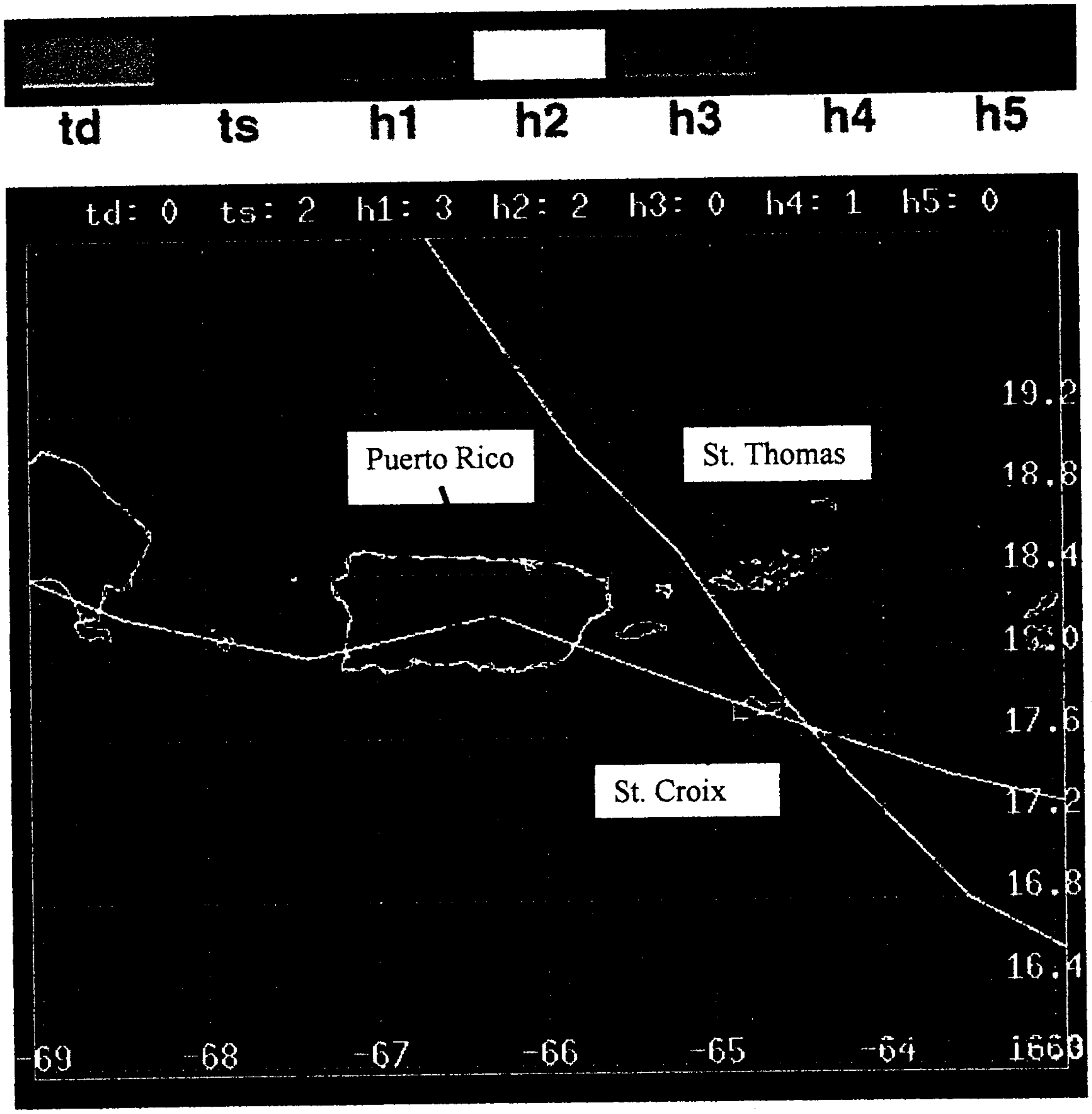
Family name	Common Name	Scientific name	Code
Lutjanidae	Lane snapper	*Lutjanus synagris*	Lut syna
Lutjanidae	Yellowtail snapper	*Ocyurus chrysurus*	Ocy chry
Monacanthidae	Orange filefish	*Aluterus schoepfii*	Alu scho
Monacanthidae	Orangespotted filefish	*Cantherhinus pullus*	Can pullu
Monacanthidae	Whitespotted filefish	*Cantherines macroceros*	Can macr
Monacanthidae	Fringed filefish	*Monacanthus ciliatus*	Mon cili
Mullidae	Yellow goatfish	*Mulloidichthys maritinicus*	Mul mart
Mullidae	Spotted goatfish	*Pseudupeneus maculatus*	Pse macu
Myliobatidae	Spotted eagle ray	*Aetobatus narinari*	Aet nari
Opistognathidae	Yellowhead jawfish	*Opistognathus aurifrons*	Opi auri
Opistognathidae	Banded jawfish	*Opistognathus macrognathus*	Opi macr
Opistognathidae	Dusky jawfish	*Opistognathus whitehursti*	Opi whit
Ostraciidae	Spotted trunkfish	*Lactophrys bicaudalis*	Lac bica
Ostraciidae	Honeycomb cowfish	*Lactophrys polygonia*	Lac poly
Ostraciidae	Scrawled cowfish	*Lactophrys quadricornis*	Lac quad
Ostraciidae	Smooth trunkfish	*Lactophrys triqueter*	Lac triq
Pomacanthidae	Cherubfish	*Centropyge argi*	Cen argi
Pomacanthidae	Queen angelfish	*Holacanthus ciliaris*	Hol cili
Pomacanthidae	Rock beauty	*Holocanthus tricolor*	Hol tric
Pomacanthidae	Angelfish	Pomacanthidae species	Pom spp
Pomacanthidae	Gray angelfish	*Pomacanthus arcuatus*	Pom arcu
Pomacentridae	Sergeant major	*Abudefduf saxatilis*	Abu saxa
Pomacentridae	Blue chromis	*Chromis cyanea*	Chr cyan
Pomacentridae	Blue chromis	*Chromis insolata*	Chr inso
Pomacentridae	Brown chromis	*Chromis multilineata*	Chr mult
Pomacentridae	Yellowtail damselfish	*Microspathodon chyrsurus*	Mic chry
Pomacentridae	Longfin damselfish	*Stegastes deincaeus*	Ste dien
Pomacentridae	Damselfish	*Stegastes dorsopunicans*	Ste dors
Pomacentridae	Dusky damselfish	*Stegastes fuscus*	Ste fusc
Pomacentridae	Beugregory	*Stegastes leucostictus*	Ste leuc
Pomacentridae	Bicolor damselfish	*Stegastes partitus*	Ste part
Pomacentridae	Threespot damselfish	*Stegastes planifrons*	Ste plan
Pomacentridae	Damselfish	*Stegastes* species	Ste spp
Pomacentridae	Cocoa damselfish	*Stegastes variabilis*	Ste vari
Scaridae	Parrotfish	Scaridae species	Sca spp
Scaridae	Blue parrotfish	*Scarus coeruleus*	Sca coer
Scaridae	Stripped parrotfish	*Scarus croicensis*	Sca croi
Scaridae	Striped parrotfish	*Scarus iserti*	Sca iser
Scaridae	Princess parrotfish	*Scarus taeniopterus*	Sca taen
Scaridae	Queen parrotfish	*Scarus vetula*	Sca vetu

APPENDIX 7B (continued).
List of Fish Species Observed During Fish Censes, **Alphabetical by Family Name**
(Including Fish Family, Common Name, Species Name and
Standardized Fish Species Code for Data Processing)

Family name	Common Name	Scientific name	Code
Scaridae	Greenblotch parrotfish	*Sparisoma atomarium*	Spa atom
Scaridae	Redband parrotfish	*Sparisoma aurofrenatum*	Spa auro
Scaridae	Redtail parrotfish	*Sparisoma chrysopterum*	Spa chry
Scaridae	Bucktooth parrotfish	*Sparisoma radians*	Spa radi
Scaridae	Redfin parrotfish	*Sparisoma rubripinne*	Spa rubr
Scaridae	Stoplight parrotfish	*Sparisoma viridre*	Spa viri
Scaridae	Parrotfish	*Sparisona* species	Spa spp
Sciaenidae	High hat	*Equetus acuminatus*	Equ acum
Sciaenidae	Spotted drum	*Equetus punctatus*	Equ punc
Scombridae	Cero	*Scomberomorus regalis*	Sco rega
Serranidae	Rock hind	*Epinephelus adscensionis*	Epi adsc
Serranidae	Graysby	*Epinephelus cruentatus*	Epi crue
Serranidae	Red hind	*Epinephelus guttatus*	Epi gutt
Serranidae	Nassau grouper	*Epinephelus striatus*	Epi stri
Serranidae	Barred hamlet	*Hypoplectrus puella*	Hyp puel
Serranidae	Hamlet	*Hypoplectrus* species	Hyp spp
Serranidae	Tiger grouper	*Mycteroperca tigris*	Myc tigr
Serranidae	Tobaccofish	*Serranus tabacarius*	Ser taba
Serranidae	Harlequin bass	*Serranus tigrinus*	Ser tigr
Serranidae	Chalk bass	*Serranus tortugarum*	Ser tort
Sparidae	Jolthead porgy	*Calamus bajonado*	Cal bajo
Sparidae	Saucereye porgy	*Calamus calamus*	Cal cala
Sparidae	Pluma	*Calamus pennatula*	Cal penn
Sphyraenidae	Great barracuda	*Sphyraena barracuda*	Sph barr
Synodontidae	Sand diver	*Synodus intermedius*	Syn inte
Synodontidae	Bluestriped lizardfish	*Synodus saurus*	Syn saur
Tetraodontidae	Sharpnose puffer	*Canthigaster rostrata*	Can rost
Tetraodontidae	Bandtail puffer	*Sphoeroides spengleri*	Sph spen
Tetraodontidae	Marbled puffer	*Sphoeroides testudineus*	Sph test

APPENDIX 8.

Paths of Major Hurricanes Near or On the U.S. Virgin Islands Between 1989 to 2000



1:73,000 scale

Source: NOAA National Hurricane Center (2000)

APPENDIX 9

Major Hurricanes in the U.S. Virgin Islands Between 1989 to 2000

Date	Maximum sustained wind (mph)	Category	Name
15 September 1989	125	Hurricane category 4	Hugo
7 October 1990	40	Tropical storm	Klaus
16 August 1993	35	Tropical storm	Cindy
16 August 1995	95	Hurricane category 2	Marilyn
9 September 1995	40	Tropical storm	Luis
9 July 1996	80	Hurricane category 1	Bertha
10 September 1996	70	Hurricane category 1	Hortense
22 September 1998	95	Hurricane category 2	George
21 October 1999	65	Hurricane category 1	Jose
17 November 1999	130	Hurricane category 4	Lenny
22 August 2000	75	Hurricane category 1	Debby

Source: NOAA National Hurricane Center (2000)

APPENDIX 10

Table of La Nina and El Nino Episodes between 1989 and 2000

Year	Months of Year			
	Jan/Feb/Mar	Apr/May/Jun	Jul/Aug/Sept	Oct/Nov/Dec
1989	C+	C-		
1990			W-	W-
1991	W-	W-	W	W
1992	W+	W+	W-	W-
1993	W-	W	W	W-
1994			W	W
1995	W			C-
1996	C-			
1997		W	W+	W+
1998	W+	W	C-	C
1999	C+	C	C-	C
2000	C	C-		

Source: NOAA National Hurricane Center (2000)

*Notes: W and C mean warm and cold water temperature respectively.
Weak periods = W- or C-
Moderate periods = C or W
Strong periods = W+ or C+