Nearshore habitats as nursery grounds for recreationally important fishes, St. Croix, U.S. Virgin Islands

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ABSTRACT

Three protected backreef embayments on St. Croix's southeast coast were sampled to determine fish species composition and juvenile fish abundance. The three study sites (Turner Hole Bay, Robin Bay, and Great Pond Bay) were sampled monthly from July 2000 to September 2001. Juvenile reef fish assemblages were sampled using three complementary methods: visual strip transect census, fish trap, and beach seine net. By comparing juvenile fish communities from distinct habitats (patch reef, seagrass, rubble, algal plains, and sand) within the three embayments, significant differences in fish densities and number of species per area were identified. Patch reef and rubble habitats had more fish species per area than any other habitat. Juvenile fish commonly observed in embayments included scarids, labrids and haemulids. The slippery dick, *Halichoeres bivittatus*, the bucktooth parrotfish, *Sparisoma radians*, the spotted goatfish, *Pseudupeneus maculatus*, and newly settled *Haemulon* unknown were among the most abundant species found in embayments. The juvenile phase of certain economically important reef fishes appear to prefer these backreef embayments.

Key Words: juvenile fish, nursery habitat, embayment, backreef

INTRODUCTION

Coastal habitats are extremely productive, diverse, and valuable marine resources (Robblee and Zieman 1984; Rooker and Dennis 1991; Boulon 1992; Lindeman and Snyder 1999). Nearshore habitats such as mangrove systems, seagrass meadows, and backreef areas support highly diverse fish and macro invertebrate communities around the world, and are essential nursery areas for juvenile fishes, lobsters and conchs (Boulon, 1986; Stoner and Waite 1990; and Appeldoorn et al 1997). Furthermore, these coastal habitats support adult fishes foraging on the rich and varied faunas associated with these structurally complex habitat types (Ogden and Zieman 1977; Zieman et al 1982; Robblee and Zieman 1984). Their importance to marine and estuarine species of commercial and recreational value has been widely demonstrated (Ogden and Zieman 1977; Zieman et al 1982; Robblee and Zieman 1984; Rooker and Dennis 1991; Boulon 1992, Lindeman and Snyder 1999; and Nagelkerken et al 2000). The direct value of nearshore habitats as nursery grounds is primarily based on the refugia that these environs provide from predation pressure, resulting in reduced mortality, although feeding links have been found (Robblee 1987; and Corcheret et al, in press). Other studies suggest that habitat complexity, hydrodynamic effects on larval supply and stable substrate may also contribute to the increased abundance and species diversity of nearshore fish communities (Rooker: and Dennis 1991; Dennis 1992; Chabanet and Letourneur 1995 and Nagelkerken et al 2000).

This report documents results from a study of nearshore fish assemblages within three backreef lagoon areas on the southeast end of St. Croix, US. Virgin Islands. This information is essential in the management of these areas to sustain and enhance their ecological and fisheries value as nursery grounds.

Description of Study Sites

The three embayments on the southeast end of St. Croix sampled in this study included: Turner Hole Bay, Robin Bay, and Great Pond Bay (see Figure 1). These embayments are a part of the southeast end bank-barrier reef system that extends from East Point to Vagthus Point (Figure 1).

Turner Hole and Robin Bay are embayments with similar characteristics (Hubbard 1989). They are almost 1,000 m long and approximately 300 m wide over most of their lengths and are enclosed by a narrow barrier reef. In both lagoons, depths range from a maximum of approximately 1 m to 8 m at both eastern and western ends and most of the bottom is covered by seagrasses (*Thalassia testudinum* and *Syringodium filiforme*) occurring in beds of varying density (Hubbard 1989). *Halimeda* spp., *Penicillus* spp, and various species of macro algae are also locally abundant within the seagrass beds (Hubbard 1989). In the deeper portions of both lagoons, areas of sand or thin glass cover are dominated by 10 to 20 cm high sand mounds formed by the burrowing shrimp, *Callianassa* spp. (Hubbard 1989). Other benthic organisms include widely scattered colonies of scleratinian corals such as *Porites astreoides, Montastrea annularis,* and *Diploria* spp. (Hubbard 1989).

The third bay, Great Pond Bay, is approximately 2 km long and 3.5 km wide. It is bounded on its landward side by the baymouth bar and seaward by a continuous coral-algal reef (Bruce et al 1989). The inshore portion of the lagoon is covered by the seagrass, *T. testudinum*, and lesser amounts of *S. filiforme* (Bruce et al 1989). Seaward of that, the majority of the lagoon floor is sand with numerous mounds produced by the burrowing shrimp, *Callianassa* spp. (Bruce et al 1989). Scattered patches of *S. filiforme* occur along with the algae, *Dictyota* spp., and *Penicillus* spp. Scattered coral heads, including *M. anularis, Diploria strigosa* and *Siderastrea* spp., also occur in the lagoon. Lagoon depths range from a maximum of approximately 1 to 7 m at both eastern and western ends.

METHODS

Sampling

Sampling Periods - The nearshore nursery habitats in three protected backreef embayments on St. Croix's southeast coast (Turner Hole Bay, Robin Bay and Great Pond Bay) were sampled monthly, from July 2000 to September 2001. However, due to engine problems with the DFW vessel and bad weather, there was no sampling during the months of November 2000 and April 2001 for all embayments. Also, there were no visual census and trap samplings for Great Pond and Robin Bay in December 2000, for Great Pond in March 2001 and for Robin Bay in August 2001. These were also due to bad weather and engine problems with the DFW vessel.

Sampling Grid - For each bay, a 20 x 20 m grid pattern was laid over a nautical chart of each embayment. Grid intersecting points were labeled with consecutive numbers. This numbered grid was the basis for selecting transect survey sites and trap sites (see below).

Transect Sites - Once a month during the survey period, 10 sites per embayment were randomly selected based on the numbered grid pattern described above. The sample size (10) for transects was based on a preliminary fish census (see Rogers et al l994).

Prior to each transect survey, the compass bearing for the transect line as randomly selected. GPS coordinates were not recorded for each transect. Instead, each location was determined by line of sight with landmarks on the shore. Once at the site, one end of the 50 m transect line tape (marked at 1 cm intervals) was dropped in the water (using a small weight), and the transect line tape was laid by the diver in the direction of the randomly selected compass bearing. A different compass bearing was randomly selected for each of the 10 transect sites sampled each month. At each transect site, two different surveys were completed: (1) a benthic survey; and (2) a fish census. These are discussed in detail below.

Any transect site that had previously been surveyed was discarded and another randomly selected site was chosen until 10 previously not sampled sites were selected. Sites selected for fish traps (see below) were excluded from the universe of possible transect sites within each embayment.

Benthic Surveys - Benthic substrate surveys were conducted at each transect site. The benthic habitat categories selected for this survey included: patch reef, rubble, sand, algal plain, and seagrass (see Adams and Ebersole in press). These habitat classifications are defined in Appendix A.

Habitat categories were recorded along the 50 m transect line. When habitat category changed, the reading along the transect line was recorded to the nearest cm. For areas of mixed substrate composition, the habitat category that dominated the particular area was recorded as the habitat category. The percentage composition of each habitat category (for each transect) was estimated by summing the length of line within a habitat category and dividing by he total length of the transect line (50 m).

Fish Census - At each transect site, a fish census was completed by two divers swimming the 50 m transect line. One diver inspected 2 m to the left of the transect line and the other diver inspected 2 m to the right of the transect line. Thus, each transect surveyed a total of 200 m^2 (50 m x 4 m). Along each transect line, divers recorded observed major habitat category type (see Appendix A) and changes in habitat along the transect, fish species in that habitat category, number of fish present for each species, and fish size categories to the nearest cm.

For each transect site, fish densities within habitats were calculated by summing the number of fish within a habitat and dividing by the total area of that habitat within the transect area (200 m^2 x percentage of a habitat from benthic survey):

For most fish species, the following size categories were used: <5 cm total length (TL), 5-10 cm TL, and >10 cm TL. For small fish species such as wrasses, grunts, gobies, blennies, cardinal fish and damselfish, an additional size category was added (<3 cm TL). For these small fish species, fish. <3 cm TL represented newly settled fish (recruits). However, since fish <3 cm TL are difficult to identify to the species level, identification of recruits was typically limited to the genus level. These are indicated here as species unknown. Data were pooled at the genus level for subsequent analyses.

Fish Traps - Fish traps used in this study were rectangular (92 cm x 57 cm x 19 ctn.) and made from vinyl-coated wire with 1.3 cm bar mesh. Each trap had one escape panel (15 x 10 cm).
The outside rectangular funnel entrance opening measured 23 cm high x 25 cm wide. The funnel was 45.7 cm deep from the outside rectangular opening to the inside oval entrance. The inside funnel opening as 10.2 cm high by 7.6 cm wide. Each trap was baited with approximately 0.5 pounds of herring.

For each embayment, ten fish trap sites were randomly selected each month based on the 20 x 20 m grid (see above). If a grid number was selected as a transect site (see above), it was omitted and never used as a fish trap site. Each trap was fished for 24 hours. All fish caught were identified and measured (total length) to the nearest millimeter, then released. The habitat where each fish trap was set was not recorded due to low visibility on several sampling dates and time constraints.

Each month, 10 new fish trap sites were randomly selected for each embayment. Once a grid site was used as a trap site, that grid site was omitted and not included in the universe for subsequent trap site selection.

Beach Seine The beach seine net measured 30.5 m x 122 cm and had weights and floats attached. The net mesh size was 1.3 cm stretch mesh. Two PVC pipes (1.75 meters long each) were fixed vertically at each end of the net.

Two beach seine hauls were conducted monthly in each embayment. In the first month, the two seine-hauls were done on the east side of each embayment, spaced about 10 to 20 m apart. The following month, the two seine-hauls were repeated on the west side of each embayment. For subsequent months, the seine-haul sites alternated from the east side to the west side of each embayment.

For each seine-haul, one end of the seine net was fixed onshore. The other end of the net was manually pulled out into the water, perpendicular to shore. Once the net was fully extended, the seaward-end of the seine net was pulled to shore in an arc with the shore-end of the net fixed. The total area of the sweep was about 730 m^2 (π x 30.5 m^2 /4). All fish caught in the seine net were identified, enumerated, measured (TL) to the nearest millimeter, and released at the point of capture.

Data Analysis

Visual Census – The distribution of fish density and number of species per area estimates (pooled embayment, transect site and monthly data) were analyzed based on the following procedures.

1. Normality was checked using the Kolmogorov-Smirnov normality test (SPSS Science 1997).

2. If estimates failed the normality test even after log (x + 1) and square root transformations, non-parametric statistics were used to analyze the data.

3. Estimates for each embayment were then compared using the non-parametric Kruskall Wallis One-Way ANOVA on ranks (Sokal and Rohlf 1981).

4. If significant differences were detected, then Dunn's multiple comparison procedure was used to detect differences in mean estimates between embayments.

The Shannon-Weaver Diversity Index H' (Shannon and Weaver 1949) and the evenness index (Pielou 1974) were applied to fish density estimates for each habitat and embayment. These two indices were calculated for each southeast St. Croix embayment by month (pooled transect site data), then for each southeast St. Croix embayment by habitat (pooled transect site and month data). H' and J' estimates (pooled embayment, transect site and monthly data) were analyzed based on the procedures outlined above.

Differences in densities of fish by fish length (size class) among habitats and embayments were also analyzed based on the procedures outline above, except that a two way ANOVA was applied (not the one-way ANOVA as indicated in item 3 above).

A two-way ANOVA on ranks was used to detect differences in fish densities between size classes and habitats (pooled embayment, transect site, and monthly data). If significant differences were detected, then Dunn's multiple comparison procedure was used to identify differences in fish densities between specific fish size classes and habitats.

Similarities of fish assemblages between habitats were measured using the percent similarity formula (PS) based on species presence and fish abundance (Gauch 1982). Transect site, month, and embayment data were pooled for this comparison.

The our most common species ("key fish species") observed in all embayments were selected for further examination. For each of these species, monthly changes in fish densities for each embayment were compared. Monthly changes in densities of recruits (<5 cm TL) of each of these species were also compared. For each key fish species, the distribution of fish density estimates for each embayment (pooled transect site and monthly data) were analyzed using the procedures outline above.

<u>Fish Traps and Seine Nets</u> - The distribution of estimated catch rates of fish and species in traps and seine nets (pooled embayment, trap site and monthly data) was analyzed using the same procedures as outlined above for visual census data.

The four most common fish species caught in fish traps and the three most common fish species caught in seine nets in all embayments were selected for further examination. For each of these key fish species, monthly changes in fish catch rates for each embayment were compared.

The distribution of trap and seine net catch rate estimates for each key species (pooled embayment, trap site, and monthly data) were analyzed using the same procedures as outlined above for visual census data.

RESULTS

Visual Strip Transect Census

For Turner Hole Bay (pooled transect site and monthly data), a total of 4,893 fishes were observed representing 66 species and 23 families (see Table 1). Small (<3 cm TL) newly settled grunts, *Haemulon* unknown, accounted for 26% of fish observed. Differentiation of these very small grunts to the species level was not possible. The slippery dick, *Halichoeres bivittatus,* was the second most abundant fish (12% of fish observed).

For Robin Bay (pooled transect site and monthly data), a total of 4,464 fishes were observed representing 48 species and 21 families (see Table 1). Newly settled grunts (genus *Haemulon)* accounted for 54% of all fish observed and the bucktooth parrotfish, *Sparisoma radians,* accounted for 11% of fish observed.

In Great Pond Bay (pooled transect site and monthly data), a total of 5,314 fishes were observed representing 53 species and 22 families (see Table 1), Small (<3 cm TL) newly settled grunts (genus *Haemulon)* accounted for 66% of fish observed, The French grunt, *H. flavolineatum* (which could be distinguished from congeners) accounted for 9% of all fish observed.

In Turner Hole Bay, seagrass was the dominant habitat sampled (Figure 2) covering almost 80% of the substrate found on transects. It was also the dominant habitat in Robin Bay transects, accounting for 85% of the habitat surveyed. However, Great Pond Bay substrate was dominated by sand (66%) rather than seagrass (20%). Tuner Hole, Robin Bay, and Great Pond Bay patch reefs were scarce, accounting for 2%, 1%, 1% of the substrate surveyed respectively (Figure 2).

Peaks in monthly mean fish density were different for each embayment. In Robin Bay, fish densities peaked in June 2001 whereas in Turner Hole Bay fish densities peaked in August 2001. In Great Pond Bay, fish densities did not show a distinct monthly abundance peak (Figures 3a). Temporal patterns in species densities were similar for the three embayments (see Figure 3b), and showed no clear trends. Species diversity (H') and evenness (J') mean values were also similar for the three embayments (see Figures 4a and b), and showed no clear seasonal trends.

Visual censuses revealed significant differences in fish density, number of species per area, and diversity indices between embayments (see Appendix B, numbers 1 to 3, $p<0.05$). Great Pond had significantly higher fish density than Robin Bay (Appendix B number 1, $p<0.05$). Turner Hole Bay had significantly higher number of species per area than Robin Bay (Appendix B number 2, $p<0.05$) and had a significantly higher diversity index than both of the other embayments (Appendix B number 3, $p<0.05$). However, there were no significant differences in evenness values among embayments (Appendix B number 4, $p>0.05$).

For Turner Hole Bay and Robin Bay, patch reef habitats had the highest number of fish and fish species per area compared with other habitats in those bays (see Figures 5a and b). In Great

Pond Bay, rubble habitats and patch reefs habitats had the highest fish and species densities respectively, compared with other habitats in this bay (Figures 5a and b).

Fish density and number of species per area estimates (pooled embayment, transect site and month data) for each habitat were significantly different (see Appendix B, numbers 5 and 6, $p<0.05$). Patch reef and rubble habitats had significantly higher fish densities than algal plain and sand habitats (see Appendix B, number 5). Patch reef and rubble habitats also had significantly higher number of species per area than other habitats (see Appendix B, number 6).

There were significant differences in H' between habitats (Figure 6a, see Appendix B, number 7, $p<0.05$). Diversity was significantly higher in patch reefs and rubble habitats than algal plain and sand habitats. There was no significant differences in J' between habitats (Figure 6b, see Appendix B, number 8, $p>0.05$).

Results of the two-way ANOVA indicated that there were significant differences in fish (size classes) found in different habitats (Tables 2 and 3, and Appendix C, number 1, $p<0.05$). Dunn's Multiple Comparison Test indicated that for all fish size classes (initially combined, then separately by each size class), patch reefs had significantly higher fish densities than in other habitats (Appendix C, number 1,2,3, and 4, $p<0.05$).

Among all three embayments, divers counted more <5 cm fish in Great Pond Bay than in the other two. More large fish (>10 cm TL) were counted in Turner Hole Bay (see Table 3) than in the other two embayments, however these differences were not significant (see Table 3, Appendix C, number 10, $p>0.05$).

Results of the percentage similarity of species composition, and fish densities between habitats (see Table 4) indicated that algal plains and seagrass beds shared the greatest similarity (67%) followed by rubble and patch reefs (64%). Fish assemblages from sand and patch reef habitats were least similar (15%, see Table 4) in this comparison.

From a total of 72 fish species observed in this study (see Table 1), 18 economically important species from the St. Croix fishery were selected for subsequent analysis. A comparison of length frequencies for each of these 18 economically important species by habitat is made in Table 5. *Sparisoma viride,* and *Scarus iserti* (Table 5) had higher densities of recruits (<5 cm TL) in patch reefs (3.42, and 27.98 recruit/100m^2, than juveniles and subadults (>10 cm TL) (0.12, and 0 subadult/100 m^2, respectively). *Ocyurus chrysurus* recruit (< 5 cm TL) densities (see Table 5) were highest on algal plains (0.41 recruit/100 m^2) while larger individuals (>10 cm TL) were most abundant on patch reefs (0.4 subadult/100m^2). *Lutjanus mahogoni* recruit (< 5 cm TL) densities (see Table 5) were highest on rubble habitats (2.53 recruit/100 m^2) while larger individuals (>10 cm TL) were most abundant on patch reefs (0.37 subadult/100 m^2). Densities of newly settled grunts *Haemulon* unknown (<3 cm TL) were highest on algal plains compared with other habitats (see Table 5).

The four most common species observed in visual transects included: *H. flavolineatum, H. bivittatus, S. radians and Haemulon* unknown (see Table 1). Monthly *H. flavolineatum* densities (for all fish size classes combined) and recruit (<5 cm TL) densities had peaks in September 2001 for Robin Bay (see Figures 7a and 7b). Monthly *H. flavolineatum* densities (for all fish size classes combined) for Turner Hole Bay had a distinctive peak in March 2001 while recruit (<5 cm TL) densities showed a peak in July and August 2000. Monthly *H. flavolineatum* densities (for all fish size classes combined) for Great Pond Bay had peaks in October 2000 and August 2001 while recruit (<5 cm TL) densities peaked in August 2001.

Monthly *H. bivittatus* densities (for all fish size groups combined) and recruit (<5 cm TL) densities are presented in Figures 8a and b. There were no distinct temporal patterns in *H. bivittatus* densities (combined size classes) and recruit (<5 cm TL) densities.

Monthly *S. radians* densities (combined size classes) and recruit (<5 cm TL) densities peaked in September 2000 and August 2001 in Turner Hole (see Figures 9a and b). For Robin Bay, overall *S. radians* density and recruit (<5 cm TL) density had a major peak in July 2001 and June 2001 respectively (see Figures 9a and b). For Great Pond there were no distinct abundance peaks for *S. radians* overall densities (combined size classes) or recruit (<5 cm TL) densities.

Monthly *Haemulon* unknown densities (combined size classes) appeared to peak in June 2001 in Tuner Hole Bay and Robin Bay (see Figure 10a). For *Haemulon* unknown recruits (<5 cm TL), density peaks were similar (compare Figures 10a and b).

Densities of each of the four key species were compared among embayments and no significant differences were observed (Appendix B, number 9-12, p>0.05).

<u>Fish Traps</u> - In Turner Hole Bay, 446 fishes were caught by traps. These fishes represented 31 species and 18 families (Table 6). The fish caught most frequently was the doctorfish, *Acanthurus chirurgus,* accounting for 23% of the total catch, followed by the bucktooth parrotfish, *Sparisoma radians* (19% of total fish caught). At Robin Bay, 322 fishes representing 24 species and 15 families were caught by traps, The bucktooth parrotfish, *S. radians*, accounted for 53% of the total catch followed by the spotted goatfish, *Pseudupeneus maculatus* (14% of total fish caught). At Great Pond Bay, 59 fishes representing 15 species and 11 families were caught by trap. The doctorfish, *A. chirurgus,* accounted for 19% of the catch, followed by the squirrelfish, *Holocentrus* unknown (17% of the total fish caught).

The monthly mean catch per trap-day (for all embayments) ranged from 0.10 to 9.5 fish per trap-day (Figure 11 a). Turner Hole Bay catch per tap-day peaked in September 2001, while that in Robin Bay peaked in July 2001 (sec Figure l la). However, there was no distinct catch rate peak for Great Pond Bay. There were significant differences in the number of fish caught per trap-haul between embayments pooled by month (Appendix B, number 13, p<0.05). Turner Hole Bay and Robin Bay had significantly higher numbers of fish caught per trap-haul than Great Pond Bay.

Monthly number of species caught per trap-day (for all embayments) is presented in Figure 11b. There were no distinct peaks in number of species caught per trap-day for any of the embayments, nor were there significant differences in number of species caught per trap-haul between embayments pooled by month (Appendix B, number 14, $p>0.05$).

In all three embayments, the fish species caught most frequently by traps were *H. flavolineatum, S. radians, P. maculatus* and *A. chirurgus* (Table 6). French grunt, *H. flavolineatum,* catch per trap-day (pooled by month) did not show any clear trends among embayments (see Figure 12a). *S. radians* catch per trap-day was highest in Turner Hole Bay and Robin Bay in September 2001 (Figure 12b). Monthly catch per trap-day for *S. radians* in Great Pond Bay did not show any peak. Monthly catch per trap-day of *P. maculatus* peaked in July 2001 in Robin Bay but there were no distinct peaks from the other embayments (Figure 12c). In Turner Hole Bay, *A. chirurgus* catches showed a distinct peak in October 2000, but no peak was evident for the other two embayments (see Figure 12d).

Analyses of length frequency distributions of *H. flavolineatum, S. radians*, *P. maculatus* and *A. chirurgus* show that trap sampling caught small fish (Figures 13 to 16). Aside from *S. radians*, which is a small species of parrotfish (no reproductive info available), the majority of trapped fish were juveniles. For reference, mean fish sizes at sexual maturity (length at which 50 percent of the population become mature for the first time) are noted in each of these figures. These results indicate that, in general, fish trapped were smaller than their mean size at sexual maturity (Billings and Munro 1974; Munro 1983; and Reeson 1983).

There were no significant differences in catch per trap-haul between embayments for *H. flavolineatum, A. chirurgus*, and *P. maculatus* (Appendix B, numbers 15 to 17, $p>0.05$). However, Turner Hole Bay and Robin Bay had a significantly higher mean number of *S. radians* caught per trap-day than Great Pond Bay (Appendix B, number 18, $p<0.05$, also see Figure 12b).

Monthly changes in length (size class) frequency distribution of key fish species were not compared here because of the small number of fish caught each month.

<u>Beach Seine</u> - In Turner Hole Bay, 77 fishes were caught by seine net representing 14 species and 8 families (Table 7). The permit, *Trachinotus falcatus,* accounted for 16% of Turner Hole seine catches. In Robin Bay, 322 fishes were caught representing 18 species and 13 families. The false pilchard *Harengula humeralis* accounted for 23% of the catches in Robin Bay. At Great Pond Bay, 279 fishes representing 27 species and 14 families were caught. The slender mojarra, *Eucinostomus jonesi,* accounted for 36% of the catch (Table 7).

Mean monthly variations in fish caught per seine-haul for the three bays has ranged from 0 to 54 fish/seine-haul (Figure 17a). In Robin Bay, catch per unit effort (CPUE) was highest in October 2000 (54 fishes per seine-haul).

Mean monthly variations in species caught per seine-haul varied from 0 to 6 species per seine-haul (see Figure 17b). For mean monthly number of species per haul the largest peak was in February and May 2001 in Great Pond Bay (see Figure 17b).

There were significant differences in the number of fish and number of species caught per seine-haul between embayments (Appendix B, numbers 19 and 20, $p>0.05$). Great Pond had a significantly higher (1) number of fish caught per seine haul, and (2) number of species caught per seine haul, than Turner Hole. However there were no significant differences in number of fish caught per seine haul, or number of species caught per seine-haul between Great Pond Bay and Robin Bay (Appendix B, numbers 19 and 20, $p>0.05$).
In all three embayments, three of the most abundant species caught by beach seine were *Caranx latus, T. falcatus* and *E. jonesi* (Table 7). In Robin Bay, *C. latus* had a major peak in January 2001 (Figure 18a). In Great Pond Bay*, E. jonesi* catch per seine-haul peaked in March 2001 (see Figure 18b). For *T. falcatus,* catch per seine-haul was highest in October 2000 in Great Pond Bay (Figure 18c).

Length-frequency distributions of *C. latus, T. falcatus,* and *E. jonesi* from seine hauls for all embayments are presented in Figures 19a to i. For reference, mean fish sizes at sexual maturity are noted in each of these figures. Results here indicate that fish caught by seine-haul were smaller than their mean size at sexual maturity (Thompson and Munro 1974; García-Cagide et al 1994).

There was no significant difference in the number fish caught per seine-haul between embayments for *C. latus*, and *T. falcatus,* based on pooled seine-haul, monthly, and embayment data (Appendix B, numbers 21 to 22, $p>0.05$), However, Great Pond Bay had a significantly higher mean number of *E. jonesi* caught per seine haul than Turner Hole Bay (Appendix B, number 23, $p<0.05$).

DISCUSSION

The fish communities of the back barrier reef lagoons in the southeast of St. Croix have some components in common with other tropical lagoon systems studied in the Caribbean. Studies done on lagoons close to reef ecosystems showed distinct reef fish communities dominated by scarids, haemulids, and labrids (see Rooker and Dennis 1991; Adams and Tobias 1999; Sedberry and Cartier 1993; Mackey 1999 and Nagelkerken et al 2000). Fish assemblages in mangrove lagoons adjacent to reefs in Puerto Rico and St. Croix were mainly composed of members of the families Lutjanidae and Haemulids such as *Lutjanus apodus* and *Haemulon flavolineatum* (see Rooker and Dennis 1991; and Adams and Tobias 1999). Sedberry and Cartier (1993) found that Haemulids such as *H. sciurus* and *H. flavolineatum* dominated the species composition in a survey of fish communities in barrier reef lagoons in Belize. In a Tortola study (Mackey 1999), juvenile fish assemblages on barrier reef lagoons were dominated by *H. aurolineatum* and *H. flavolineatum*. In Curacao, Nagelkerken et al (2000) found *H. flavolineatum* and *S. iserti* were the dominant species of reef fish in a barrier reef lagoon.

In the Caribbean region, the influence of coal reef habitats adjacent to mangrove lagoons and seagrass beds is reflected by greater fish species richness. The exclusive occurrence of several primary coral reef fish species constitutes an additional factor influencing the structure of nearshore fish assemblages of tropical lagoons (see Robblee and Zieman 1984; Gladfelter and Gladfelter 1978; and Nagelkerken et al 2000). Previous studies (Ogden and Zieman 1977; Robblee and Zieman 1984; Shulman 1984; and Robblee 1987) on the foraging behavior of coral reef fishes over seagrass beds suggest that many reef fishes do not seem to recognize seagrass beds, patch reefs, and algal plains as distinct habitats but apparently perceive them as a spatial continuum. Nevertheless, they may partition this continuum temporally by taking shelter on the reefs during the day and foraging on seagrass beds at night (Ogden and Zieman 1977; Robblee and Zieman 1984; Shulman 1984; and Robblee 1987).

In this study the fish assemblages of the three southeast St. Croix embayments showed strong similarities with each other. Dominant among the fish in all the three embayments were newly settled grunts *Haemulon unk., H. flavolineatum*, *Halichoeres bivittatus, and Sparisoma radians.* Turner Hole Bay supported the greatest species diversity with 66 species, whereas Robin Bay had only 41 species (see Table 1). *H. flavolineatum, H. bivittatus* and *Haemulon* unknown, accounted for >66% or all fishes observed by divers in the visual strip transect census. The more abundant fish species found in this study were primarily herbivores and planktivores (Table 1). Some of these dominant species, such as members of the family Haemulidae (*H. flavolineatum* and newly settled grunts of the genus *Haemulon*), are recreationally and commercially important to the local nearshore fishery (Tobias 2000a; and Mateo 2000).

Most fish (95%) inhabiting the backreef lagoon areas (Turner Hole Bay, Robin Bay, and Great Pond Bay) were small (<10 cm TL) and very few (5%) larger fish (>10 cm TL) were observed. These findings suggest that backreef lagoon areas of southeast St. Croix play an important role as nursery grounds for economically important species in the early stages of their life cycle.

Previous studies on tropical reef lagoons in the Caribbean have shown the importance of these habitats for juvenile reef fishes (Ogden and Zieman 1977; Robblee and Zieman 1984; Shulman 1984; McFarland et al 1985; Shulman and Ogden 1987; and Sedberry and Cartier 1993; Mackey 1999 and Nagelkerken et al 2000). Different habitats comprising a reef lagoon system provide heterogeneity in habitat structure that may modify the outcome of biological interactions such as competition and predation (Shulman 1985; and Robblee 1987). These heterogeneous environments may also promote diversity by enhancing recruitment to and maintenance of juvenile fish populations which have requirements for multiple resources (Shulman 1984 and 1985; and Shulman and Ogden 1987).

Parrish (1989) suggested that coastal habitats may intercept large numbers of recruits and may offer some advantages over coral reefs for early survival for settling fish post larvae and developing juveniles. Since many reef ecosystems are of very limited area, they are not favorably situated to receive abundant recruits. Although coral reefs are important habitat for many fish species, they may represent a difficult target for settling planktonic fish larvae due to their small surface area. A strategy of settling nearby in suitable nursery habitats and migrating to the reef later as an adult would seem very adaptive for newly settling fish (Parrish 1989). Those nursery habitats would insure an adequate supply of recruits (migrants) to the reef populations.

Non-reef lagoonal habitats (such as seagrass beds, algal plains, and mangroves systems) may serve as accumulators of recruits since these habitats are often extensive and more continuous than reef habitats (Parrish 1989). These areas are often close to the shore where arriving larvae are more likely to be retained due to their large area and low wave impact. As a result, such areas may effectively intercept and maintain planktonic fish larvae that do not encounter suitable reef habitat for settlement. These alternative nursery habitats may offer improved larval fish settlement survival compared to settlement directly onto reefs (Parrish 1989).

Three factors have been cited as contributing to the increased survival of reef fish recruits on lagoonal habitats: (1) reduced predation intensity (Shulman and Ogden 1987; Sedberry and Cartier 1993; and Nagelkerken et al 2000; (2) increased space availability for settlement of recruits (Shulman 1984; Shulman and Ogden 1987; and Eggleston 1995); and (3) differences in productivity and food availability (Robblee 1987; and Corcheret et al, in press).

Several studies have demonstrated that there is generally a lower density of adult fish in coastal lagoons, and thus piscivory should be absent or greatly reduced in these areas (Shulman and Ogden 1987; Sedberry and Cartier 1993; and Nagelkerken et al 2000). Studies done in barrier reef lagoons in the Caribbean show that recruitment and juvenile reef fish abundance are higher with increased distance from the main reef (Shulman and Ogden 1987; Sedberry and Cartier 1993; and Nagelkerken et al 2000). According to Shulman and Ogden (1987), post settlement mortality and recruitment of newly settled *H. flavolineatum* on Teague Bay had an inverse relationship with increasing distance from the reef. They attributed this to a gradient in predation intensity decreasing with distances very far away from the reefs.

Coastal lagoonal habitats such as seagrass beds and algal plains have been shown to provide protective concealment for newly settling fishes (Shulman 1984; Shulman and Ogden 1987; and Eggleston 1995). Coastal areas where there are high macroalgae cover and high density of seagrass shoots may decrease the foraging efficiency of potential predators (Shulman 1984; Shulman and Ogden 1987; and Eggleston 1995). Also increased productivity of detrivorous benthic and planktonic prey organisms, important food for juvenile fishes found on seagrass beds and algal plains, probably results in increased juvenile fish biomass and species richness in lagoonal habitats relative to other habitats (Robblee 1987; and Corcheret et al, in press).

At the embayments studied here, fish species formed communities within seagrass, sand, patch reefs, algal plains and rubble habitats. The seagrass and algal plain habitats at all embayments were dominated by small resident fish such as *Halichoeres* spp., *S. radians* and juveniles of non-resident, economically important species such as *Huemulon* unknown and *Ocyurus chrysurus*. Patch reef and rubble habitats harbored a higher number of species per unit area and were mostly dominated by small juvenile damselfish, parrotfish, grunts, and doctorfish.

The differences in fish size distributions observed between habitats suggests different habitat preferences by certain sizes of fish. Many local economically important coral reef fish (such as *S. iserti*, *Acanthurus chirurgus*, and *A. bahianus*) recruits were found on patch reefs and rubble habitats. Species such as newly settled grunts *Haemulon* unknown and *O. chrysurus* recruits decades has led to very low levels of herbivorous fish, which normally play an important part in keeping algae from overgrowing reefs (Hughes 1994). In the absence of herbivorous fish, the role of keeping algae levels in check fell to a species of grazing sea urchin *Diadema antillarum* (Hughes 1994). When an epidemic nearly wiped out *D. anti1larum* on Jamaican reefs in the early 1980s, algae quickly overgrew and killed a vast amount of corals (Hughes 1994).

An analogous situation may exist in the embayments of southeast St. Croix. Historically, the coastal areas of St. Croix have been used as fishing grounds by commercial and recreational fishers (William Tobias USVI Division, of Fish and Wildlife personal communication). Creel surveys of recreational fishing activities have found that most of the fish caught from the coastline are of relatively small size (USVI Recreational Fisheries Assessment Study F-8: unpublished data). Throughout the course of this study, commercial fish pots and spearfishing activities were observed within these embayments and illegal fishing activities (such as traps without escape panels and unattended gill nets) were also evident. Although it was not quantified, patch reefs and fore-reefs in the southeastern barrier bank system appeared to have a high cover of macroalgae due to the low number of herbivorous fish and sea urchins (author, personal observation). At present it is unclear whether the high algal cover is related to levels of fishing (past or present) in these embayments.

Seasonal fluctuations in the density of fishes and the number of species per area in southeast St. Croix embayments were observed in most cases with peaks in late summer and lows in winter (Figures 3a and b, and 7a to 10b). These seasonal variations may be related to the reported correlation between increased larvae/juvenile fish settlement and recruitment and summer increases in the number of species and fish present (Williams and Sale 1981; and Doherty and Williams 1988). Many fish species spawn during the spring which coincides with the influx of post larvae and juveniles into estuarine areas in late spring and summer (Williams and Sale 1981; and Doherty and Williams 1988). In this study, summer recruitment pulses were evident for some species such as *Haemulon* unknown and *S. radians,* although the magnitude of these pulses varied between embayments (Figure 7b).

There have been few studies documenting the fish fauna of the southeast coast of St. Croix (Caselle and Warner 1996; Tobias 2001; and Adams and Ebersole, in press). Tobias (2001) reported on a fish survey done in the mangrove lagoon of Great Pond, where the fish assemblage was dominated by Lutjanids (*L. apodus* and *L. griseus*) and Gerreids (*Gerres cinereus*, and *Eucinostomus jonesi*). Tobias (2001) also found that species diversity and abundance of reef fishes were lower than observed in Salt River Bay and Altona Lagoon mangrove ecosystems (see also Adams and Tobias 1999). Tobias (2001) suggested that Great Pond has a lower species richness compared to other mangroves systems in St Croix because Great Pond has a shallower depth, restricted seawater exchange and fresh water input. Larval supply may also be reduced by the limited volume of water entering the pond through the entrance channel (Tobias 2001). Alternatively, the buildup of mud from terrestrial runoff (up to 30 cm in depth) may impact benthic community development, thereby reducing the quality or habitat available to juvenile fishes (Tobias 2001).

Studies addressing reef fish recruitment on the southeast coast of St. Croix have had contrasting results (Caselle and Warner 1996; Adams and Ebersole, in press). Caselle and Warner (1996) studied the spatial and temporal variability in fish recruitment in St. Croix at sites spaced equally around the Island. They found a distinct pattern of reef distribution for the southshore of St Croix. On the south leeward side, fish recruitment rates increased from west to east. They also found that recruitment rates for *T. bifasciatum* and other species were higher during the fall in the south shore. They concluded that physical oceanographic processes appeared to be responsible for patterns of recruitment on the south shore of St. Croix. Despite consistent patterns of recruitment to sites in the south shore of St. Croix, habitat selection did not appear to be important at the scale investigated (Caselle and Warner 1996).

Adams and Ebersole (in press) examined the spatial distribution of some abundant reef fish in the back reef lagoons in St. Croix to determine the relative importance of oceanographic and benthic process on recruitment of coral reef fishes. Results of their study indicated little influence of oceanographic process in distribution of fish recruits among sites but did reveal consistent fish preferences of certain habitats among sites. Lagoonal habitats such as patch reefs and rubble were the most heavily utilized nursery habitats by newly settled grunts, doctorfishes and wrassess, and damselfishes. Species such as *Acanthurus s*pp. and *Haemulon* spp. exhibited ontogenetic habitat shifts and densities of large fishes of these species were strongly related to the quality of lagoon nursery habitats. Our findings suggest that factors such as availability of suitable habitat can be very important in structuring fish communities in tropical lagoons.

In this study we did not find an east to west gradient in densities of post-settlement fishes in any of the habitats at the sites surveyed (Table 3). Turner Hole had a greater species diversity than the other bays. However this may be related to habitat composition, Turner Hole is more heterogeneous than the other embayments (Figure 2.). Nevertheless the differences in abundance of fish recruits between habitats among bays suggests that apparently some species have preferences over certain types of habitats. Abundance of certain species such as *A. chirurgus*, *A. bahianus, S. iserti, E. guttatus,* and *T. bifasciatum* at Turner Hole may be related to the higher amount of substrate cover of their preferred habitats such as rubble and patch reefs (Nagelkerken et al 2000; and Adams and Ebersole, in press) over other embayments. In contrast, newly settled grunts *Haemulon* unk. and the rozy razor fish, *Hemipteronotus martinicensis,* were more frequently observed on Great Pond Bay than any other embayment. This may be related to the higher amount of substrate cover of algal plains and sand over other embayments. Algal Beds are known to be settlement areas for juvenile grunts (Ogden and Zieman 1977; Robblee and Zieman 1984; Shulman 1984; and Shulman and Ogden 1987) whereas the rozy razorfish is typically found on sandy bottoms (Nagelkerken et al 2000; and Mateo 2001).

The three methods used to sample nearshore habitats yield satisfactory although somewhat contrasting results due to biases inherent in each method (Boulon 1992). Fish traps tended to under represent certain species (such as *H. bivittatus*) that apparently avoided traps or were small enough to pass through the trap mesh and not to be caught (Mackey 1999). However, traps allowed accurate total length measurements of the most abundant species. In this study baitfish such as the false pilchard, small permits and slender mojarras were more abundant in seine net catches than in transects and fish traps. However, seines were limited to areas adjacent to the shore without rocky and hard bottom substrates. The visual census method can provide a list of species in an area. It is possible to collect some length frequency information based on visual estimates of fish size. However, visual estimates are not as accurate as actually measuring each fish. Nevertheless, by utilizing these three methods at the same time, a more complete view of the finfish community can be achieved than from any one method alone. Results here document the importance of these nearshore habitats for juvenile fishes. Most fish sampled by trap and beach seine nets were smaller in size than their mean size at sexual maturity (for trap catches see Figures 13 to 16, for beach seine catches see Figures 19a to i).

The fish species composition of the three embayments were also similar to the one found for northeast coast embayments of St. Croix embayments previously surveyed by USVI Division of Fish and Wildlife (Mateo 2001; and Mateo and Tobias 2001). Both studies had similar dominant species within all different methods (visual census: *H. bivittatus, S. radians, Haemulon unknown*; fish traps: S *radians, H. flavolineatum, P. maculatus;* seine nets: *C. latus, T. falcatus* and *E. jonesi*). However, the northeast embayments had a higher number of fish and species per transect than the southeast coast embayments. They also had greater species richness. Trap catch rates were higher in the northeast coast than in the southeast embayments. Northeast trap catches also had higher species diversity than that in southeast embayments.

Overall this study showed that the role of lagoonal habitats of the southeast bank barrier reef system as nursery grounds differs between habitats and it is very much influenced by the distinct patterns of reef fish habitat utilization. Patch reefs and rubble areas harbored the highest densities of juvenile and adult economically important fishes, presumably as a result of their high structurally complexity, which provide protection against predation (Sedberry and Cartier 1993; Nagelkerken et al 2000; and Adams and Ebersole, in press). Meanwhile seagrass beds, the most dominant habitat within the lagoon, was characterized by low fish abundance and species diversity and contained very few commercial species such as yellowtail snapper recruits (*O. chrysurus)* and newly settled grunts (*Haemulon* unknown).

Several studies have shown that fish species richness and abundance on tropical lagoons can be enhanced throughout habitat connectivity between other marine ecosystems (Dennis 1992; Sedberry and Cartier 1993; Mackey 1999; and Nagelkerken et al 2000). Economically important reef fish such as snappers, grunts, and parrotfishes are more abundant in the lagoonal habitats of Belize, Tortola and Curacao than St. Croix because of the presence of nearby mangrove habitats within their seagrass bed-coral reef complex, (Sedberry and Cartier 1993; Mackey 1999; and Nagelkerken et al 2000). The bank barrier reef lagoons of east end of St. Croix do not have an extensive mangrove ecosystem nearby except for a small area in Great Pond (Tobias 2001). In addition, the seagrass meadows that cover most of the portion of the St. Croix north and south east End bank barrier reef lagoons have narrower and shorter *Thalassia testudinum* seagrass blades than other areas in the Caribbean (John Ogden, personal communication). Therefore, they provide a relatively low degree of shelter for economically important reef fishes.

Based on trap and seine net catches in this study (see Table 6), backreef lagoons appeared to be a key foraging grounds for economically important species and also serve as a nursery grounds for juvenile fish. Species caught in traps such as squirrelfishes, grunts, goatfishes and snappers are

Appledoorn, R., J. Beets, J. Bohnsack, S. Bolden, D. Matos, S. Meyers, A. R.osario, Y. Sadovy and W. Tobias. 1992. Shallow Water Reef Fish Stock Assessment for the U.S. Caribbean. NOAA Tech. Memo. NMFS-SEFSC-304. DOC/NOAA/NMFS/SFSC Miami, FL 33149. 70 pp.

Appeldoorn, R.S., C.W. Recksieck, R.L. Hill, F.E. Pagan, and G.D. Dennis. 1997. Marine protected areas and reef fish movements; the role of habitat in controlling ontogenetic movements. Proc. 8th Int: Coral Reef. Symp. 2: 1917-1922.

Baelde, P. 1990. Differences in the structures of fish assemblages in *Thalassia testudinum* beds in Guadalupe, French West Indies, and their ecological significance. Mar. Biol. 105: 163-173.

Billings, V.C. and J.L. Munro. 1974. The biology, ecology, exploitation and management of Caribbean reef fishes: Pomadasydae (grunts). Part 5. Res. Rep. Zool. Dep. Univ. West Indies. 3:1-128 (cited from Fish Base Ver.1.2 1995)

Boulon, R.H. 1986. Distribution of fisheries habitats within the Virgin Islands Biosphere Reserve. Biosphere Reserve Research Report No. 8. 56 pp.

Boulon, R.H. 1992. Use of mangrove proproot habitats by fish in the northern U.S. Virgin Islands. Proc. Gulf and Carib. Fish. Inst. 41: 189-204.

Bruce, G., J. Harkness, J. Hewlett, M. Hill, D. Hubbard, T. McGovern, C. Reed, and H. Roberts. 1989. Sedimentary Environments of Great Pond Bay St. Croix USVI. Pp. 161-166, *in* D. Hubbard (ed.), Terrestrial and Marine Geology of St. Croix, U.S. Virgin Islands, Special Publ. No. 8, West Indies Lab., Teague Bay, St. Croix. 196 pp.

Caselle, J. and R. Warner. 1996. Variability in recruitment of coral reef fishes: the importance of habitat at two spatial scales. Ecology 77(8): 2488-2504.

Chabanet, P. and Y. Letourneur. 1995. Spatial pattern of size distribution of four fish species on Reunion coral reef flats. Hydrobiologia: 299-308.

Clifton, K.E. 1991. Subordinate group members act as food-finders within striped parrotfish Territories. J. Exp. Mar. Biol. Ecol. 145: 141-148.

Cocheret de la Morinière E., B.J.A. Pollux, I. Nagelkerken, G. van der Velde. In press. Can ontogenetic diet changes or spatial distribution of food explain migration patterns of grunts and snappers using mangroves and seagrass beds as nurseries in a Caribbean bay? Est. Coast Shelf. Sci.

Dennis, G.D. 1992. Island mangrove habitats as spawning and nursery areas for commercially important fishes in the Caribbean. Proc: Gulf Carib. Fish. Inst. 41: 205-225.

Doherty, P.J. and D. McB. Williams. 1988. The replenishment of coral reef fish populations. Oceanogr. Mar. Biol. Annu. Rev. 26: 487-551.

Eggleston, D.B. 1995. Recruitment in Nassau grouper (*Epinephelus striatus*): Post-settlement abundance, microhabitat features, and ontogenetic habitat shifts. Mar. Ecol. Prog. Ser. 124: 9-22.

ICLARM. 1995. FishBase: a biological database on fish. Ver 1.2. CD-ROM, ICLARM, Manila, Philippines.

García-Cagide, A., R. Claro, and B.V. Koshelev. 1994. Reproducción. Pp. 187-262. *In:* R. Claro (ed.), Ecología de los peces marinos de Cuba. Inst. Oceanol. Acad. Cienc. Cuba. and Cen. Invest. Quintana Roo (CIQRO) México.

Gauch, H.G.J. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press Cambridge. 314 pp.

Gladfelter, W.B. and E.H. Gladfelter. 1978. Fish community structure as a function of habitat structure on West Indian patch reefs. Rev. Biol. Trop. 26(Supl. 1): 65-84.

Hernandez-Delargo, E. and A. Sabat. 2000. Ecological status of essential fish habitats through an anthropogenic environmental stress gradient in Puerto Rican coral reefs. Proc. Gulf Carib. Fish. Inst. 51: 457-470.

Hubbard, D. 1989. Depositional environments of Turner Hole reef complex. Pp.155-161. *In:* D. Hubbard (ed.) Terrestrial and Marine Geology of St. Croix, U.S. Virgin Islands. Special Publ. No. 8, West Indies Lab., Teague Bay, St. Croix. 196 pp.

Hughes, T.P. 1994 Catastrophes, phase shifts, and large scale degradation of a Caribbean coral reef. Science 265: 1547-1551.

Lindeman, K.C. and D.B Snyder. 1999. Nearshore hardbottom fishes of southeast Florida and effects of habitat burial caused by dredging. Fish. Bull. 97 (1): 508-525.

McFarland, W.N., E.B. Brothers, J.C. Ogden, M.J. Shulman, E.L. Bermingham, and N.M. Kothchian Prentiss. 1985 Recruitment patterns in young French grunts *Haemulon flavolineatum* (family Haemulidae) at St. Croix, Virgin Islands. Fish. Bull. US. 83: 413-426.

Mackey, G. 1999. Habitat utilization by juvenile reef fish. Pp 24 to 25. *In:* Caribbean Marine Protected Areas Project: The role of Marine Protected Areas in Fisheries Management and Biodiversity conservation in Coral Reef Ecosystems. ICLARM Technical Report. 64 pp.

Mateo, I. 2000. Recreational fisheries assessment study F-8: Final Report. U.S.V.I. Division of Fish and Wildlife. 59 pp.

Mateo, I. 2001. Recreational fisheries habitat assessment study F-7: Final Report U.S.V.I. Division of Fish and Wildlife. 72 pp.

Mateo, I. and W. Tobias. 2001. The role of nearshore habitats as nursery grounds for juvenile fishes on the northeast coast of St. Croix, U.S.V.I. Proc. Gulf Carib. Fish. Inst. 52: 512-530.

Munro, J.L. 1983. The biology, ecology and bionomics of the goatfishes, Mullidae. Pp 142-154 *in:* J.L. Munro (ed.), Caribbean coral reef fishery resources. ICLARM Studies and Reviews 7. 276 pp.

Nagelkerken, I., M. Dorenbosch, W.C.E.P. Verbek, E. Cocheret de la Moriniere, and G. Van der Velde. 2000. Importance of shallow-water biotopes of a Caribbean bay for juvenile coral reef fishes: patterns in biotope association, community structure and spatial distribution. Mar. Ecol. Prog. Ser. 202: 175-192.

Nemeth, R.S. and J.S. Nowlis. 2001. Monitoring the effects of land development on the near-shore reef environment. Bull. Mar. Sci. 69 (2): 759-776.

Ogden, J.C. and J.C. Zieman. 1977. Ecological aspects of coral reef, seagrass beds in the Caribbean. Pp 377-389, *In:* R.S.M.A.S. Univ. of Miami (eds.), Proc. 3rd Int. Coral Reef Symp. 656 pp.

Parrish, J.D. 1989. Fish communities of interacting shallow-water habitats in tropical oceanic regions, Mar. Ecol. Prog. Ser. 58: 143-160.

Pielou, E.C. 1974. Population and community ecology: principles and methods. Gordon and Breach Science, London. 424 pp.

Reeson, P.H. 1983. The biology, ecology and bionomics of the surgeonfishes, Acanthuridae. Pp. 178-190, *in.* J.L. Munro (ed.) Caribbean coral reef fishery resources. ICLARM Stud. Rev. 7. 276 pp.

Risk, A. 1997, Effects of habitat on the settlement and postsettlement success of the ocean surgeonish, *Acanthurus bahianus.* Mar. Ecol. Prog. Ser. 61: 51-59.

Robblee, M.B. 1987. Spatial organization of the nocturnal fish fauna of a tropical seagrass feeding ground. Ph.D. Dissertation. University of Virginia. 144 pp.

Robblee, M.B. and J.C. Zieman. 1984. Diel variation in the fish fauna of a tropical seagrass feeding ground. Bull. Mar. Sci. 34(3): 335-345.

Roberts, C.M. 1997. Connectivity and management of Caribbean coral reefs. Science 278 1454-1457.

Rogers, C.S., G. Garrison, R. Grober, Z. Hillis, and M. Franke. 1994. Coral reef monitoring manual for the Caribbean and western Atlantic. National Park Service Publication. 42 pp.

Rooker, J.R. and G.D. Dennis. 1991. Diel lunar and seasonal changes in a mangrove fish assemblage off southwestern Puerto Rico. Bull. Mar. Sci. 49(3): 684-698.

Sedberry, G.R., and J. Cartier. 1993. The fish community of a shallow tropical in Belize, Central America. Estuaries. 16: 198-215.

Shannon, C.E. and W. Weaver. 1949. The mathematical theory of communication. University of Illinois Press, Urbana, Illinois. 163 pp.

Shulman, M.J. 1984. Resource limitation and recruitment patterns in a coral reef fish assemblage. J. Exp. Mar. Biol. Ecol. 74: 85-109.

Shulman, M.J. 1985. Recruitment of coral reef fishes: effects of distribution of predators and shelter. Ecology. 66: 1056-1066.

Shulman, M.J. and J. Ogden. 1987. What controls tropical reef fish populations: recruitment or benthic mortality? An example in the Caribbean reef fish *HaemuIon flavolineatum*. Mar. Ecol. Prog. Ser. 39: 223-242.

Sokal, R.R., and F.J. Rohlf. 1981. Biometry. W.H. Freeman and Company, New York. 959 pp.

SPSS Science. 1997. Sigma Stat 2.0 Statistical Software User's Manual.

Stoner, A.W. and J.M. Waite. 1990. Distribution and behavior of queen conch *Strombus gigas* relative to seagrass standing crop. Fish. Bull. 88: 573-585.

Thompson, R. and J.C. Munro. 1974: The, biology, ecology and exploitation and management of the Caribbean reef fishes. Part V Carangidae (jacks). Res. Rep. Zool. Dep. Univ. West Indies 3:1-43 (cited from Fish Base Ver.1.2 1995).

Tobias, W. 2000. State/Federal Cooperative Fishery Statistics Program. Final Report submitted to National Marine Fisheries Service. Government of the US Virgin Islands. 79 pp.

Tobias, W. 2001. Mangrove habitat as nursery rounds for recreationally important fish species - Great Pond, St Croix, U.S. Virgin Islands. Proc. Gulf Carib. Fish. Inst. 52: 468-487.

Tolimieri N. 1998. Contrasting effects of microhabitat use on large–scale adult abundance in two families of Caribbean reef fishes. Mar. Ecol. Prog. Ser. 111: 1-6.

Williams, D. McB. and P.F. Sale, 1981. Spatial and temporal patterns of recruitment of juvenile coral reef fishes to coral habitats within One Tree Lagoon. Great Barrier Reef. Mar. Biol. 64: 245-253.

Zieman, J.C., S.A. Mack, and A.L. Mills. 1982. The ecology of the seagrasses of south Florida: a community-profile. U.S. Fish. Wildlife. Serv. Biol. Serv. Prog. FWS/OBS-82-85. 152 pp.

known to forage on seagrass beds at night for feeding while they rest during the day over the reef (Ogden and Zieman 1977; Robblee 1987; and Cocheret et al, in press).

These findings have important consequences for the management and conservation of tropical resources. Overexploitation of coastal resources through intense fishing pressure and coastal development are presently the main threats facing coral reefs in the US Caribbean (Appledoorn et al 1992). In Puerto Rico and the U.S. Virgin Islands, coastal development for tourism projects has caused extensive loss and fragmentation of fringing coastal habitats (Hernandez and Sabat 2000; and Nemeth and Nowlis 2001).

Marine protected areas have been shown to be useful tools for fisheries management and the conservation of marine biodiversity (Appledoorn et al 1997; and Roberts 1997). No-take zones will be most effective when they are connected by larval supply from other areas (Roberts 1997). Depending on the area downstream and local retention processes, marine protected areas may predominately act as sources or sinks for pelagic larvae (Roberts 1997). It is possible that mangroves, seagrass beds and backreef lagoons may function as both important sinks for presettlement fishes as well as sources of juveniles and subadults to nearby coral reefs. Risk (1997) found that *A. bahianus* larvae consistently settled in backreef lagoon habitats at Teague Bay St. Croix in preference to fore reefs. This indicated habitat selection by presettlement larvae. Nagelkerken et al (2000) showed similar preferences and ontogenetic habitat shifts for the most common reef fishes from the families Acanthuridae, Lutjanidae, Haemulidae and Scaridae in Curacao. Therefore, marine protected areas should incorporate areas of seagrass, mangrove and backreef lagoon habitats in order to provide adequate settlement habitats for fish larvae and sources of recruitment to coral reefs if protected areas are to be effective.

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LITERATURE CITED

Adams, A. and Ebersole, J. In Dress. Use of Lagoon Habitats and Back Reef by Coral Reef Fishes. Mar. Ecol. Prog. Ser.

Adams, A. and Tobias, W.J. 1999. Red mangrove prop-root habitat as a finfish nursery area: a case study of Salt River Bay St. Croix, U.S.V.I. Proc. Gulf Carib. Fish. Inst. 46:22-46.

Table 1. Total Number of Fish and Species Observed, and Percentage (Number of a Fish Species Observed/Total Number of Fish Observed in an Embayment) for Each Southeast St. Croix Embayment from July 2000 and September 2001 Based on Pooled Monthly and Transect Site Data. Number of Transects per Embayment: Turner Hole=130; Robin Bay=110; Great Pond=110

FAMILY	SPECIES	Turner Hole Bay No. of Fish	Turner Hole Bay Percent	Robin Bay No. of Fish	Robin Bay Percent	Great Pond Bay No. of Fish	Great Pond Bay Percent
Acanthuridae	*Acantharus bahianus*	238	4.86	65	1.46	41	0.77
	Acanthurus chirurgus	360	7.36	185	4.14	75	1.41
	Acanthurus coeruleus	19	0.39	7	0.16	16	0.30
Apogonidae	*Apogon unk.*	1	0.02	1	0.02	2	0.04
Aulostomidae	*Aulostomus maculatus*	2	0.04	*	*	*	*
Balistidae	*Balistes vetula*	2	0.04	2	0.04	1	0.02
	Canthidermis sufflamen	*	*	1	0.02	*	*
Bothidae	*Bothus lunatus*	2	0.04	*	*	*	*
Carangidae	*Caranx crysos*	7	0.14	*	*	4	0.08
	Caranx ruber	9	0.18	2	0.04	29	0.55
Chaetodontidae	*Chaetodon capistratus*	5	0.10	4	0.09	8	0.15
	Chaetodon striatus	9	0.18	7	0.16	1	0.02
Diodontidae	*Diodon hystrix*	*	*	*	*	1	0.02
Gerreidae	*Gerres cinereus*	1	0.02	1	0.02	*	*
Gobiidae	*Coryphopterus glaucofraenum*	2	0.04	*	*	28	0.53
	Gobiosoma unk.	*	*	1	0.02	*	*
Haemulidae	*Haemulon unk.*	1278	26.12	2450	54.88	3495	66.13
	Haemulon carbonarium	*	*	*	*	8	0.15
	Haemulon flavolineatum	446	9.12	283	6.34	477	8.98
	Haemulon plumieri	94	1.92	4	0.09	18	0.34
Pomacanthidae	*Holocanthus ciliaris*	2	0.04	1	0.02	11	0.21
Holocentridae	*Holocentrus adscensionis*	60	1.23	5	0.11	5	0.21
	Myripristis jacobus	22	0.45	1	0.02	*	*
Labridae	*Doratonotus megalepsis*	*	*	1	0.02	*	*
	Bodianus rufus	*	*	*	*	1	0.02
	Halichoeres unk.	*	*	*	*	2	0.04
	Halichoeres bivittatus	574	11.73	357	8	351	6.61
	Halichoeres garnoti	10	0.20	*	*	*	*
	Halichoeres poeyi	42	0.86	10	0.22	3	0.06
	Halichoeres radiatus	2	0.04	*	*	*	*

Table 1 (continued). Total Number of Fish and Species Observed, and Percentage (Number of a Fish Species Observed/Total Number of Fish Observed in an Embayment) for Each Northeast St. Croix Embayment from July 2000 and September 2001 Based on Pooled Monthly and Transect Site Data. Number of Transects per Embayment: Turner Hole=130; Robin Bay=110; Great Pond=110

FAMILY	SPECIES	Turner Hole Bay		Robin Bay		Great Pond Bay	
		No. of Fish	Percent	No. of Fish	Percent	No. of Fish	Percent
Labridae	*Hemipteronotus martinicensis*	7	0.14	14	0.31	172	3.24
	Hemipteronotus splendens	2	0.04	2	0.04	4	0.08
	Thalassoma bifasciatum	441	9.01	49	1.10	37	0.70
Lutjanidae	*Lutjanus mahogoni*	31	0.63	91	2.04	8	0.15
	Lutjanus analis	2	0.04	*	*	*	*
	Lutjanus synagris	1	0.02	*	*	4	0.08
	Ocyurus chrysurus	74	1.51	17	0.38	33	0.62
Monacanthidae	*Monacanthus ciliatus*	5	0.10	10	0.22	4	0.08
Malacanthidae	*Malacanthus plumieri*	6	0.12	*	*	*	*
Mullidae	*Mulloidicthys martinicus*	2	0.04	*	*	*	*
	Pseudupeneus maculatus	22	0.45	68	1.52	3	0.06
Ostraciidae	*Lactophrys triqueter*	1	0.02	1	0.02	3	0.06
Paralichthydae	*Paralichthys tropicus*	3	0.06	*	*	2	*
Pomacanthidae	*Pomacanthus paru*	2	0.04	*	*	*	*
Pomacentridae	*Abudefduf saxatilis*	8	0.16	*	*	*	*
	Chromis cyanea	3	0.06	*	*	*	*
	Chromis multilineata	12	0.25	*	*	*	*
	Microspathodon chrysurus	10	0.20	1	*	*	*
	Stegastes fuscus	32	0.65	16	0.36	11	0.21
	Stegastes leucostictus	280	5.72	125	2.80	76	1.43
	Stegastes partitus	100	2.04	56	2.04	32	0.60
	Stegastes planifrons	4	0.08	4	0.09	2	0.04
	Stegastes variabilis	1	0.02	*	*	14	0.26
Scaridae	*Cryptotomus roseus*	8	0.16	10	0.22	60	1.13
	Scarus iserti	133	2.72	104	2.33	96	1.81
	Sparisoma aurofrenatum	29	0.59	1	0.02	*	*
	Sparisoma radians	319	6.52	471	10.55	88	1.66
	Sparisoma viride	36	0.74	11	0.25	22	0.41
	Sparisoma chrysopterum	25	0.51	*	*	*	*
Sciaenidae	*Equetus acuminatus*	9	0.18	*	*	2	0.04
Scombridae	*Scomberomorus regalis*	1	0.02	*	*	*	*
Serranidae	*Epinephelus guttatus*	29	0.59	5	0.11	2	0.04

Table 1 (continued). Total Number of Fish and Species Observed, and Percentage (Number of a Fish Species Observed/Total Number of Fish Observed in an Embayment) for Each Southeast St. Croix Embayment from July 2000 and September 2001 Based on Pooled Monthly and Transect Site Data. Number of Transects per Embayment: Turner Hole=130; Robin Bay=110; Great Pond=110

FAMILY	SPECIES	Turner Hole Bay		Robin Bay		Great Pond Bay	
		No. of Fish	Percent	No. of Fish	Percent	No. of Fish	Percent
Serranidae	*Epinephelus fulvus*	17	0.35	5	0.11	*	*
	Hypoplectrus unicolor	2	0.04	*	*	*	*
	Serranus tabacarius	1	0.02	*	*	*	*
	Serranus tigrinus	2	0.04	1	0.02	3	0.06
Sparidae	*Calamus bajonado*	2	0.04	*	*	*	*
Sphyraenidae	*Sphyraena barracuda*	3	0.06	*	*	*	*
Sygnathidae	*Cosmocampus elucens*	1	0.02	1	0.02	*	*
Synodontidae	*Synodus foetens*	*	*	*	*	1	0.02
Tetradontidae	*Canthigaster rostrata*	21	0.43	6	0.13	13	0.24
	Sphoeroides spengleri	23	0.47	7	0.16	26	0.49
	Total Number of Fish	4893		4464		5314	
	Total Number of Species	66		41		47	

Mean (Standard Error) Community Parameters of fish censused with visual transects during July 2000 to September 2001. All months were pooled.

	Turner Hole Bay	Robin Bay	Great Pond Bay
No. of fish/100m^2	18.6 (2.02)	20.5 (3.7)	23.7 (2.7)
No of species/100m^2	2.87 (0.2)	1.99 (0.18)	1.98 (0.17)
Diversity Index (H')	0.92 (0.04)	0.62 (0.04)	0.50 (0.04)
Evenness (J')	0.82 (0.01)	0.80 (0.02)	0.75 (0.02)

*none observed

Table 2. Number of Fish Observed and Number of Fish Densities By Size Groups and By Habitat Based on Pooled Monthly, Transect Site, and Southeast St, Croix Embayment Data (July 2000 to September 2001).

Habitat	Habitat Area* (m^2)	Habitat Cover (%)	No. of Species Observed	No. of Fish Observed (Mean No. Fish/100 m^2) <5 cm	5-10 cm	>10 cm	Total	Density Fish / 100m^2	Species / 100m^2
Seagrass	43759	62.51	46	3526 (8.05)	806 (1.84)	198 (0.45)	4530	10.3	0.1
Algal Plain	5770	8.24	35	4543 (78.7)	123 (2.13)	6 (0.10)	4672	80.9	0.6
Patch Reef	790	1.13	62	2143 (271.2)	796 (100.5)	348 (44.05)	3287	416.5	2.2
Sand	18416	26.31	15	294 (1.59)	85 (0.46)	56 (0.30)	435	2.36	0.5
Rubble	1265	1.81	39	1454 (114.9)	242 (19.1)	51 (4.03)	1747	119.1	9.5
Total	70000			11960	2052	659	14671		

*note: Area = Total area of habitat surveyed in transects.

Table 3. Number of Fish Observed and Fish Densities By Fish Size Groups and Southeast St. Croix Embayments, Number of Species per 100 rn^2 by Embayment; and Number of Fish Observed and Fish Densities by Fish Size Groups by Habitat and Southeast St. Croix Embayment (July 2000 to September 2001).

Site	Bay Size (*1) (km^2)	Survey Area(*2) (m^2)	No. of Species Observed	No. of Fish Observed (Fish/100m^2) <5 cm	5-10 cm	>10 cm	Total	Species /100m^2
Turner Hole Bay	0.37	26,000	66	3436 (13.2)	1050 (7.8)	407 (1.56)	4893 (18.8)	0.2
Robin Bay	0.64	22,000	41	3678 (16.7)	639 (6.5)	147 (0.66)	4464 (20.2)	0.2
Great Pond Bay	2.30	22,000	47	4846 (22.01)	363 (7.5)	105 (0.47)	5314 (24.1)	0.2
Total		70,000		11960 (17.1)	2052 (2.9)	659 (0.94)	14671 (20.9)	
	Habitat Area (*3) (km^2)	Habitat Surveyed (*4) (m^2)		No. of Fish Observed (Fish/100 m^2) <5 cm	5-10 cm	>10 cm	Overall	
Turner Hole Bay	0.37							
Seagrass	0.30	20895		1059 (5.1)	227 (1.1)	130 (0.6)	1416 (6.7)	
Algal Plain	0.01	712		487 (68.4)	13 (1.8)	1 (0.1)	501 (70.3)	
Patch Reef	0.01	473		1176 (248.6)	592 (125.1)	225 (47.6)	1993 (421.3)	
Sand	0.04	3077		55 (1.78)	4 (0.13)	4 (0.13)	63 (2.04)	
Rubble	0.01	843		659 (78.2)	214 (25.3)	47 (5.6)	920 (109.1)	
Robin Bay	0.64							
Seagrass	0.54	18692		1876 (10)	520 (2.78)	52 (0.3)	2448 (13.1)	
Algal Plain	0.02	773		622 (80.5)	9 (1.2)	0 (0)	631 (81.6)	
Patch Reef	0.01	147		502 (341.5)	75 (51.)	87 (59.2)	664 (451.7)	
Sand	0.06	2042		2 (0.1)	8 (0.4)	4 (0.2)	14 (0.7)	
Rubble	0.01	346		676 (195.4)	27 (7.8)	4 (1.1)	707 (204.3)	
Great Pond Bay	2.30							
Seagrass	0.44	4173		591 (14.2)	59 (1.4)	16 (0.4)	666 (15.9)	
Algal Plain	0.44	4284		3434 (80.2)	101 (0.2)	5 (0.1)	3540 (82.5)	
Patch Reef	0.02	170		465 (273.5)	129 (75.9)	36 (21.2)	630 (370.6)	
Sand	1.38	13297		237 (1.3)	73 (0.4)	48 (0.3)	358 (1.94)	
Rubble	0.00	76		119 (156.6)	1 (1.31)	0 (0)	120 (157.8)	

*notes

1. Area Estimated using a planimeter.

2 Survey area is the area surveyed by the benthic visual survey within each embayment.

3. Habitat Area = Bay Size estimated using a planimeter x Habitat Percent Cover estimated from benthic visual transects.

4 Habitat Surveyed is the area of each habitat surveyed by the benthic visual survey within each embayment.

Table 4. Percent Similarity Values Between Habitats Sampled Based on Percent Similarity of Species Composition and Fish Densities From Pooled Monthly, Transect Site, and Southeast St Croix Embayment Data (July 2000 to September 2001).

	Seagrass	Patch Reef	Algal Plain	Sand	Rubble
Seagrass		36	67	50	61
Patch Reef			21	15	64
Algal Plain				61	4
Sand					40
Rubble					

Table 5. Number of Fish per Size Group and Fish Densities of 18 Economically Important Species By Habitat for Southeast St. Croix Embayments, Based on Pooled Monthly, Transect Site, and Embayment Data between July 2000 and September 2001.

	No. of Fish in Each Size Group						No. of Fish/100m²				
Species	Family Acanthuridae										
A. bahianus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	69	47	26	142	0	8.7	5.94	3.3	17.9
	Rubble	0	96	20	1	117	0	7.58	1.58	0.08	9.24
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	5	0	0	5	0	0.08	0	0	0.08
	Seagrass	20	33	0	0	53	0.04	0.07	0	0	0.11
	Total	20	203	67	27	317					
A. chirurgus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	1	152	119	96	368	0.13	19.2	15.1	12.1	46.6
	Rubble	16	92	18	2	128	1.26	7.3	1.4	0.16	10.1
	Sand		1	0	0	1	0	0.08	0	0	0.08
	Algal Plain	3	3	0	0	6	0.05	0.05	0	0	0.1
	Seagrass	19	54	0	0	73	0.04	0.12	0	0	0.16
	Total	39	302	137	98	576					
A. coeruleus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	29	8	10	6	53	3.67	1.01	1.26	0.75	6.7
	Rubble	0	2	1	0	3	0	0.25	0.13	0	0.38
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	
	Total	29	10	11	6	56					
	Family Haemulidae										
H. carbonarium	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	0	0	0	0	0	0	0	0	0
	Rubble	0	0	0	0	0	0	0	0	0	0
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	8	0	0	8	0	0.14	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total	0	8	0	0	8					
H. flavolineatum	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	277	106	20	403	0	35.1	13.4	2.53	51.
	Rubble	0	47	1	0	48	0	3.71	0	0.08	3.8
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	251	294	0	0	545	4.35	5.09	0	0	9.44
	Seagrass	32	196	0	0	228	0.07	0.44	0	0	0.51
	Total	283	814	107	20	1224					
H. plumieri	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	43	30	14	87	0	5.44	3.8	1.77	11.01
	Rubble	0	1	1	0	2	0	0.08	0.08	0	0.16
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	16	0	0	16	0	0.28	0	0	0.28
	Seagrass	0	20	0	0	20	0	0.04	0	0	0.04
	Total	0	167	32	14	125					
Haemulon spp.	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	245	5	1	1	252	31.1	0.63	0.13	0.13	31.8
	Rubble	552	70	0	0	622	43.6	5.5	0	0	49.2
	Sand	239	0	0	0	239	1.3	0	0	0	1.3
	Algal Plain	3620	41	0	0	3661	62.7	0.7	0	0	63.4
	Seagrass	2355	0	0	3	2358	5.4	0	0	0.01	5.4
	Total	7011	116	1	4	7248					

Table 5 (continued). Number of Fish per Size Group and Fish Densities of 18 Economically Important Species By Habitat for Southeast St. Croix Embayments, Based on Pooled Monthly, Transect Site, and Embayment Data between July 2000 and September 2001.

	No. of Fish in Each Size Group						No. of Fish/100m^2				
Species	Family Lutjanidae										
O. chrysurus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	0	12	3	15	0	0	1.5	0.38	1.89
	Rubble	0	4	1	0	5	0	0.3	0.1	0	0.41
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	24	2	0	26	0	0.4	0.03	0	0.44
	Seagrass	0	70	9	0	79	0	0.2	0.02	0	0.18
	Total	0	98	24	3	125					
L. mahogoni	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	17	1	2	19	0	2.15	0.12	0.25	2.41
	Rubble	0	32	0	0	32	0	2.52	0	0	2.52
	Sand	0	1	0	0	1	0	0.01	0	0	0.01
	Algal Plain	0	17	0	0	17	0	0.29	0	0	0.29
	Seagrass	0	30	1	0	31	0	0.07	0	0	0.07
	Total	0	97	2	2	101					
L. synagris	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	0	0	0	0	0	0	0	0	0
	Rubble	0	0	0	0	0	0	0	0	0	0
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	2	0	0	2	0	0.004	0	0	0.004
	Total		2			2					
L. analis	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	0	0	0	0	0	0	0	0	0
	Rubble	0	0	0	0	0	0	0	0	0	0
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	2	2	0	0	0	0.004	0.004
	Total	0	0	0	2	2					
	Family Scaridae										
S. aurofrenatum	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	22	2	8	32	0	2.78	0.25	1.01	4.05
	Rubble	0	0	3	0	3	0	0	0.24	0	0.24
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total	0	22	5	8	35					
S. chrysopterum	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	3	4	15	22	0	0.38	0.51	1.89	2.78
	Rubble	0	0	0	0	0	0	0	0	0	0
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total	0	3	4	15	22					
S. iserti	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	58	162	8	0	228	7.3	20.51	1.01	0	28.8
	Rubble	10	48	20	0	78	0.8	3.81	1.58	0	6.1
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	6	0	0	6	0	0.11	0	0	0.1
	Seagrass	4	17	0	0	21	0.01	0.04	0	0	0.05
	Total	72	233	28	0	333					

Table 5 (continued). Number of Fish per Size Group and Fish Densities of 18 Economically Important Species By Habitat for Southeast St. Croix Embayments, Based on Pooled Monthly, Transect Site, and Embayment Data between July 2000 and September 2001.

		No. of Fish in Each Size Group					No. of Fish/100m^2				
Species	Family Scaridae										
S. viride	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	27	20	4	51	0	3.4	2.51	0.51	6.41
	Rubble	0	14	2	1	17	0	1.1	0.25	0.13	2.15
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total	1	40	22	5	68					
	Family Serranidae										
E.fulvus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	1	8	6	15	0	0.13	1.01	0.76	1.89
	Rubble	0	1	1	5	7	0	0.08	0.08	0.4	0.55
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total	0	2	9	11	22					
E.cruentatus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	0	0	1	1	0	0	0	0.13	0.13
	Rubble	0	0	0	0	0	0	0	0	0	0
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total				1						
E.guttatus	Habitat	<3cm	<5cm	5-10cm	>10cm	Total	<3cm	<5cm	5-10cm	>10cm	Total
	Patch Reef	0	0	14	16	30	0	0	1.77	2.02	3.79
	Rubble	0	0	3	3	6	0	0	0.24	0.24	0.48
	Sand	0	0	0	0	0	0	0	0	0	0
	Algal Plain	0	0	0	0	0	0	0	0	0	0
	Seagrass	0	0	0	0	0	0	0	0	0	0
	Total			17	19	36					

Table 6. Total Number of Fish and Species Caught by Fish Trap and Percentage (Number of a Fish Species Caught/Total Number of Fish Caught m an Embayment) for Each Southeast St. Croix Embayment between July and September 2001 Based on Pooled Monthly Data. Number of trap-days per embayment: Turner Hole=130, Robin Bay =110 Great Pond =110

FAMILY	SPECIES	Turner Hole Bay		Robin Bay		Great Pond Bay	
		No. of Fish	Percent	No. of Fish	Percent	No. of Fish	Percent
Acanthuridae	*Acanthurus chirurgus*	105	23.54	19	5.81	13	21.31
	Acanthurus bahianus	*	*	8	2.45	*	*
	Acanthurus coeruleus	4	0.90	7	2.14	1	1.64
Aulostomidae	*Aulostomus maculatus*	5	1.12	1	0.31	*	*
Balistidae	*Balistes vetula*	3	0.67	*	*	*	*
	Canthidermis sufflamen	*	*	3	0.92	*	*
Bothidae	*Paralichthys spp*	*	*	*	*	*	*
Chaetodontidae	*Chaetodon capistratus*	6	1.35	3	0.92	5	8.20
	Chaetodon ocellatus	*	*	1	0.31	*	*
	Chaetodon striatus	3	0.67	*	*	2	3.28
Haemulidae	*Haemulon aurolineatum*	1	0.22	1	0.31	*	*
	Haemulon flavolineatum	40	8.97	19	5.81	9	14.75
	Haemulon chrysargyreum	3	0.67	*	*	*	*
	Haemulon plumieri	7	1.57	2	0.61	*	*
	Haemulon striatum	*	*	1	0.31	*	*
Holocentridae	*Holocentrus unk.*	37	8.30	16	4.89	10	16.39
	Myripristis jacobus	2	0.45	6	1.83	1	1.64
Labridae	*Halichoeres bivittatus*	4	0.90	1	0.31	*	*
	Halichoeres radiatus	1	0.22	*	*	*	*
	Lachnolaimus maximus	*	*	1	0.31	1	1.64
Lutjanidae	*Lutjanus mahogoni*	4	0.90	*	*	*	*
	Lutjanus apodus	*	*	1	0.31	*	*
	Lutjanus synagris	*	*	*	*	6	9.84
	Ocyurus chrysurus	48	10.76	*	*	1	1.64
Monacanthidae	*Monacanthus ciliatus*	4	0.90	*	*	*	*
Mullidae	*Mulloidicthys martinicus*	1	0.22	6	1.83	*	*
	Pseudupeneus maculatus	57	12.78	46	14.07	5	8.20
Muraenidae	*Gymnothorax moringa*	8	1.79	4	1.22	*	*
Ostraciidae	*Lactophrys triqueter*	*	*	2	0.61	2	3.28
Paralichthydae	*Paralichthys spp*	*	*	*	*	*	*
Pomacanthidae	*Pomacanthus paru*	4	0.90	*	*	2	3.28
Pomacentridae	*Stegastes leucostictus*	1	0.22	1	0.31	*	*
Scaridae	*Sparisoma radians*	84	18.83	173	52.91	1	1.64
Serranidae	*Alphestes afer*	4	0.90	2	0.61	*	*
	Epinephelus fulvus	1	0.22	*	*	*	*
	Epinephelus guttatus	1	0.22	*	*	*	*
	Epinephelus striatus	1	0.22	*	*	*	*
Sciaenidae	*Equetus acuminatus*	1	0.22	*	*	*	*
Sparidae	*Calamus bajonado*	3	0.67	*	*	*	*
	Calamus calamus	1	0.22	*	*	*	*

Table 6. Total Number of Fish and Species Caught by Fish Trap and Percentage (Number of a Fish Species Caught/Total Number of Fish Caught m an Embayment) for Each Southeast St. Croix Embayment between July and September 2001 Based on Pooled Monthly Data. Number of trap-days per embayment: Turner Hole=130, Robin Bay =110 Great Pond =110

FAMILY	SPECIES	Turner Hole Bay No. of Fish	Turner Hole Bay Percent	Robin Bay No. of Fish	Robin Bay Percent	Great Pond Bay No. of Fish	Great Pond Bay Percent
Tetradontidae	*Sphoeroides spengleri*	2	0.45	3	0.92	2	3.28
	Total Number of Fishes	446		327		61	
	Total Number of Species	31		24		15	

Mean (Standard Error) Community Parameters of fish caught with traps during July 2000 to September 2000. All months were pooled.

	Turner Hole Bay	Robin Bay	Great Pond Bay
No. of fish/trap-day	1.53 (0.79)	2.30 (0.79)	0.45 (0.22)
No. of species/trap-day	1.00 (0.27)	0.43 (0.12)	0.33 (0.15)

*not caught

Table 7. Total Number of Fish and Species Caught b Seine Net and Percentage (Number of a Fish Species Caught/Total Number of Fish Caught in an Embayment) for Each Southeast St. Croix Embayment (28 seine hauls/embayment) between July 2000 and September 2001 Based on Pooled Monthly Data.

		Turner Hole Bay		Robin Bay		Great Pond Bay	
FAMILY	SPECIES	No. of Fish	Percent	No. of Fish	Percent	No. of Fish	Percent
Acanthuridae	*Acanthurus bahianus*	*	*	*	*	1	0.36
	Acanthurus chirurgus	*	*	1	0.31	1	0.36
	Acanthurus coeruleus	*	*	*	*	3	1.08
Carangidae	*Caranx hippos*	10	12.99	4	1.24	*	*
	Caranx latus	13.	16.88	40	12.42	6	*
	Trachinotus falcatus	15	19.48	54	16.77	46	*
	Trachinotus goodei	4	5.19	1	0.31	1	0.36
Clupeidae	*Harengula humeralis*	*	*	45	13.98	11	*
	Harengula clupeola	*	*	114	35.40	4	*
Engraulidae	*Anchoa unk.*	*	*	1	0.31	8	2.87
	Hypoatherina harringtonensis	*	*	10	3.11	12	4.30
Exocoetidae	*Hemiramphus braciliencis*	8	10.39	4	1.24	39	13.98
Gerreidae	*Gerres cinereus*	5	6.49	*	*	15	5.38
	Eucinostomus jonesi	6	7.79	22	6.83	61	21.86
Haemulidae	*Haemulon flavolineatum*	*	*	*	*	10	3.58
	Haemulon plumieri	*	*	*	*	1	0.36
	Haemulon carbonarium	*	*	*	*	1	0.36
	Anisotremus surinamensis	*	*	4	1.24	*	*
	Haemulon album	*	*	*	*	1	0.36
Lutjanidae	*Lutjanus apodus*	3	3.90	8	10.39	17	6.09
	Lutjanus synagris	2	2.60	*	*	1	0.36
	Ocyurus chrysurus	*	*	*	*	11	3.94
Monacanthidae	*Monacanthus ciliatus*	1	1.30	1	0.31	*	*
Ostraciidae	*Lactophrys triqueter*	1	1.30	*	*	1	0.36
	Lactophrys polygonia	1	1.30	1	0.31	1	0.36
Paralichthydae	*Paralychthys tropicus*	*	*	*	*	1	0.36
Polynemidae	*Polydactylus virginicus*	6	7.79	10	3.11	11	3.94
Scaridae	*Sparisoma radians*	*	*	1	0.31	3	1.08
Sciaenidae	*Umbrina coroides*	*	*	1	0.31	*	*
Sphyraenidae	*Sphyraena barracuda*	*	*	*	*	9	3.23
Tetradontidae	*Sphoeroides spengleri*	2	2.60	*	*	3	1.08
	Total Number of Fish	77		322		279	
	Total Number of Species	14		18		27	

Mean (Standard Error) Community Parameters of fish caught with seine nets during July 2000 to September 2001.

	Turner Hole Bay	Robin Bay	Great Pond Bay
No. of fish/seine haul	2.92 (0.64)	11.42 (3.6)	10.43 (2.4)
No. of species/seine haul	1.13 (0.3)	3.37 (0.28)	0.17 (0.42)

*not caught.

Figure 1. Location of the three southeast St. Croix (U.S.V.I.) embayments surveyed (Turner Hole Bay, Robin Bay, and Great Pond Bay)

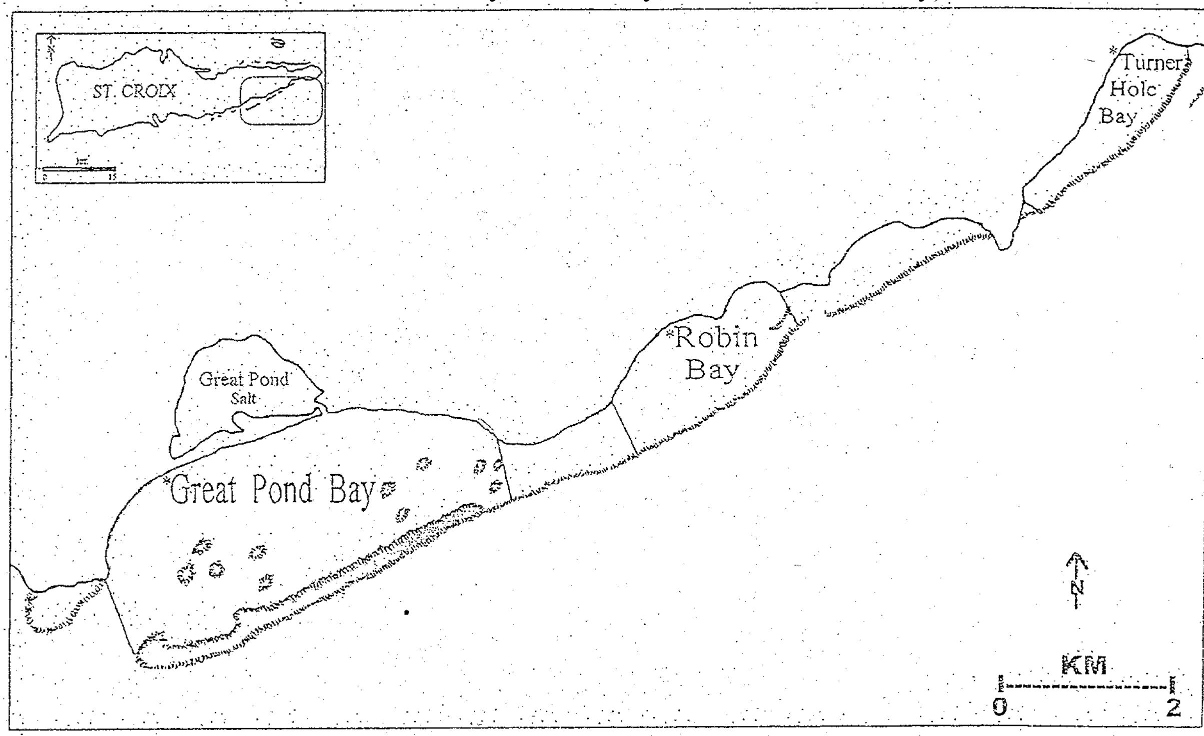


Figure 2. Substrate Percentage Composition for Southeast St. Croix Embayments based on Pooled Month and Transect Site Data (Total Area of Each Bay Covered on Transects: Turner Hole =26,000m^2, Robin Bay = 22,000m^2, Great Pond = 22,000m^2).

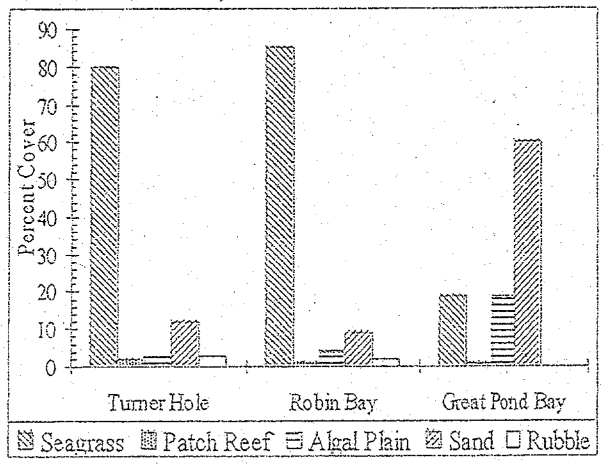
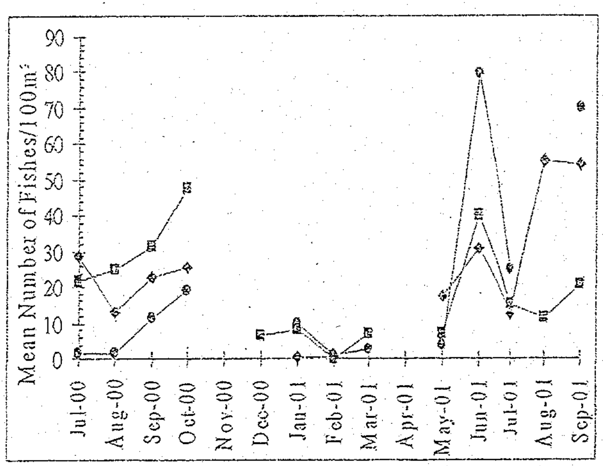
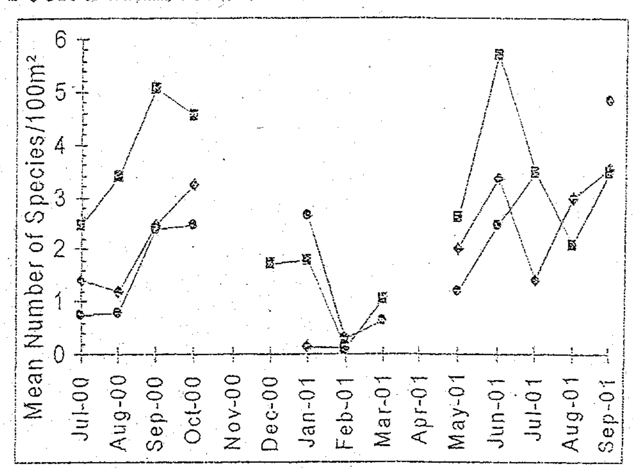


Figure 3a. Mean Monthly Fish Densities For Each Southeast St. Croix Embayment based on Pooled Transect Site Data.



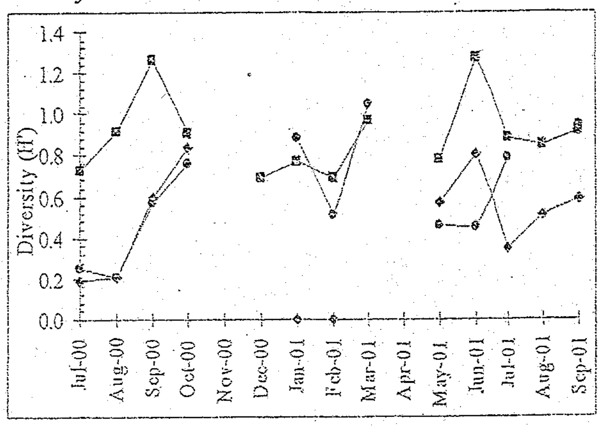
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 3b. Mean Monthly Number of Species for Each Southeast St. Croix Embayment based on Pooled Transect Site Data



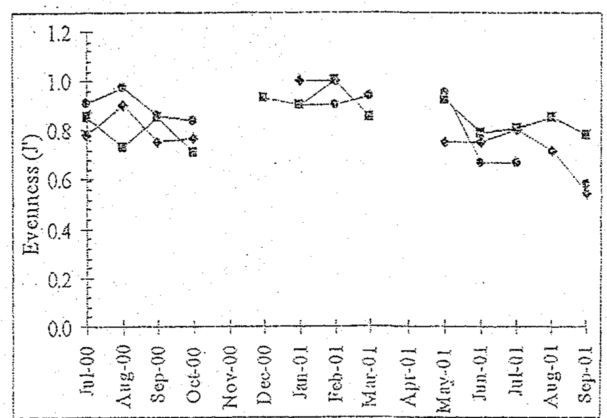
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 4a. Monthly Shannon Wiener Diversity Index (H') For Each Southeast St. Croix Embayment based on Pooled Transect Site Data



Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 4b. Monthly Pielou Evenness Index (J') For Each Southeast St. Croix Embayment Based on Pooled Transect Site Data



Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 5a. Mean Fish Densities For Southeast St. Croix Embayment By Habitat Based on Pooled Monthly and Transect Site Data

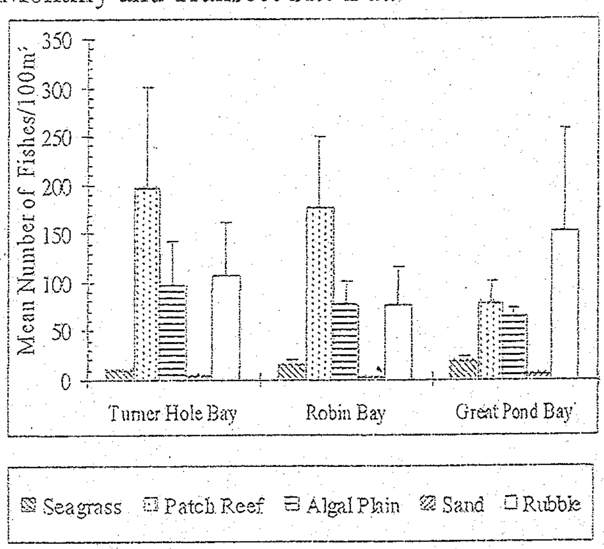


Figure 5b. Mean Number of Species For Southeast St. Croix Embayments By Habitat Based on Pooled Monthly and Transect Site Data

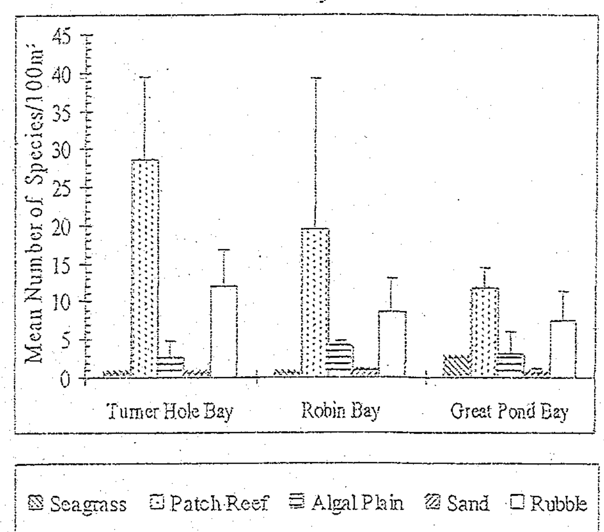


Figure 6a. Shannon Wiener Diversity Indexes (H') For Southeast St. Croix Embayments By Habitat Based on Pooled Monthly and Transect Site Data

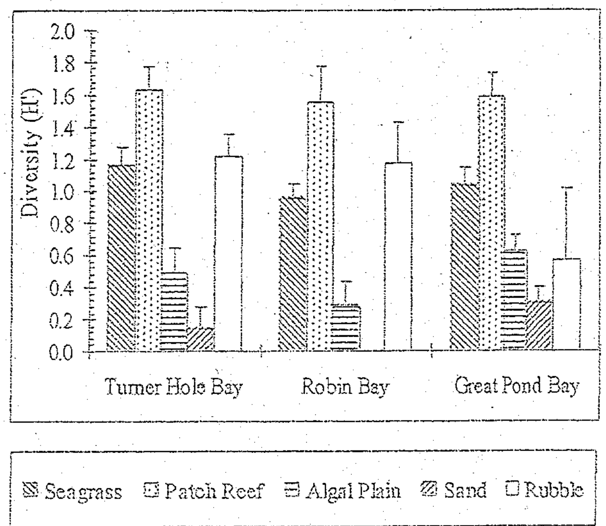


Figure 6b. Pielou Evenness Index (J') For Southeast St. Croix Embayments By Habitat Based on Pooled Monthly and Transect Site Data

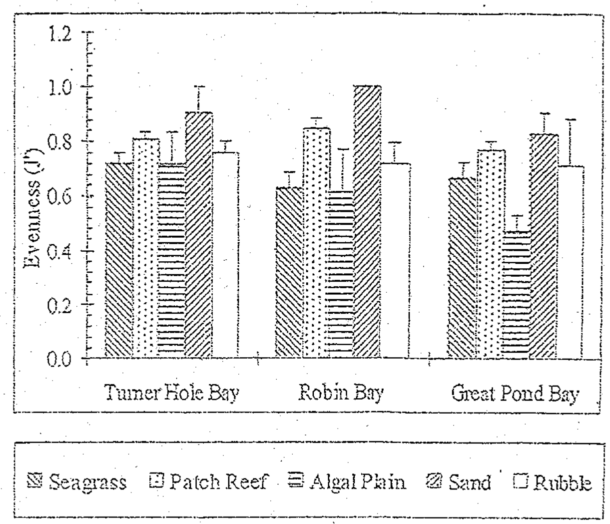
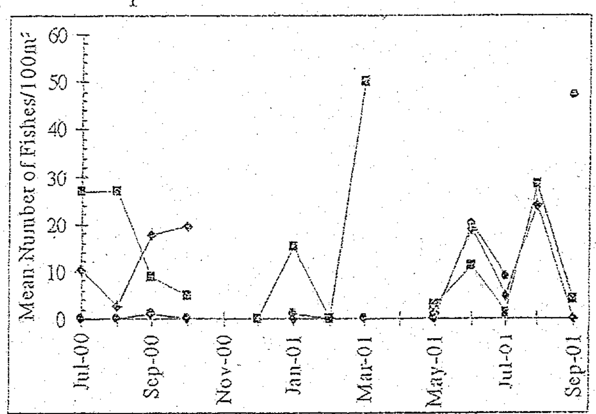
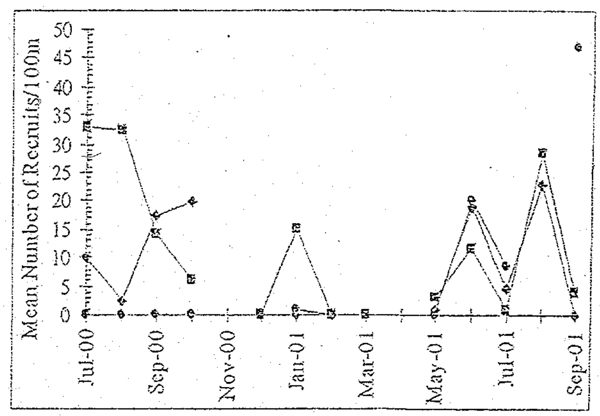


Figure 7a. Mean Monthly *Haemulon flavolineatum* Densities for Southeast St. Croix Embayments Based on Pooled Transect Site and Size Group Data.



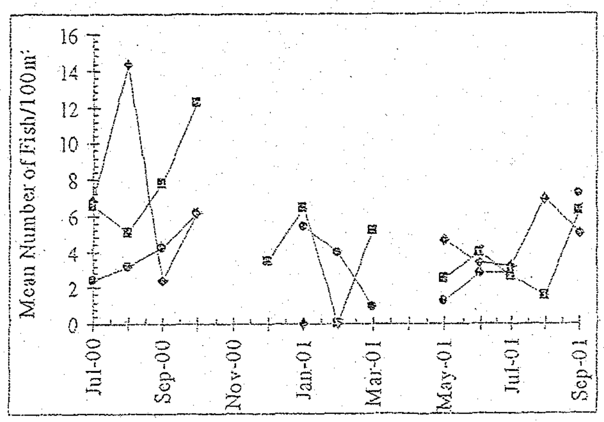
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 7b. Mean *Monthly Haemulon flavolineatum* Recruit (< 5 cm TL) Densities for Southeast St. Croix Embayments Based on Pooled Transect Site Data.



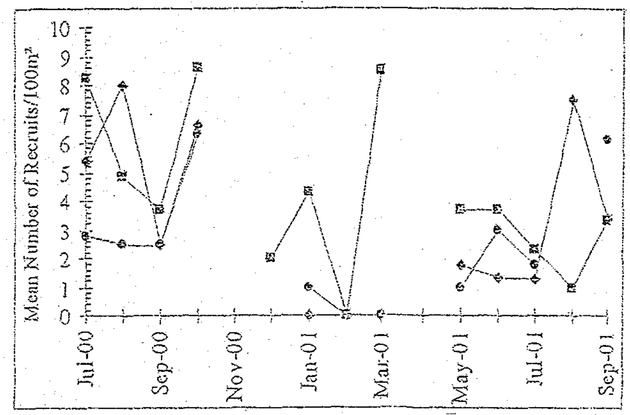
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 8a. Mean Monthly *Halichoeres bivittatus* Densities for Southeast St. Croix Embayments Based on Pooled Transect Site and Size Group Data



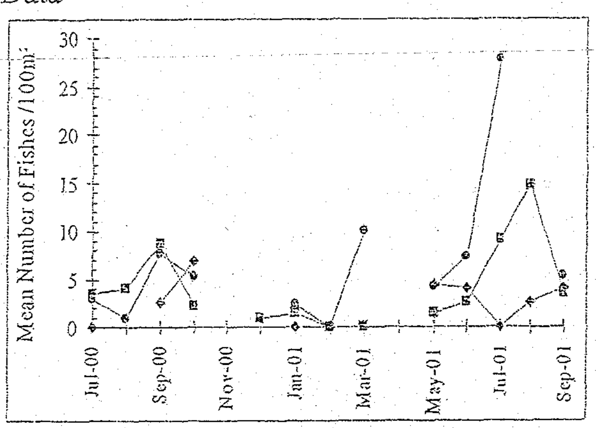
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 8b. Mean Monthly *Halichoeres bivittatus* Recruit (<5 cm TL) Densities for Southeast St. Croix Embayments Based on Pooled Transect Site Data.



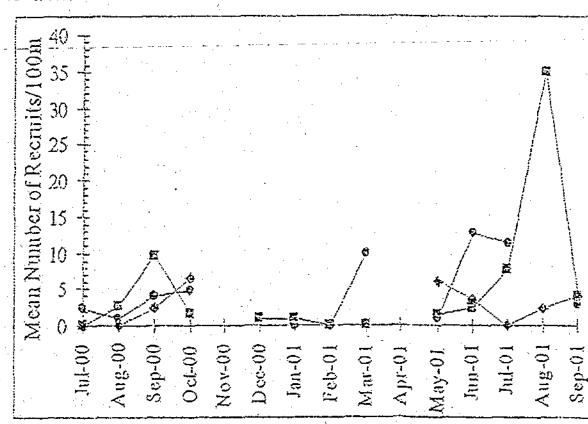
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 9a. Mean Monthly *Sparisoma radians* Densities for Southeast St. Croix Embayments Based on Pooled Transect Site and Size Group Data



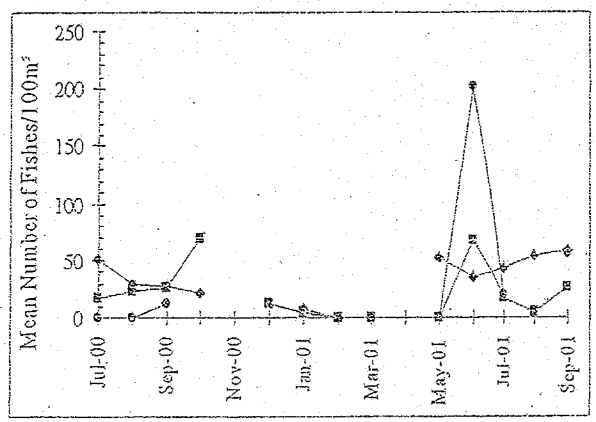
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 9b. Mean Monthly *Sparisoma radians* Recruit (<5 cm TL) Densities for Southeast St. Croix Embayments Based on Pooled Transect Site Data.



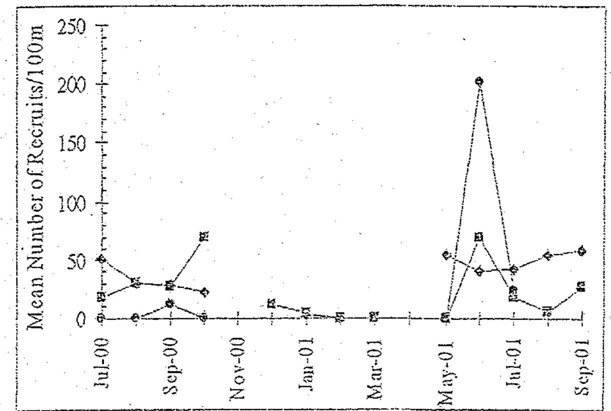
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 10a. Mean Monthly *Haemulon* spp. Densities for Southeast St. Croix Embayments Based on Pooled Transect Site and Size Group Data



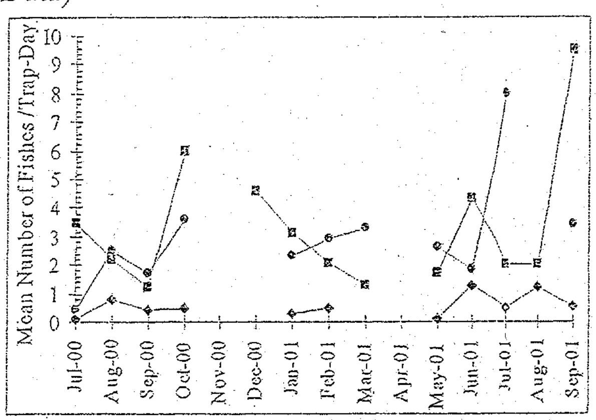
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 10b. Mean Monthly *Haemulon* spp. Recruit (<5cm TL) Densities for Southeast St. Croix Embayments Based on Pooled Transect Site Data



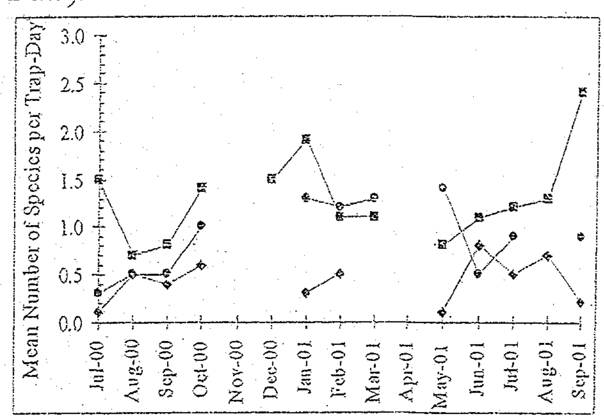
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 11a. Mean Number of Fish Caught Per Trap-Day in Southeastern St. Croix Embayments by Month (Pooled Trap-day Data)



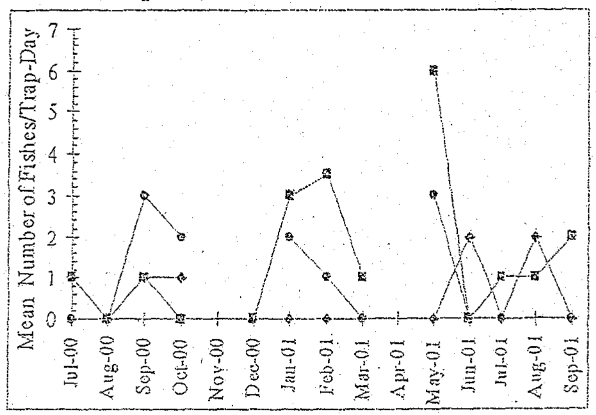
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 11b. Mean Number of Species Caught Per Trap-day in Southeast St. Croix Embayments by Month (Pooled Trap-day Data).



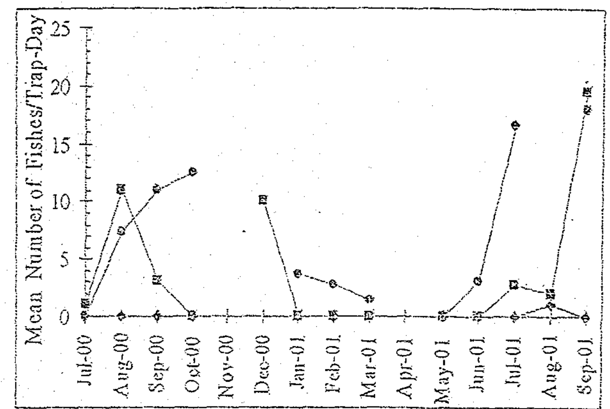
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 12a. Monthly Mean Number of *Haemulon flavolineatum* Caught Per Trap-Day for Southeast St. Croix Embayments Based on Pooled Trap-day Data



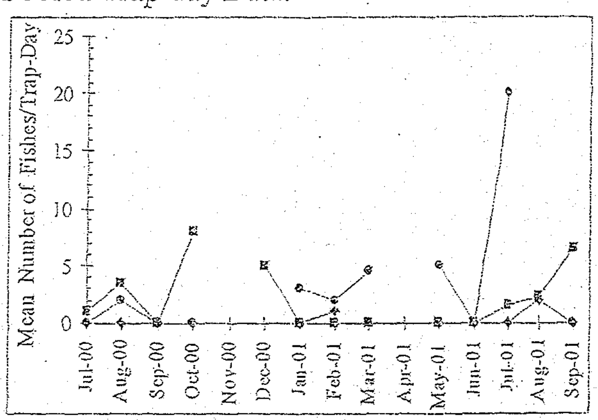
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 12b. Monthly Mean Number of *Sparisoma radians* Caught Per Trap-Day for Southeast St. Croix Embayments Based on Pooled Trap-day Data.



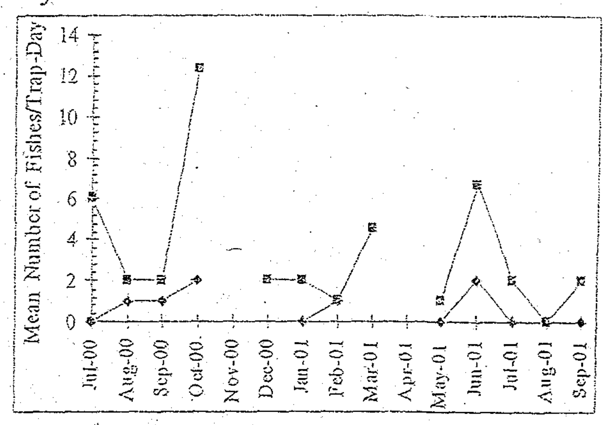
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 12c. Monthly Mean Number of *Pseudupeneus maculatus* Caught Per Trap-Day for Southeast St. Croix Embayments Based on Pooled Trap-day Data.



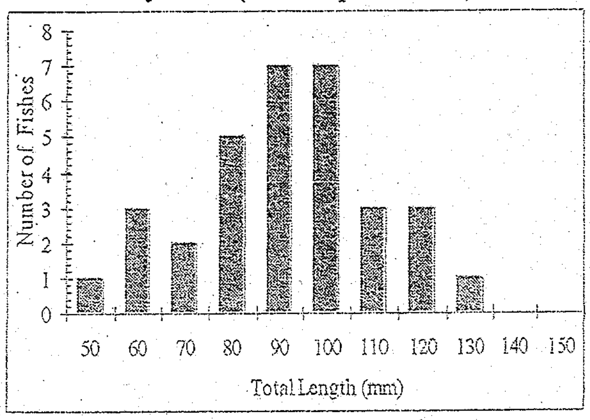
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 12d. Mean Number of *Acanthurus chirurgus* Caught Per Trap-Day for Southeast St. Croix Embayments Based on Pooled Trap-day Data.



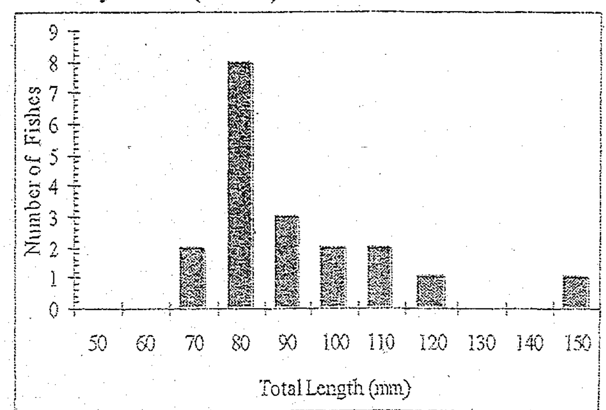
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 13a. Length Frequency Distribution of *Haemulon flavolineatum* Caught by Traps in Turner Hole Bay Based on Pooled Trap-day and Monthly Data (subsample, N=32).



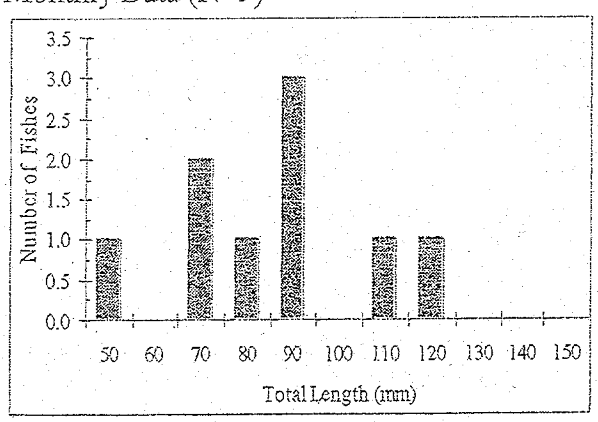
Mean Size at Sexual Maturity 160mm TL (Billings and Munro 1974).

Figure 13b. Length Frequency Distribution of *Haemulon flavolineatum* Caught by Traps in Robin Bay Based on Pooled Trap-day and Monthly Data (N=19)



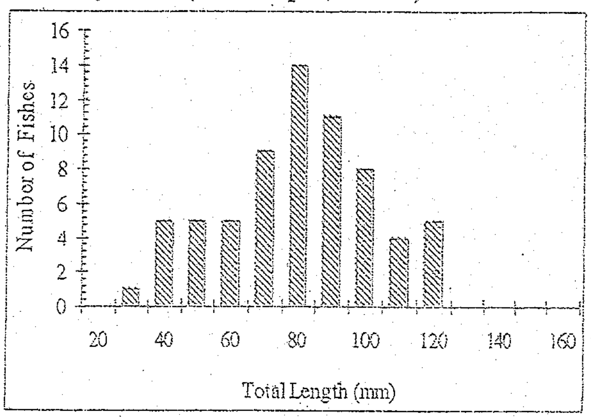
Mean Size at Sexual Maturity 160mm TL (Billings and Munro 1974).

Figure 13c. Length Frequency Distribution of *Haemulon flavolineatum* Caught by Traps in Great Pond Bay Based on Pooled Trap-day and Monthly Data (N=9)



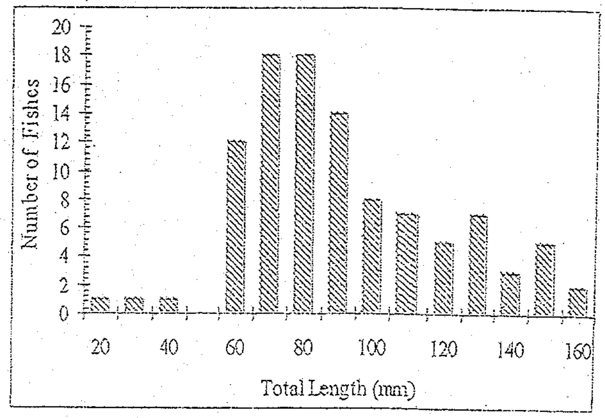
Mean Size at Sexual Maturity 160mm TL (Billings and Munro 1974).

Figure 14a. Length Frequency Distribution of *Sparisoma radians* Caught by Traps in Turner Hole Bay Based on Pooled Trap-day and Monthly Data (subsample, N=67)



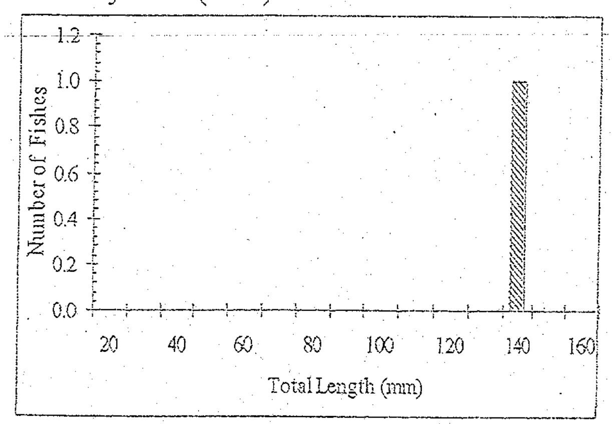
Mean Size at Sexual Maturity = No Information Available

Figure 14b. Length Frequency Distribution of *Sparisoma radians* Caught by Traps in Robin Bay Based on Pooled Trap-day and Monthly Data (subsample, N=102).



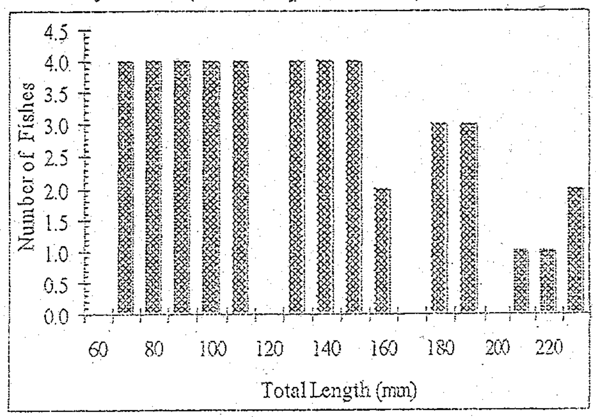
Mean Size at Sexual Maturity = No Information Available

Figure 14c. Length Frequency Distribution of *Sparisoma radians* Caught by Traps in Great Pond Bay Based on Pooled Trap-day and Monthly Data (N=1)



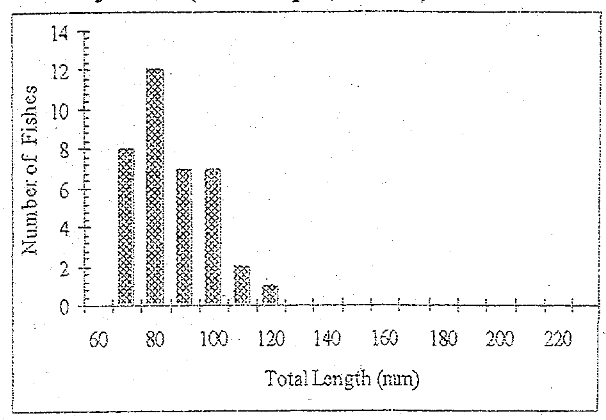
Mean Size at Sexual Maturity = No Information Available

Figure 15a. Length Frequency Distribution of *Pseudupeneus maculatus* Caught by Traps in Turner Bay Based on Pooled Trap-day and Monthly Data (subsample, N=44)



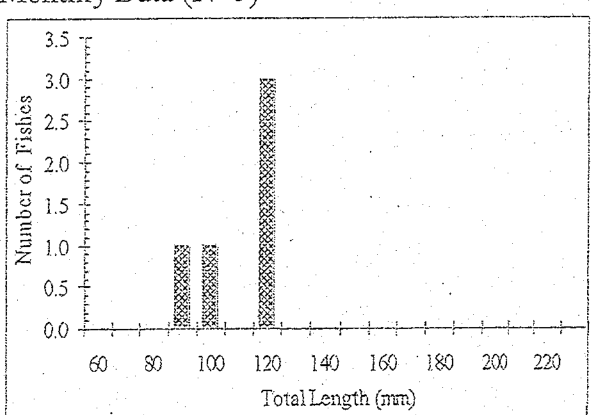
Mean Size at Sexual Maturity = 180 mm TL (Munro 1983).

Figure 15b. Length Frequency Distribution of *Pseudupeneus maculatus* Caught by Traps in Robin Bay Based on Pooled Trap-day and Monthly Data (subsample, N=37).



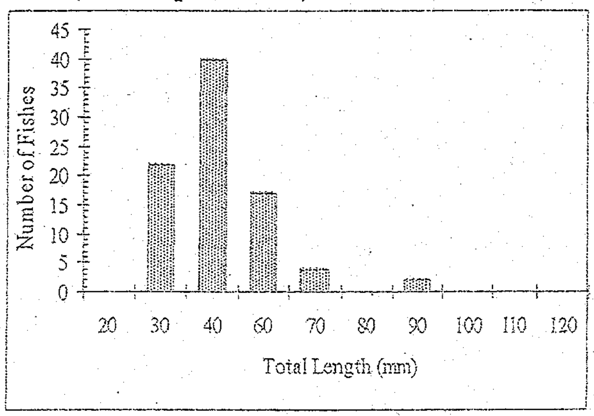
Mean Size at Sexual Maturity = 180 mm TL (Munro 1983).

Figure 15c. Length Frequency Distribution of *Pseudupeneus maculatus* Caught by Traps in Great Pond Bay Based on Pooled Trap-day and Monthly Data (N=5)



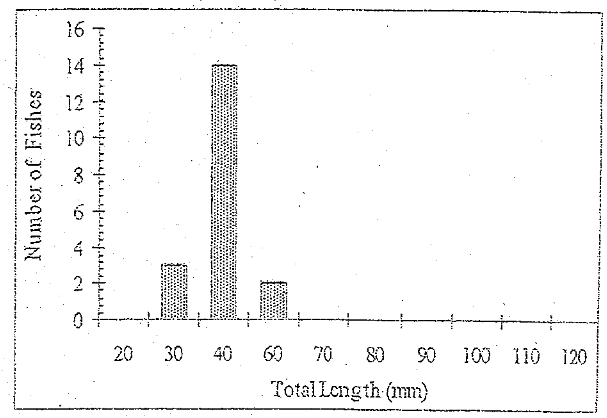
Mean Size at Sexual Maturity = 180 mm TL (Munro 1983).

Figure 16a. Length Frequency Distribution of *Acanthurus chirurgus* Caught by Traps in Turner Hole Bay Based on Pooled Trap-day and Monthly Data (subsample, N=85)



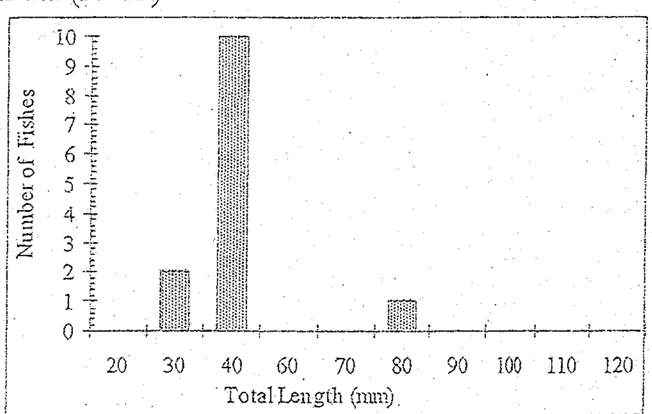
Mean Size at Sexual Maturity = 140 mm TL (Reeson 1983).

Figure 16b. Length Frequency Distribution of *Acanthurus chirurgus* Caught by Traps in Robin Bay Based on Pooled Trap-day and Monthly Data (N=19)



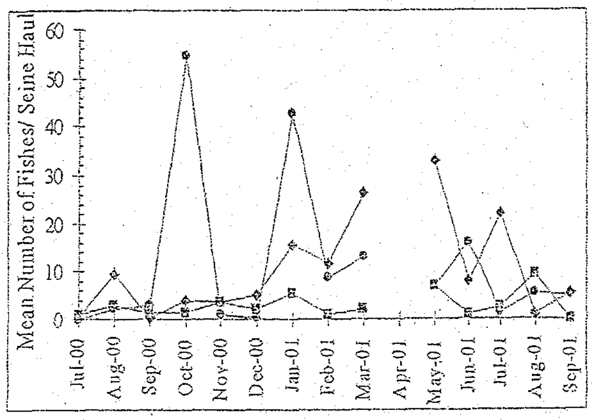
Mean Size at Sexual Maturity = 140 mm TL (Reeson 1983).

Figure 16c. Length Frequency Distribution of *Acanthurus chirurgus* Caught by Traps in Great Pond Bay Based on Pooled Trap-day and Monthly Data (N=13)



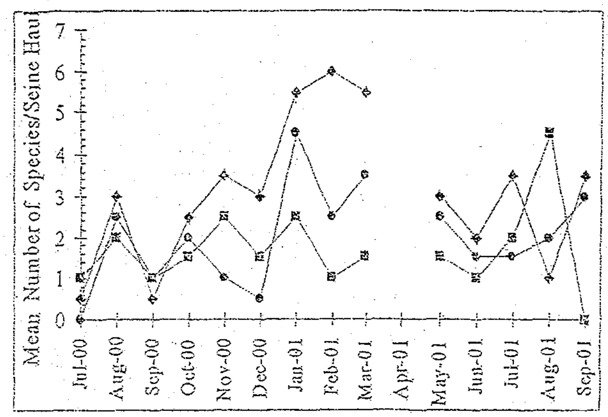
Mean Size at Sexual Maturity = 140 mm TL (Reeson 1983).

Figure 17a. Mean Monthly Number of Fish Caught Per Seine-Haul for Southeast St. Croix Embayments Based on Pooled Seine-Haul Data.



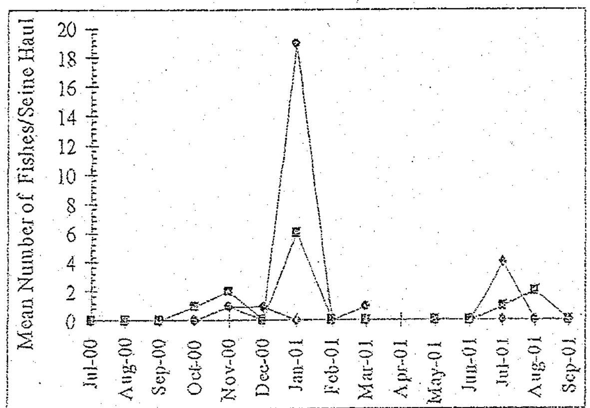
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 17b. Mean Monthly Number of Species Caught Per Seine-Haul for Southeast St. Croix Embayments Based on Pooled Seine-Haul Data



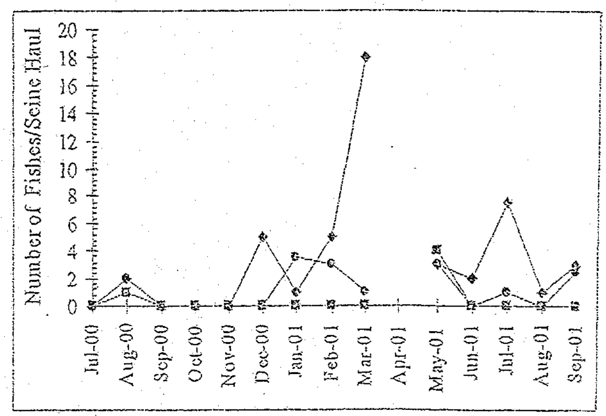
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 18a. Monthly Mean Number of *Caranx latus* Caught per Seine Net-Haul for Southeast St. Croix Embayments Based on Pooled Seine Net-Haul Data



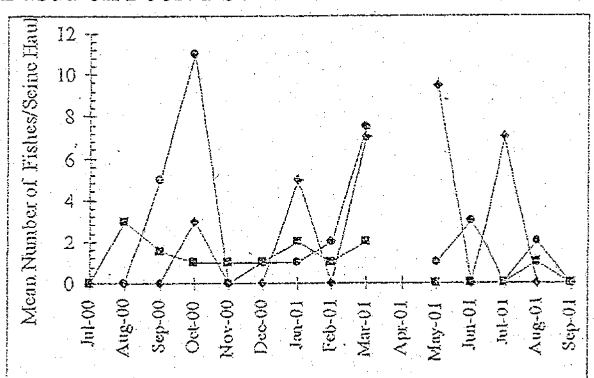
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 18b. Monthly Mean Number of *Eucinostomus jonesi* Caught per Seine Net-Haul for Southeast St. Croix Embayments Based on Pooled Seine Net-Haul Data



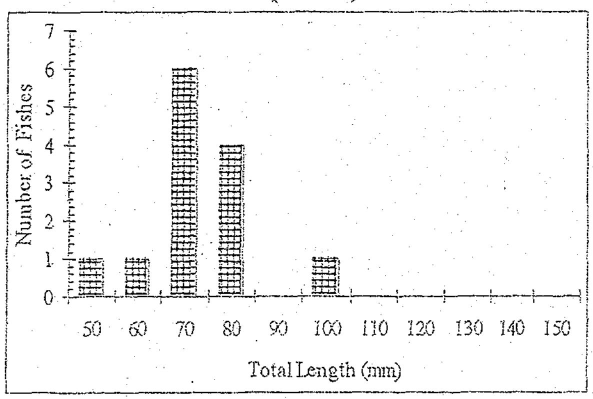
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 18c. Monthly Mean Number of *Trachinotus falcatus* Caught per Seine Net-Haul for Southeast St. Croix Embayments Based on Pooled Seine Net-Haul Data



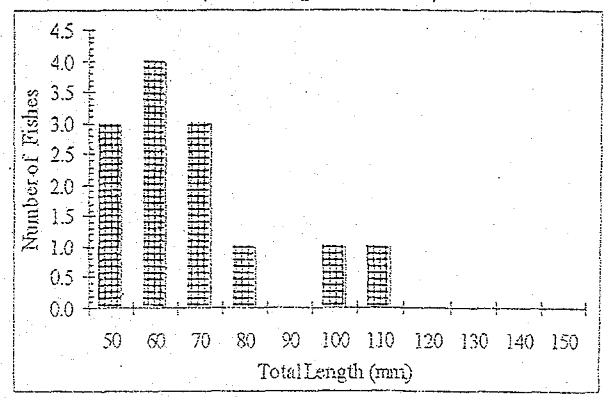
Legend: Turner Hole Bay Robin Bay Great Pond Bay

Figure 19a. Length Frequency Distribution of *Caranx latus* Caught by Seine Net-Hauls in Turner Hole Bay Based on Pooled Monthly and Seine Net-Haul Data (N=13).



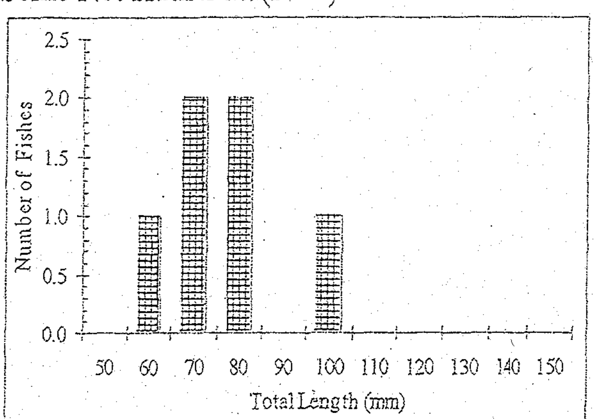
Mean Size at Sexual Maturity = 370 mm TL (Thomson and Munro 1974).

Figure 19b. Length Frequency Distribution of *Caranx latus* Caught by Seine Net-Hauls in Robin Bay Based on Pooled Monthly and Seine Net-Haul Data (subsample, N=13).



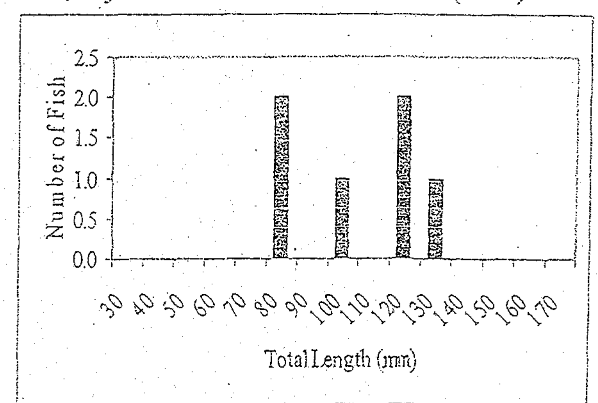
Mean Size at Sexual Maturity = 370 mm TL (Thomson and Munro 1974).

Figure 19c. Length Frequency Distribution of *Caranx latus* Caught by Seine Net-Hauls in Great Pond Bay Based on Pooled Monthly and Seine Net-Haul Data(N=6)



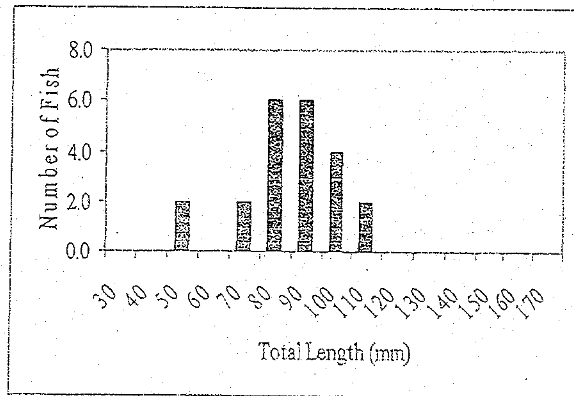
Mean Size at Sexual Maturity = 370 mm TL (Thomson and Munro 1974).

Figure 19d. Length Frequency Distribution of *Eucinostomus jonesi* Caught by Seine Net-Hauls in Turner Hole Bay Based on Pooled Monthly and Seine Net-Haul Data (N=6).



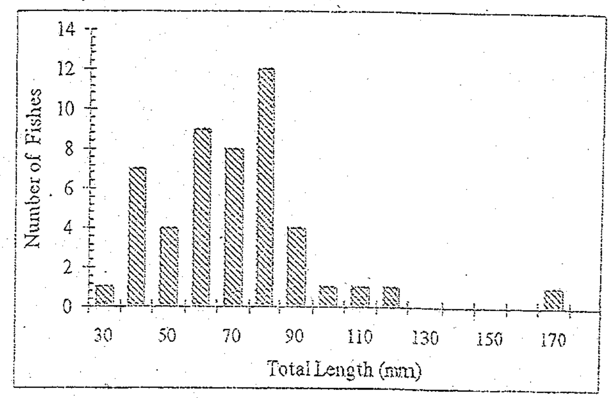
Mean Size at Sexual Maturity = No Information Available

Figure 19e. Length Frequency Distribution of *Eucinostomus jonesi* Caught by Seine Net-Hauls in Robin Bay Based on Pooled Monthly and Seine Net-Haul Data (N=22).



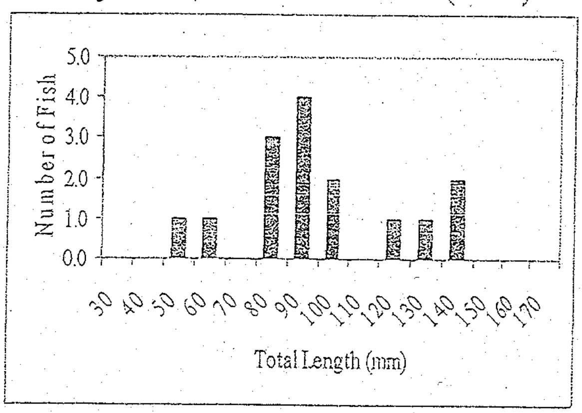
Mean Size at Sexual Maturity = No Information Available.

Figure 19f. Length Frequency Distribution of *Eucinostomus jonesi* Caught by Seine Net-Hauls in Great Pond Bay Based on Pooled Monthly and Seine Net-Haul Data (subsample, N=49)



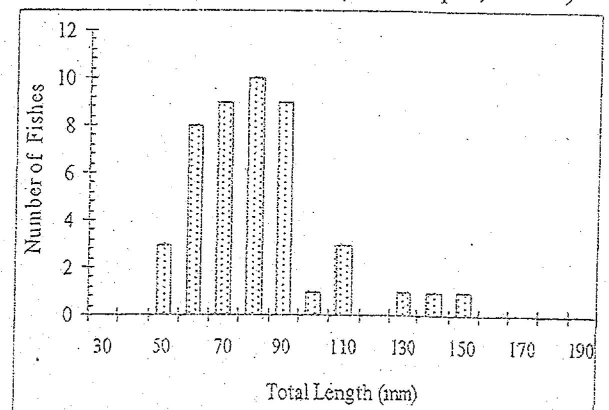
Mean Size at Sexual Maturity = No Information Available

Figure 19g. Length Frequency Distribution of *Trachinotus falcatus* Caught by Seine Net-Hauls in Turner Hole Bay Based on Pooled Monthly and Seine Net-Haul Data (N=15).



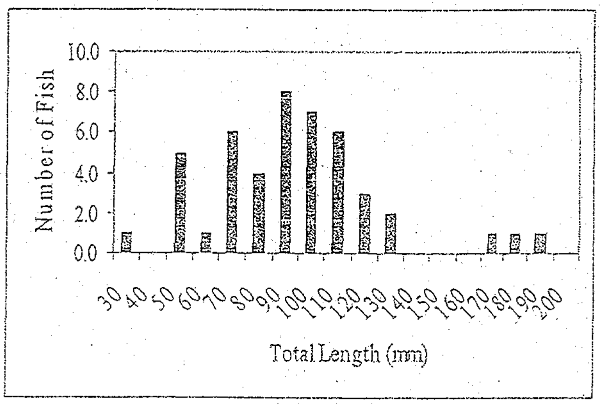
Mean Size at Sexual Maturity = 250 mm TL (García-Cagide et al 1994, cited in ICLARM 1995).

Figure 19h. Length Frequency Distribution of *Trachinotus falcatus* Caught by Seine Net-Hauls in Robin Bay Based on Pooled Monthly and Seine-Net Haul Data (subsample, N=46)



Mean Size at Sexual Maturity = 250 mm TL (García-Cagide et al 1994).

Figure 19i. Length Frequency Distribution of *Trachinotus falcatus* Caught by Seine Net-Hauls in Great Pond Bay Based on Pooled Monthly and Seine-Net Haul Data (N=46)



Mean Size at Sexual Maturity = 250 mm TL (García-Cagide et al 1994).

APPENDIX A
Definition of Embayment Habitat Types

Habitat Type	Definition of Each Habitat (after Adams and Ebersole, In Press)
Patch Reef	Isolated, high calcareous structure (not part of the contiguous reef) with a vertical profile that often but not always contains live coral cover. The most important characteristic is vertical relief.
Rubble	Low-relief calcareous structure composed primarily of dead dying coral fragments that are not attached to the substrate. Rubble habitat may occur over extended areas or as isolated fragments within seagrass, sand, or algal plain habitats
Seagrass	Monospecific or nearly monospecific, stands of *Thalassia testudinum*, with varying densities of *Syringodium filiforme* mixed in.
Sand	Areas of open sand with no or very little (≤10% cover) plants or coralline material represented.
Algal Plain	Sand bottom dominated by *Dictyota* spp*., Halimeda* spp., *Penicillus* spp., *Acanthophora* spp., and *Udotea* spp*.,* which may include sparse stands *of S. filiforme* and *T. testudinum.*

Appendix B

Summary of Normality Test, One-way ANOVA, and Multiple Comparison Test Results for the Southeast Coast of St. Croix, USVI

Patch reef=PR, algal plain=AP, sand=S, R=rubble, seagrass=SG
TH=Turner Hole Bay, RB=Robin Bay, GP=Great Pond Bay

No	Comparison	Kolmogorov-Smirnov Normality Test (*1)	Kruskall-Wallis One Way ANOVA (*2)	Dunn's Multiple Comparison Test
1	Fish density between embayments (visual census)	Failed	Not significant (p>0.05)	Significant differences (p<0.05) in fish density; GP>RB
2	Number of species between embayments (visual census)	Failed	Not significant (p>0.05)	Significant differences (p<0.05) in number of species density, TH>RB
3	Diversity index between embayments (visual census)	Failed	Not significant (p>0.05)	Significant differences (p<0.05) in diversity index, TI-1 GP T >TB
4	Evenness index between embayments (visual census)	Failed	Not significant (p>0.05)	Not applicable
5	Fish density between. habitats (visual census)	Failed	Significant differences (p<0.05)	Significant differences (p<0.05 in fish density, PR>AP, PR>S, R>AP, R>S
6	Number of species between habitats (visual census)	Failed	Significant differences (p<0.05)	Significant differences (p<0.05) in number of species density, PR>AP, PR>S, PR>SG, R>AP, R>S, R>SG
7	Diversity index between habitats (visual census)	Failed	Significant differences (p<0.05)	Significant differences (p<0.05) in diversity index, PR>AP, PR>S, R>S, R>AP
8	Evenness index between habitats (visual census)	Failed	Not significant (p>0.05)	Not applicable
9	*H. bivittatus* densities between embayments (visual census)	Failed	Not significant (p>0.05)	Not applicable
10	*S. radians* densities between embayments (visual census)	Failed	Significant differences (p<0.05)	Not applicable

Appendix B (continued)

Summary of Normality Test, One-way ANOVA, and Multiple Comparison Test Results for the Southeast Coast of St. Croix, USVI

Patch reef=PR, algal plain=AP, sand=S, R=rubble, seagrass=SG
TH=Turner Hole Bay, RB=Robin Bay, GP=Great Pond Bay

No	Comparison	Kolmogorov-Smirnov Normality Test (*1)	Kruskall-Wallis One Way ANOVA (*2)	Dunn's Multiple Comparison Test
11	*Haemulon* unk. densities between embayments (visual census)	Failed	Significant differences (p<0.05)	Not applicable
12	*H. flavolineatum* densities between embayments (visual census)	Failed	Significant differences (p<0.05)	Not applicable
13	Number of fish caught per trap-day between embayments (fish trap)	Failed	Not significant (p>0.05)	Significant differences (p<0.05) in number of fish caught per trap day, TH>GP, RB>GP
14	Number of species caught per trap-day between embayments (fish trap)	Failed	Not significant (p>0.05)	Not applicable
15	*A. chirurgus* catch rates between embayments (fish trap)	Failed	Not significant (p>0.05)	Not applicable
16	*H. flavolineatum* catch rates between embayments (fish trap)	Failed	Not significant (p>0.05)	Not applicable
17	*P. maculatus* catch rates between embayments (fish trap)	Failed	Not significant (p>0.05)	Not applicable
18	*S. radians* catch rates between embayments (fish trap)	Failed	Significant differences (p<0.05)	Significant differences (p<0.05) in catch rates, TH>GP, RB>GP
19	Number of fish caught per haul between embayments (seine-haul)	Failed	Significant differences (p<0.05)	Significant differences (p<0.05) in number of fish caught per haul, GP>TH)
20	Number of species caught per haul between embayments (seine-haul)	Failed	Significant differences (p<0.05)	Significant differences (p<0.05) in number of species per haul, GP>TH

Appendix B (continued)

Summary of Normality Test, One-way ANOVA, and Multiple Comparison Test Results for the Southeast Coast of St. Croix, USVI

Patch reef=PR, algal plain=AP, sand=S, R=rubble, seagrass=SG
TH=Turner Hole Bay, RB=Robin Bay, GP=Great Pond Bay

No	Comparison	Kolmogorov-Smirnov Normality Test (*1)	Kruskall-Wallis One Way ANOVA (*2)	Dunn's Multiple Comparison Test
21	*C. latus* catch rates between embayments (seine-haul)	Failed	Not significant (p>0.05)	Not applicable
22	*T. falcatus* catch rates between embayments (seine-haul)	Failed	Not significant (p>0.05)	Not applicable
23	*E. jonesi* catch rates between embayments (seine-haul)	Failed	Not significant (p>0.05)	Significant differences (p<0.05) in *E. jonesi* catch rates between embayments GP>TH

Appendix C.

Summary of Normality Test, Two way ANOVA, and Multiple Comparison Test Results for the Southeast Coast of St. Croix, USVI

Patch reef=PR, algal plain=AP, sand=S, R=rubble, seagrass=SG
TH=Turner Hole Bay, RB=Robin Bay, GP=Great Pond Bay

No	Comparison	Kolmogorov-Smirnov Normality Test (*1)	Two Way ANOVA on Ranks (*2)	Dunn's Multiple Comparison Test
1	Fish densities by Habitat and by Size Class	Failed	Significant differences ($p<0.05$) by treatment and between treatments	1. Significant differences ($p<0.05$) in fish density, PR>S, PR>SG, PR>AP, PR>R, R>AP, R>S 2. <5 cm TL fish density significantly higher ($p<0.05$) than all other size class densities (pooled habitats)
2	Fish densities by habitat for <5 cm TL fish			Significant differences ($p<0.05$) in fish density, PR>S, PR>SG, PR>S, PR>AP, R>S
3	Fish densities by habitat for 5-10 cm TL fish			Significant differences ($p<0.05$) in fish density, PR>S, PR>SG, PR>S, PR>AP, R>S
4	Fish densities by habitat for >10 cm TL fish			Significant differences ($p<0.05$) in fish density, PR>S, PR>SG, PR>S, PR>AP, R>AP
5	Fish densities by size class for seagrass habitat			<5 cm TL fish density significantly higher ($p<0.05$) than >10 cm TL fish density in seagrass
6	Fish densities by size classes for patch reef habitat			<5 cm TL fish density significantly higher ($p<0.05$) than all other size classes in patch reefs
7	Fish densities by size classes for algal plain habitat			<5 cm TL fish density significantly higher ($p<0.05$) than all other size classes in algal plains
8	Fish densities by size class for rubble habitat			<5 cm TL fish density significantly higher ($p<0.05$) than all other size classes in rubble habitat

Appendix C. (continued)

Summary of Normality Test, Two way ANOVA, and Multiple Comparison Test Results for the Southeast Coast of St. Croix, USVI

Patch reef=PR, algal plain=AP, sand=S, R=rubble, seagrass=SG
TH=Turner Hole Bay, RB=Robin Bay, GP=Great Pond Bay

No	Comparison	Kolmogorov-Smirnov Normality Test (*1)	Two Way ANOVA on Ranks (*2)	Dunn's Multiple Comparison Test
9	Fish densities by size class for sand habitat			Not significant ($p>0.05$)
10	Fish densities by embayment and by size class	Failed	Significant differences ($p<0.05$) by treatment. No significant differences between treatments ($p>0.05$). No Significant Interactions ($p>0.05$) among treatments	1. <5 cm TL fish density significantly higher ($p<0.05$) than all other size class densities (pooled embayments) 2. No significant differences ($p>0.05$) in fish density by embayment
11	Fish densities by embayment for <5 cm TL fish			Not significant ($p>0.05$)
12	Fish densities by embayment for 5-10 cm TL fish			Not significant ($p>0.05$)
13	Fish densities by embayment for >10 cm TL fish			Not significant ($p>0.05$)
14	Fish densities by size classes for Cottongarden Bay			Not significant ($p>0.05$)
15	Fish densities by size classes for Teague Bay			Not significant ($p>0.05$)
16	Fish densities by size classes for Yellowcliff Bay			Not significant ($p>0.05$)