SEAMAP-C USVI

St. Croix & St. Thomas/St. John Fisheries Independent Trap and Line Survey, 1992-2002

SUMMARY REPORT: Data analysis and conclusions

May 2005

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INTRODUCTION

The Southeast Area Monitoring and Assessment Program for the Caribbean (SEAMAP-C) is a cooperative program between the National Marine Fisheries Service, the Department of Natural and Environmental Resources in Puerto Rico and the Department of Planning and Natural Resources, Division of Fish & Wildlife in the U.S. Virgin Islands. Under the SEAMAP-C program, fishery-independent data is collected to assess status of the marine resources of the U.S. Caribbean and to monitor any changes in that status. Such fishery-independent data can provide an objective analysis of the marine resources without reliance on the data provided by commercial and recreational fishermen. Fishery-dependent data can be greatly influenced by economic conditions, vessel and gear designs, choice of fishing grounds and catch discard patterns. Biostatistical analyses of such data reflect the age structures and biomass of fish in the catch rather than the population as a whole.

Between 1992-2002, a fishery independent survey of reef fish populations using traditional fishing gears (traps and hook & line) has been carried out in St. Croix and St. John. An earlier analysis of the data set arising from this study revealed that approximately 60% of the data was missing from the database limiting valid conclusions that could be drawn (Pagán *et al*., 2004). The database has since been updated and expanded to include all available data. This written report provides an analysis of the complete data set for each island and accompanies the full electronic database. Interpretation of data analysis is hindered without consideration of the aims implicit within sample methodologies. Thus, a description of the broad methods employed in the data collection is also provided in Appendix 1.

METHODS

(See accompanying files for final version of complete data set submitted to SEAMAP-C and Appendix 1 for sampling methods)

(a) Data set corrections

(i) Sampling locations

Sampling was conducted in quadrants within a larger sample area defined for each island (Figures 1 & 2). The majority of the trap/hand line catches recorded have an associated latitude and longitude. However, geographic coordinates were missing from 6 sampling days in St John in 1992 (16 & 22 January, 5 & 20 February, 11 & 24 March). For these dates, the original field notes record a quadrant and sub-quadrant number that define the location of the trap in reference to the overall SEAMAP grid for the region. For the missing dates, the GPS position (lat. and long.) defining the center point of the sub-quadrant sampled was used in the GIS analyses of catch results.

(ii) Depths

According to the SEAMAP data sheet, depths should have been recorded in fathoms. Using the spatial information recorded during each trip, trap positions were plotted on a bathymetric chart to verify the depth scale used. This illustrated that samples conducted during 1999-2000 in St. John were entered as feet. These have now been converted to fathoms.

(iii) Fish sizes

Fish lengths are recorded in one or both of two columns; total length and fork length. However, conventions appear to have changed between islands and years such that in some instances all fish lengths are entered under fork length and in others all lengths are recorded as total lengths. In some instances, knowledge of species morphology can allow separation of these and use of the most appropriate measure. For the following species total length does not differ significantly from fork length and these measures have been combined to give a single list of fish total lengths: *Cephalopholis cruentatus, Cephalopholis fulvus, Chaetodon capistratus, Chaetodon sedentarius, Chaetodon striatus, Epinephelus guttatus, Scarus taeniopterus.* These additional species have significantly different fork and total lengths but these have not been consistently recorded in the data set limiting further analyses that can be conducted: *Acanthurus chirurgus, Acanthurus coeruleus, Sparisoma aurofrenatum.*

(b) Data analysis

Analysis of the data set is complicated by the variable intensity of sampling between years and islands as well as the variable locations of each sampling day within the large sample area (see Appendix 1 for sampling methodologies). To identify temporal trends in catch size and composition, sampling dates were combined within islands. For St Croix, sample dates from 1993/4 were combined and compared to those in 2002. For St. John, three year sets were created by combining sample dates; 1992/3, 1994/5 and 1999/2000. This has several benefits which include increasing the sample size (one sample = one day) for each category. More importantly, this minimised the effects of variable sampling across habitats, depths and distances from shore, allowing comparison between dates with confounding factors reduced as much as possible. Where appropriate, graphs are presented with each year displayed separately.

The data were then analysed in three main ways; (a) analysis of catch per unit effort (CPUE), (b) description of catch compositions and marketable catch and bycatch and (c) analysis of catches, population structure and spatial trends of the dominant species for each island.

On each sample day, 9-12 traps were each soaked for between 135-585 minutes. Similarly, 1-6 handlines were fished for between 135-525 minutes. To standardize effort across days and gear type, catch per unit effort was defined as the catch weight (kg) per minute fished for each trap or handline. This definition of CPUE assumes independence of each trap and handline, however, for the majority of the analyses, catches by gear type were averaged for each sample day minimising the impact of interactions between traps and handlines. Some discrepancy may remain in comparisons of hook & line catch between islands as fishing was conducted while drifting within the sub-quadrant in St. Croix but in a single anchored position within the sub-quadrant in St. John. The sampling area was stratified by depth into three classes (i) 0-10 fathoms, (ii) 10-20 fathoms and (iii) > 20 fathoms. Sampling frequency in St. Croix was designed so that the samples in each depth class reflect the relative area covered by those depth ranges. However, planned sample locations were subsequently subject to modification owing to logistics, weather conditions and boat availability and these original stratifications are not evident in the data set. The effect of depth on CPUE is considered briefly in this analysis assuming a minimal effect of date on the change in CPUE with depth.

Catch compositions were described based on biomass and frequency of individuals within the catch. Marketable catch was distinguished from bycatch using species identity and minimum marketable sizes. These were defined for each island using information provided by the Division of Fish & Wildlife, USVI (Table 2). Since marketable sizes of species vary between islands, this analysis reflects the changing relative availability of species for the fishing markets in either island and not changes in the underlying population from which individuals are sampled. Similarly, comparisons between years in the relative proportions of each species again reflect relative fish availability for the market for each year class, as well as changing fishing locations, and may not accurately represent changes to the species populations.

For those species for which five or more individuals were captured in each area, average fork lengths are calculated for each year class. In addition, population structures, through size distributions and sex ratios, are analysed for the most frequently captured species in each area. In St. Croix, only coney were captured in numbers large enough to allow valid analysis. In St. John, population data are presented for red hind, coney, queen triggerfish and yellowtail snapper. For each species, these biostatistical results are presented alongside an analysis of CPUE (as defined above) and a description of spatial patterns of catch.

Since the sampling methodology incorporated a significant spatial component, spatial patterns of CPUE were explored using ArcGIS (See accompanying files for database and ArcGIS files). Habitat maps have been constructed for the nearshore regions of St. Croix and St. Thomas (Kendall et al. 2001). In addition to a bathymetric chart, these habitat maps were used to examine spatial patterns of CPUE for each sampling day. Unfortunately, available habitat maps cover only a very small proportion of the sampled area in St. John and cannot provide information for a thorough analysis.

RESULTS & DISCUSSION

A total of 83 sample dates were recorded, 15 in St. Croix and 68 in St. John (Table 1, Figures 3 & 4). Sampling was conducted between January 1992 and July 2002 but was not conducted simultaneously on the two sample areas. Data for St. Croix were collected on three days between August and December 1993, three days between January and February 1994, and eight days between January and July, 2002. Sampling south of St. John was conducted at varying times across six different years (Table 1).

Across all sample dates, 1098 individuals from 39 species were captured in St. Croix and 1490 individuals from 65 species were captured in St. John. Similarly, the total biomass of captured fish was higher in St. John reflecting the greater number of days spent sampling (St. Croix: 231.87 kg, St John: 698.45 kg).

(a) Catch per unit effort (CPUE)

(i) Gear type and temporal trends

For both islands, CPUE for each day was higher using hook & line than trap fishing (Paired–t test: St Croix: $t = 2.51$, $df = 16$, $P = 0.02$, St. John: $t = 3.19$, $df = 53$, $P = 0.002$, Figure 5).

In St. Croix, there was no difference between 1993/4 and 2002 in CPUE when gear types are combined (Mean ± SD: 1993/4: 0.0204 ± 0.00148 kg/min, 2002: 0.00171 ± 0.00178 kg/min, $t = 0.38$, $df = 15$, $P = 0.071$). Similarly, there was no change in average CPUE from hook & line fishing between years (T-test: $P > 0.05$). However, there was a significant decline in average CPUE from trap fishing between 1993/4 and 2002 in St. Croix ($t = 2.59$, $df = 15$, $P = 0.02$, Figure 6a).

In St. John, there was no difference in CPUE between year classes (1992/3, 1994/5 and 1999/2000) when gear types are combined (ANOVA: $P > 0.05$) and no difference in CPUE from hook & line fishing (ANOVA: $P > 0.05$). However, CPUE from traps was significantly higher in 1999/2000 than in the previous year classes (ANOVA: $F_{5\ 56} = 5.97$, $P < 0.001$, Figure 6b).

The increase in mesh size from June 1994 onwards directly corresponds to the two sample periods recorded in St. Croix as no further sampling was conducted in 1994 after the changed regulation size. Thus, the same decline from 1993/4 to 2002 in trap CPUE in St. Croix is seen when mesh sizes are compared (T-test: $t = 2.59$, $df = 15$, $P = 0.02$). By comparison, the increase in mesh size corresponds to a significant increase in trap CPUE in St. John (1.25 inch mesh: 0.00072 ± 0.00091 kg/min, 1.5 inch mesh: 0.00183 ± 0.00228 kg/min, $t = 2.45$, $df = 59$, $P = 0.02$).

(ii) Spatial trends

Across all gear types, in St John, CPUE increased with depth to a maximum at 15-20 fathoms. By comparison, the highest CPUE in St. Croix was seen at 10-15 fathoms (Figure 7). However, there was considerable variability in CPUE at each depth and differences between depth classes are not significant (ANOVA: $P > 0.05$ for both islands). There were also no significant differences in CPUE between depth classes on either island when trap and hook & line fishing were considered separately (ANOVA: $P > 0.05$ in all cases).

The majority of sampling in St. Croix was conducted over colonised pavement with and without channels, thus differences in CPUE between habitat types are difficult to detect (Figure 8). Similarly, there is no clear pattern of increasing or decreasing CPUE with distance from shore in St. Croix (Figure 8).

Unfortunately, in St. John much of the sampling areas is outside the near-shore areas for which habitat maps are available. However, the high CPUE at greater depths (> 25 fathoms) in St. John is clearly driven by samples conducted along the shelf edge as well as specific mid-shelf features evident on a bathymentric chart (Figure 9).

(iii) Discussion

Differences in CPUE are evident across islands, gear types and with time. Although the higher CPUE from hook & line fishing is evident from both islands this is largely the only pattern that is consistent between locations and times. The overlap between temporal trends in trap CPUE with a changed regulation mesh size hampers the detection of a specific effect of year versus mesh size. In fact, the discrepancy between islands may be suggestive of other factors such as fishing locations and variable seasons or times affecting the trap CPUE. A clearer analysis of changes in CPUE, especially over time, requires either a significantly larger data set or, more importantly, repeated sampling at the same location during the same time and season across years.

(b) Catch composition

(i) St Croix: temporal trends

In 1993/4 the total catch biomass in St Croix was dominated by two species, coney (*C. fulva*) and sand tilefish (*M. plumieri*), which together comprised 56% of the total catch biomass (Table 3). The same two species also dominated the catch in 2002 and comprised an even greater proportion of the total catch biomass (71%, Table 3). However, the remainder of the catch differed between year classes. A total of 27 species were captured in 1993/4 and 26 species in 2002, however, only 15 of these overlapped between years. Red hind (*E. guttatus*) experienced the largest increase in total catch biomass between years changing the proportion of this species in the total catch from 4% to 9%.

Total catch frequency was also dominated by coney in both year classes, however, all other species differed in catch frequency between years (Table 4). There were also significant differences in species importance between catch biomass and catch frequency. Butterflyfish (*Chaetodon* spp.) comprised a far greater proportion of the total catch by frequency than by weight. By contrast, low frequency catches of larger species such as blacktipped shark and blue runner have a large impact on the proportion of each species catch by biomass.

(ii) St Croix: marketable catch versus bycatch

Individual fish were identified as catch or bycatch based on species identity and total or fork length as defined in Table 2. There was no notable change in the total trapped biomass of catch and bycatch in St Croix between 1993/4 and 2002 (Table 5 & 6). In both years, the trapped catch was dominated by coney (*C. fulva*, 54.3% and 51.4 % of the marketable catch biomass in 1993/4 and 2002, respectively). In 1993/4, the dominant component of trap bycatch biomass was queen triggerfish (*B. vetula*) considered too small to be marketable. By comparison, the dominant component of trap bycatch biomass in 2002 was butterflyfish (*Chaetodon* spp, Table 5). In terms of frequency, butterflyfish formed the most significant component of trap bycatch in both years (34.5% and 70.7% of bycatch frequency in 1993/4 and 2002 respectively, Table 6). In 1993/4, eight of 21 species trapped are not marketable (38%). Similarly, in 2002, five of 19 species trapped were bycatch (26.3%). However, there were changes in the composition of bycatch. While in 1993/4, 33% of the catch biomass of yellowtail snapper was considered bycatch, in 2002, 100% of the catch of this species was marketable.

Hook & line catch in St. Croix was also dominated by coney which comprised 71.3% and 71.7% of the hook & line marketable catch biomass in 1993/4 and 2002 respectively (Table 7). Blue runner (*C. crysos*), not captured in traps, also formed a significant component of the hook & line catch. Bycatch from hook & line fishing was dominated by sand tilefish which comprised 54.4 % and 77.7% of the total hook & line bycatch biomass and 51.2% and 54.7% of the hook & line bycatch frequency in 1993/4 and 2002 respectively (Tables 7 & 8).

(iii) St John: temporal trends

Total catch biomass and frequency in St. John (from both gear types) was dominated in all years by red hind (*E. guttatus*) and queen triggerfish (*B. vetula*) which together formed 43-50% of the total catch biomass (Tables 9 & 10). Smaller species including coney (*C. fulva*) formed a larger proportion of the catch frequency while the larger ocean triggerfish (*C. sufflamen*) contributed more significantly to catch biomass. A total of 66 species were captured across all years however only a proportion of these were captured in each year class.

(iv) St John: marketable catch versus bycatch

Individual fish were identified as catch or bycatch based on species identity and total or fork length as defined in Table 2. Total marketable trap catch biomass ranged from 88-95% of the total trapped biomass between 1992 and 2000. In 1992/3 and 1994/5, the dominant proportion of the trapped biomass comprised red hind and queen triggerfish (Table 11). However, the importance of coney has been steadily increasing such that in 1999/2000 it comprised the greatest proportion of the total trap catch biomass (Table 12). By contrast, coney was the most frequently captured species in all years while the frequency of captured red hind and queen triggerfish has declined between 1992-5 and 1999/2000 (Tables 13 & 14).

The proportion of red hind in the trap catch has decreased from 29% to 16% of the total catch by biomass and from 21% to 7% of the total catch by frequency between 1994/5 and 1999/2000, respectively. The relative proportion of yellowfin grouper also experienced a dramatic decline from 1992-1995 to 1999/2000 (Tables 11-14).

The proportion of the total biomass captured in traps defined as bycatch has increased from 6-5% in 1992-1995 to 12% in 1999/2000. This is also reflected in an increase in the frequency of individuals defined as bycatch to 36% in 1999/2000. Trap bycatch biomass, in 1992/3 and 1999/2000, was dominated by small yellowtail snapper. By contrast, in 1994/5 schoolmasters made up the main biomass component of trap bycatch. In terms of frequency of individuals, trap bycatch in all years was dominated by butterflyfish (Tables 11-14)

No blue tang were captured in 1994/5. However, despite the increase in trap mesh size, the proportion of marketable blue tang captured has changed from 100% marketable in 1992/3 to

100% bycatch in 1999/2000. Although they comprise only a small proportion of the total catch by biomass the proportion of each species catch that is defined as bycatch has also increased for ocean surgeonfish, doctorfish, white grunt and yellowtail snapper.

Marketable catch captured using hook & line fishing in St. John was dominated in all years by red hind (29-31% of total catch biomass, 22-34% of total catch frequency) although the proportion of coney by biomass and frequency has increased through all years (Tables 15&16). The proportion of the total hook & line catch biomass defined as bycatch has declined from 43% to 5% between 1992 and 2000. This largely reflects a decrease in the % biomass of ocean triggerfish contributing to the total catch (Table 15).

(v) Discussion

These temporal trends in the composition of marketable catch and bycatch from traps seem to be suggestive of changing populations of the fished species. However, the results could also merely arise from differing effort between years as well as differing locations fished.

Overall, fishing catch on both islands was dominated by small serranid species throughout the sampling periods. There is no indication through the sampling period of any population change if the larger species, especially Nassau groupers.

Bycatch from traps fished on both islands is dominated by butterflyfish which, though small, are captured with relatively high frequency. Interestingly, across islands and gear types, an increasing proportion of an increasing number of species is defined as bycatch. Determining whether this reflects changing population structures or is the result of fishing biases is critical to determine the potential impacts of fishing on the reef fish resources.

By contrast, the high bycatch from hook & line fishing in St Croix is largely determined by the number of sand tilefish caught, while in St. John ocean triggerfish dominate the hook & line bycatch. These bycatch compositions seem most likely to reflect the habitats fished and are suggestive that the effectiveness of hook & line fishing in capturing marketable species is largely dependent on the specific location of fishing.

(c) Species analysis: population structure, CPUE and spatial analysis

(i) Fish total lengths: general trends

Across all years and gear types, seventeen species with more than five individuals captured were reported for St. Croix. There was no consistent change in fork length for these species between 1993/4 and 2002 (Table 17). Twenty-eight species with more than five captures were recorded for St. John and again no consistent changes in fish lengths were evident between years (Table 18).

The variable sample sizes reduce the power of any statistical analyses. However, there are significant patterns merely in the list of species captured in both islands. For example, no large serranid species were captured using either gear type in St. Croix (Table 17). Nassau groupers (*E. striatus*) were included within the summary for St. John (Table 18) despite only three individuals being captured because of the biological importance of these species. It is very informative that in 68 days spent fishing south of St John only three Nassau groupers were captured in traps and none using hook & line. In both areas and across all years, the serranid catch was dominated in numbers by the smaller red hind, coney and graysby. Also notable is the lack of parrotfish

(Scaridae) recorded. Only a single parrotfish species (princess parrotfish, *Scarus taeniopterus*) had five captures on each island.

It is possible that these results reflect the selectivity of traps and hook & line fishing methods which, although independent from commercial fishing biases, still introduce some target biases. However, since both groupers and parrotfish are both preferred species in the local markets and biologically important components of a range of habitats, these results should prompt a more detailed look at the status of these populations.

(ii) St Croix: Coney (*Cephalopholis fulva*)

Six hundred & seventy-two coney were captured across three sampling days in 1993/4 and nine sampling days in 2002. The majority of fish were captured using hook & line (80.8%). However, there was no significant difference between gear type in the total length (TL) of fish captured (Mean ±SD: hook & line: 214.42 ± 27.64 mm, trap: 216.38 ± 30.39 mm, t-test: $P > 0.05$). A similar proportion of both males and females (18.1% and 20.0% respectively) were captured in traps.

As predicted in a protogynous species, in 1993/4 males were significantly larger and weighed more than females (T-tests: TL: $t = 5.86$, $df = 122$, $P < 0.001$, Figure 10a, weight: $t = 4.83$, $df = 122$, $P < 0.001$). However, in 2002 there was no significant difference between sexes in total length, although males remained significantly heavier than females (T-tests: TL: $t = 1.86$, $df = 516$, $P = 0.2$, Figure 10b, weight: $t = 2.60$, $df = 516$, $P = 0.01$). Between 1993/4 and 2002 the average size of males declined significantly while the average size of females increased (T-tests: female: $t = 2.07$, $df = 496$, $P = 0.04$, male: $t = 3.12$, $df = 142$, $P = 0.002$, Figure 10). In 1993/4 the sex ratio of captured fish was close to unity (male: female 1: 1.75), however, more females were caught per male in 2002 (1: 4.23).

Gravid females and ripe males were observed in December, January and February in 1993/4 but were observed in February, June and July in 2002. This is most likely to be a reflection of sampling dates rather than an accurate assessment of when these fish spawn. Spent females were also observed in December January and February in 1993/4.

Catch weight (kg) per minute fished (CPUE) did not differ significantly between 1993/4 and 2002 when hook & line and trap fishing are considered together or separately (T-tests: $P > 0.05$ in all cases). There was also no significant differences between depth classes in coney CPUE when hook & line fishing and traps are considered together and separately (ANOVA: $P > 0.05$ in all cases). Catches of coney were highest on pavement, with and without channels, while lower and zero catches were recorded from the sand and seagrass habitats between Buck Island and the main island of St. Croix (Figure 11). The prevalence of pavement habitats in St. Croix is likely to be a significant factor contributing to high catches of coney.

(iii) St John: red hind (*Epinephelus guttatus*)

Two hundred & fifty-nine red hind were captured on 45 of 68 sampling days. Almost half of the individuals were captured in traps (48%) and there was no significant difference between gear type in the total length (TL) of fish captured (Mean ±SD: hook & line: 332.63 ± 57.71 mm, trap: 322.87 ± 49.8 mm, T-test: $P > 0.05$). A similar proportion of both males and females (39.5% and 44.0% respectively) were captured in traps.

Across all individuals, red hind captured in 1994/5 tended to be larger than in either 1992/3 or 1999/2000 (ANOVA: $F_{2\ 265} = 2.69$, $P = 0.70$, Figure 12). However, the median and modal values from the frequency distribution of individuals in each year showed a consistent increase (Figure 12). In 1992/3 males were significantly larger than females (T-test: $t = 2.34$, $df = 21$, $P = 0.03$, Figure 13a). However, in 1994/5 and 1999/2000 there was no significant difference in the size of males and females (T-tests: $P > 0.05$, Figures 13b & 13c). The maximum size of females increased from 1992 to 2000 while both the maximum and minimum sizes of males decreased in the same period. Sex ratios in 1992/3 and 1994/5 were close to unity (males: females, 1992/3: 1:1.09, 1994/5: 1:1.36. However, more females were captured per male in 1999/2000 (1:6.43).

Gravid females and ripe males were observed in December-March consistent with the spawning aggregation period for these fish. However, some spent individuals apparently captured in August and September may have been misidentified.

Catch weight of red hind per minute fished averaged for each day of fishing was significantly higher in 1999 than in other years (ANOVA: $F_{5\ 57} = 3.70$, $P = 0.006$). However, sample sites differed between years, potentially confounding this result. Although formal habitat classifications are not available for a large part of the sampling area, CPUE of red hind is highest along the shelf edge, the midshelf reefs and a known reef feature occurring south of Ditliff Point St. John (Figure 14). Furthermore, although sampling was conducted along the insular shelf south of the mid-shelf reef system that divides this shelf, this sampling was visibly clustered along the shelf edge and on specific reef features (Figure 4) and is therefore likely to have artificially elevated mean catches of red hind for these deep water regions.

(iv) St. John: coney (*Cephalopholis fulva*)

Four hundred & seven individuals were captured between 1992 and 2000. Seventy-six percent of these were captured in traps. However, again there was no significant difference between gear types in total length of fish caught (Mean ±SD: hook & line: 247.62 ± 36.0 mm, trap: 243.68 ± 32.68 mm, T-test: $P > 0.05$).

Across all individuals, the average length of coney captured was significantly higher in 1994/5 than in 1992/3 or 1999/2000 (ANOVA: $F_{2\ 404} = 5.14$, $P = 0.01$). However, this reflects a decreased frequency of capture of smaller fish rather than an overall increase in fish length during this period (Figure 15). In 1992/3 no individuals were recorded as male and only 10 were identified as female. Therefore, no differences between sizes of sexes could be determined. However, in 1994/5 and 1999/2000 there was no difference in the total length of males and females or the weight of males and females (T-tests: $P > 0.05$ in all cases, Figure 15). In 1994/5, 2.28 females were captured per male while in 1999/2000, 7.88 females were captured per male.

There were no significant differences between depth classes in coney CPUE from traps, hook & line fishing and both methods combined (ANOVA: $P > 0.05$ in all cases). However, catches of coney from traps were significantly higher in 1999 than in other years (ANOVA: $F_{5\ 57} = 9.16$, $P < 0.001$). This is most likely to reflect the differing sampling locations between years. Catches of coney were highest along the mid-shelf ridge and shelf edge, areas that were intensively sampled in 1999/2000. However, the highest CPUE recorded for a single sample date was recorded at Eagle Shoal on the south-west tip of St. John (Figure 16).

(v) St. John: queen triggerfish (*Balistes vetula*)

One hundred & sixty-five individuals were captured between 1992-2000. Trap catches represented 57-76% of the total catch. Fish captured using traps were significantly larger than those caught on hook & line (Mean ±SD: hook & line: 312.11 ± 50.79 mm, trap: 271.03 ± 55.24 mm, T-test: t = 4.30, df = 132, P < 0.001).

There was a significant decline in the average fork length of queen triggerfish caught between 1992/3 and 1999/2000 (ANOVA: $F_{2\ 161}$ = 5.02, P = 0.008). However, this appears to result largely from increased catches of smaller individuals rather than a shifted size structure although there was a small decline in the number of larger fish captured (Figure 17). Across all years, there was no difference in the average size of males and females (T-tests: P > 0.05 in all cases). Low numbers of both males and females were identified, however, sex ratios are close to unity in all years (1992/3: 1:1, 1994/5: 1:1.1, 1999/2000: 1:1.5).

There were no differences in queen triggerfish CPUE between depth classes (ANOVA: P > 0.05). However, there was a trend towards increased CPUE from all gear types in 2000 than in other years (ANOVA: $F_{5\ 57}$ = 2.22, P = 0.07). CPUE of queen trigger was variable across the insular shelf but is also clearly high on the shelf edge and on mid-shelf features (Figure 18).

(vi) St. John: yellowtail snapper (*Ocyurus chrysus*)

Eighty-seven yellowtail snapper were captured south of St. John. Forty-nine of these were captured in traps. Fish caught in traps were smaller than those captured by hook & line (Mean ±SD: hook & line: 303.0 ± 55.21 mm, trap: 252.82 ± 29.98 mm, T-test: t = 3.95, df = 63, P < 0.001). There was a significant decline in fork length of captured individuals between 1992/3 and 1999/2000 (ANOVA: $F_{26\ 60}$ = 2.33, P = 0.004), however, there is also a significant interaction with fishing method. The change in fork length between year classes appears to be driven by an increasing percentage of the catch from trap rather than hook & line fishing and it is unclear whether there is any underlying change in the population.

(vii) Discussion

Significant variability exists between species and islands in changes to population structure and CPUE between 1992 and 2002. Increasing overlap in the sizes of male and female coney is most frequently an indicator of overfishing. However, in St. Croix, this result is driven by an increase in female size which would not be predicted under conditions of heavy fishing pressure. Since there is little change in CPUE across the time period sampled, it is perhaps likely that changes in the population structure reflect variable sampling across the large areas of pavement habitat available in St. Croix. A similar picture exists for St John serranid species. A decrease in the average and maximum size of male red hind is symptomatic of overfishing and yet the average size of females increased significantly in the same period which may potentially significantly increase the reproductive output of the population. Sex ratios close to unity are rare for such species where males typically defend a harem of five to seven females and again this may largely reflect sampling biases. No clear pattern is evident from analyses of other species including yellowtail snapper and queen triggerfish. Both species show small indicators of changing population structure however the significant interactions with gear type introduces considerable variability into the results.

CONCLUSIONS & RECOMMENDATIONS

(i) Although a significant increase in trap CPUE from St. John and a decrease in trap CPUE in St. Croix was detected this is overshadowed by the large variability in CPUE both within and between islands. There are no clear changes in overall CPUE for each island and the variability that exists is more indicative of the variable returns from a fishing dependent survey methodology.

(ii) On both islands, fishing catch recorded from both gear types was dominated by small serranid species throughout the sampling periods. There is no indication through the sampling period of any change, or recovery, of the larger species, especially Nassau groupers. There were also mixed patterns of change in coney and red hind catch from both islands that are most likely to reflect varying sample locations.

(iii) Bycatch from traps was dominated by small reef species, especially butterflyfish. However, changes to the underlying population from which these fish were sampled cannot be determined from the present data. Hook & line bycatch was dominated by pelagic triggerfish and/or sand tilefish.

(iv) Although several patterns emerge from analysis of the data, the continual presence of confounding variables reduces confidence in the validity of these trends. The most critical of these is location. In virtually all the analyses conducted, changes that appear to be taking place across years may be the result of changed sample locations rather than a real change in the underlying populations. This data set provides a useful baseline from which to characterise the local fishing resources. However, more valuable data could be collected in the future by repeated sampling of a small subset of the locations reported.

(v) Although fisheries independent data is critical to assess the status of local marine resources, methods which themselves rely on fishing techniques to sample the population automatically introduce biases into the results. For example, such biases may help to explain the very low parrotfish catches recorded from both islands. Neither traps or hook & line techniques attract these herbivorous fishes, yet they form an important ecological component of the reef system. Additional surveying techniques are important to supplement the data presented here and to clarify the biases that these fishing techniques introduce into the data recorded.

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Acknowledgements

Thanks to Jason Vasques, Roger Uwate, Barbara Kojis, Ruth Gomez and William Tobias who provided helpful comments on an earlier draft.

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Table 1. Frequency of sampling days for each month between 1992 and 2000 conducted south of St. John, USVI.

	1992	1993	1994	1995	1999	2000
January	2		2			3
February	3		3	2		1
March	4		1	2		5
April						1
May						
June			4			
July			1			
August		2	2		1	
September		3	3		4	
October	2		5		1	
November	2	3				
December	1	3				
TOTAL	14	11	21	4	6	10

Table 2. Species marketablility and minimum target size (fork length, FL or total length, TL) for St. Croix and St. Thomas/St. John. Marketability and estimated minimum target sizes provided by the Division of Fish & Wildlife, USVI.

		St. Croix			St. John/St. Thomas		
			Min size (mm)	Length		Min size (mm)	Length
Acanthurus bahianus	Ocean surgeon	Y	150	FL	Y	170	FL
Acanthurus chirurgus	Doctorfish	Y	150	FL	Y	170	FL
Acanthurus coerulus	Blue tang	Y	150	FL	Y	150	FL
Alectis ciliaris	African pompano	Y	225	FL	N		
Aluterus monocerus	Unicorn leatherjacket	N			N		
Aluterus schoepfi	Orange filefish	Y	200	FL	Y	300	TL
Aluterus scriptus	Scrawled filefish	Y	180	FL	Y	300	TL
Balistes capriscus	Gray triggerfish	N			N		
Balistes vetula	Queen triggerfish	Y	200	FL	Y	200	FL
Calamus spp	Porgy	Y	180	FL	Y	200	FL
Calamus calamus	Sheepshead porgy	Y	200	FL	Y	200	FL
Calamus penna	Saucereye porgy	Y	200	FL	Y	200	FL
Canthidermis sufflamen	Ocean trigger	Y	280	FL	N		
Caranx bartholomaei	Yellow jack	Y	225	FL	N		
Caranx crysos	Blue runner	Y	180	FL	Y	200	FL
Caranx ruber	Bar jack	Y	160	FL	Y	200	FL
Carcharhinus limbatus	Blacktip shark	Y	800	FL	Y	900	FL
Cephalopholis cruentatus	Graysby	Y	180	TL	Y	200	TL
Cephalopholis fulvus	Coney	Y	180	TL	Y	150	TL
Chaetodon capistratus	Foureye butterflyfish	N			N		
Chaetodon sedentarius	Reef butterflyfish	N			N		
Chaetodon striatus	Banded butterflyfish	N			N		
Elagatis bipinnulata	Rainbow runner	Y	300	FL	Y	200	FL
Epinephelus guttatus	Red hind	Y	180	TL	Y	200	TL
Epinephelus striatus	Nassau grouper	N			N		
Gymnothorax moringa	Spotted moray	N			N		
Gymnothorax ocellatus	Ocellated moray	N			N		
Haemulon album	White margate	Y	200	FL	Y	150	FL
Haemulon aurolineatum	Tomtate	Y	150	FL	Y	150	FL
Haemulon flavolineatum	French grunt	Y	180	FL	Y	200	FL
Haemulon plumieri	White grunt	Y	180	FL	Y	200	FL
Haemulon sciurus	Bluestriped grunt	Y	180	FL	Y	200	FL
Haemulon striatus	Striped grunt	Y	150	FL	Y	150	TL
Halichoeres bivittatus	Slippery dick	N			N		
Halichoeres garnoti	Yellowhead wrasse	N			N		
Halichoeres poeyi	Blackear wrasse	N			N		
Halichoeres radiatus	Puddingwife	Y	200	FL	N		
Hemipteronotus splendens	Green razorfish	N			N		
Holocanthus tricolor	Rock beauty	Y	180	FL	N		
Holocentrus spp	Squirrelfish	Y	200	FL	Y	150	FL
Holocentrus adscensionis	Squirrelfish	Y	200	FL	Y	150	FL
Holocentrus rufus	Longspine squirrelfish	Y	200	FL	Y	150	FL
Hypoplectrus nigricans	Black hamlet	N			N		
Hypoplectrus unicolor	Butter hamlet	N			N		
Lactophrys bicaudalis	Spotted trunkfish	Y	160	FL	Y	150	TL
Lactophrys quadricornis	Scrawled cowfish	Y	160	FL	Y	150	TL
Lactophrys trigonus	Trunkfish	Y	180	FL	Y	150	TL
Lactophrys triqueter	Smooth trunkfish	Y	150	FL	Y	150	TL

Lutjanus apodus	Schoolmaster	Y	200	FL	N		
Lutjanus buccanella	Blackfin snapper	Y	160	FL	Y	230	TL
Lutjanus griseus	Gray snapper	Y	200	FL	N		
Lutjanus jocu	Dog snapper	Y	150	FL	N		
Lutjanus synagris	Lane snapper	Y	180	FL	Y	200	FL
Lutjanus vivanus	Silk snapper	Y	200	FL	Y	150	FL
Malacanthus plumieri	Sand tilefish	N			N		
Mulloidichthys martinicus	Yellow goatfish	Y	150	FL	Y	150	FL
Melichthys niger	Black durgon	N			N		
Mycteroperca venenosa	Yellowfin grouper	Y	200	FL	Y	300	TL
Mycteroperca rubra	Comb grouper	N			N		
Myripristis jacobus	Blackbar soldierfish	N			N		
Ocyurus chrysus	Yellowtail snapper	Y	220	FL	Y	250	FL
Pomacanthus arcuatus	Gray angelfish	Y	250	FL	Y	220	TL
Pomacanthus paru	French angelfish	Y	250	FL	Y	200	TL
Pseudopeneus maculatus	Spotted goatfish	Y	180	FL	Y	200	TL
Remora remora	Remora	N			N		
Rypticus saponaceus	Soapfish	N			N		
Scarus croicensis	Striped parrotfish	N			N		
Scarus taeniopterus	Princess parrotfish	Y	200	TL	N		
Scarus vetula	Queen parrotfish	Y	200	TL	Y	200	TL
Sparisoma aurofrenatum	Redband parrotfish	Y	180	TL	Y	200	TL
Sparisoma chrysopterum	Yellowtail parrotfish	Y	200	TL	N		
Sparisoma viride	Stoplight parrotfish	Y	160	TL	Y	200	TL
Sphyraena barracuda	Barracuda	N			N		
Synodus foetens	Lizardfish	N			N		
Xanthichthys ringens	Sargassum trigger	N			N		

Table 3. Total captured biomass (kg) of each species from all gear types in St. Croix in 1993/4 and 2002. Species are ordered according to rank position in 1993/4.

		1993/4			2002		
		Biomass	% Total	Rank	Biomass	% Total	Rank
Cephalopholis fulva	Coney	23.58	43.54	1	98.41	55.37	1
Malacanthus plumieri	Sand tilefish	6.95	12.83	2	27.64	15.55	2
Balistes vetula	Queen trigger	4.28	7.89	3	2.95	1.66	5
Pseudupeneus maculatus	Spotted goatfish	3.53	6.51	4	0.23	0.13	25
Carcharhinus limbatus	Blacktip shark	2.20	4.06	5			
Epinephelus guttatus	Red hind	2.03	3.74	6	16.25	9.14	3
Remora remora	Remora	1.90	3.51	7	13.58	7.64	4
Caranx crysos	Blue runner	1.50	2.78	8			
Ocyurus chrysus	Yellowtail snapper	1.00	1.85	9	0.30	0.17	24
Haemulon plumieri	White grunt	0.88	1.62	10	0.35	0.20	23
Chaetodon capistratus	Foureye butterfly	0.83	1.53	11	2.63	1.48	6
Holocentrus rufus	Longspine squirrel	0.80	1.48	12	1.78	0.10	7
Acanthurus bahianus	Ocean surgeonfish	0.70	1.29	13	1.45	0.82	9
Haemulon flavolinatum	French grunt	0.63	1.15	14	0.98	0.55	12
Caranx bartholomaei	Yellowjack	0.60	1.11	15			
Cephalopholis cruentatus	Graysby	0.53	0.97	16	1.63	0.91	8
Gymnothorax ocella	Ocellated moray	0.50	0.92	17			
Holocentrus adscensionis	Squirrelfish	0.30	0.55	18			
Sparisoma aurofrenatum	Redband parrotfish	0.28	0.51	19	0.13	0.07	26
Synodus foetens	Lizardfish	0.23	0.42	20			
Balistes capriscus	Gray triggerfish	0.20	0.37	21			
Mulloidichthys martinicus	Yellowgoatfish	0.18	0.32	22			
Lactophyrs triqueter	Smooth trunkfish	0.18	0.32	23			
Scarus taeniopterus	Princess parrotfish	0.13	0.23	24	0.60	0.34	20
Holocanthis tricolor	Rock beauty	0.13	0.23	25			
Halichoeres garnoti	Yellowhead wrasse	0.10	0.18	26			
Aluterus schoepfi	Orange filefish	0.05	0.09	27			
Chaetodon striatus	Banded butterfly				1.05	0.59	10
Acanthurus coerulus	Blue tang				0.99	0.56	11
Lactophrys quadricornis	Scrawled cowfish				0.98	0.55	13
Lactophrys trigonus	Trunkfish				0.95	0.53	14
Holocentrus spp	Squirrelfish				0.85	0.48	15
Gymnothorax moringa	Spotted moray				0.75	0.42	16
Halichoeres poeyi	Blackear wrasse				0.75	0.42	17
Chaetodon sedentarius	Reef butterflyfish				0.73	0.41	18
Kyphosus incisor	Chub				0.65	0.37	19
Lutjanus buccanella	Blackfin snapper				0.60	0.34	21
Lactophrys bicaudalis	Spotted trunkfish				0.55	0.31	22

Table 4. Frequency of each species captured from all gear types in St. Croix in 1993/4 and 2002. Species are ordered according to rank position in 1993/4.

		1993/4			2002		
		Frequency	% Total	Rank	Frequency	% Total	Rank
Cephalopholis fulva	Coney	126	48.65	1	546	65.15	1
Pseudupeneus maculatus	Spotted goatfish	23	8.88	2	1	0.12	19
Malacanthus plumieri	Sand tilefish	20	7.72	3	75	8.95	2
Chaetodon capistratus	Foureye butterfly	19	7.34	4	28	3.34	5
Balistes vetula	Queen trigger	16	6.18	5	6	0.72	13
Acanthurus bahianus	Ocean surgeonfish	7	2.70	6	12	1.43	8
Holocentrus rufus	Longspine squirrel	6	2.32	7	14	1.67	7
Epinephelus guttatus	Red hind	6	2.32	8	46	5.49	3
Ocyurus chrysus	Yellowtail snapper	5	1.93	9	1	0.12	19
Cephalopholis cruentatus	Graysby	4	1.54	10	11	1.31	9
Haemulon flavolinatum	French grunt	4	1.54	10	7	0.84	12
Haemulon plumieri	White grunt	4	1.54	10	2	0.24	16
Holocentrus adscensionis	Squirrelfish	2	0.77	13			
Remora remora	Remora	2	0.77	13			
Caranx crysos	Blue runner	2	0.77	13	38	4.53	4
Sparisoma aurofrenatum	Redband parrotfish	2	0.77	13	1	0.12	19
Carcharhinus limbatus	Blacktip shark	1	0.39	17			
Synodus foetens	Lizardfish	1	0.39	17			
Gymnothorax ocella	Ocellated moray	1	0.39	17			
Caranx bartholomaei	Yellowjack	1	0.39	17			
Mulloidichthys martinicus	Yellowgoatfish	1	0.39	17			
Halichoeres garnoti	Yellowhead wrasse	1	0.39	17			
Holocanthis tricolor	Rock beauty	1	0.39	17			
Scarus taeniopterus	Princess parrotfish	1	0.39	17	4	0.48	14
Balistes capriscus	Gray triggerfish	1	0.39	17			
Aluterus schoepfi	Orange filefish	1	0.39	17			
Lactophyrs triqueter	Smooth trunkfish	1	0.39	17			
Chaetodon striatus	Banded butterfly				16	1.91	6
Chaetodon sedentarius	Reef butterflyfish				9	1.07	10
Acanthurus coerulus	Blue tang				7	0.84	11
Lutjanus buccanella	Blackfin snapper				4	0.48	14
Gymnothorax moringa	Spotted moray				2	0.24	16
Holocentrus spp	Squirrelfish				2	0.24	16
Kyphosus incisor	Chub				1	0.12	19
Halichoeres poeyi	Blackear wrasse				1	0.12	19
Lactophrys quadricornis	Scrawled cowfish				1	0.12	19
Lactophrys trigonus	Trunkfish				1	0.12	19
Lactophrys bicaudalis	Spotted trunkfish				1	0.12	19

Table 5. Composition of marketable catch and bycatch from traps with 1.25 inch mesh (1992 to March 1994) and 1.5 inch mesh (June 1994-2002) in St Croix, USVI. Percentages are based on the weight (kg) of the catch.

		1.25 inch mesh				1.5 inch mesh			
		% of species catch		% of total catch		% of species catch		% of total catch	
		catch	bycatch	catch	bycatch	catch	bycatch	catch	bycatch
Acanthurus bahianus	Ocean surgeon	89.29	10.71	2.29	0.27	84.48	15.52	3.99	0.73
Acanthurus coeruleus	Blue tang					78.28	21.72	2.53	0.70
Aluterus schoepfi	Orange filefish		100		0.18				
Balistes capriscus	Gray triggerfish		100		0.73				
Balistes vetula	Queen triggerfish	57.93	42.07	7.68	5.58	93.22	6.78	8.97	0.65
Caranx bartholomaei	Yellow jack	100		2.19					
Cephalopholis cruentatus	Graysby	100		1.92		100		0.65	
Cephalopholis fulvus	Coney	96.14	3.86	43.23	1.74	95.39	4.61	39.12	1.89
Chaetodon capistratus	Foureye butterflyfish				3.02		100		8.56
Chaetodon sedentarius	Reef butterflyfish						100		2.36
Chaetodon striatus	Banded butterflyfish						100		3.42
Epinephelus guttatus	Red hind	100		2.83		100		9.21	
Haemulon flavolineatum	French grunt	100		2.29		100		3.18	
Haemulon plumieri	White grunt		100		0.46		100		0.33
Halichoeres garnoti	Yellowhead wrasse		100		0.37				
Holocanthus tricolor	Rock beauty		100		0.46				
Holocentrus spp	Squirrelfish					100		2.36	
Holocentrus adscensionis	Squirrelfish	100		1.10					
Holocentrus rufus	Longspine squirrelfish	25.0	75.0	0.55	1.65	24.53	75.47	1.06	3.26
Kyphosus incisor	Chub						100		2.12
Lactophrys triqueter	Smooth trunkfish	100		0.64					
Lutjanus buccanella	Blackfin snapper					100		1.22	
Malacanthus plumieri	Sand tilefish		100		2.19				
Mulloidichthys martinicus	Yellow goatfish	100		0.64					
Ocyurus chrysurus	Yellowtail snapper	67.50	32.50	2.47	1.19	100		0.98	
Pseudupeneus maculatus	Spotted goatfish	85.11	14.89	10.97	1.92	100		0.73	
Scarus taeniopterus	Princess parrotfish		100		0.46	100		1.55	
Sparisoma aurofrenatum	Redband parrotfish	100		1.01		100		0.41	
TOTAL				79.80	20.20			75.97	24.03

Table 6. Composition of marketable catch and bycatch from traps with 1.25 inch mesh (1992- March 1994) and 1.5 inch mesh (June 1994-2002) in St Croix, USVI. Percentages are based on the frequency of the catch.

		1.25 inch mesh				1.5 inch mesh			
		% of species catch		% of total catch		% of species catch		% of total catch	
		catch	bycatch	catch	bycatch	catch	bycatch	catch	bycatch
Acanthurus bahianus	Ocean surgeon	71.43	28.57	2.98	1.19	75.0	25.0	5.14	1.71
Acanthurus coeruleus	Blue tang					57.14	42.86	2.29	1.71
Aluterus schoepfi	Orange filefish		100		0.60				
Balistes capriscus	Gray triggerfish		100		0.60				
Balistes vetula	Queen triggerfish	33.33	66.67	2.98	5.95	83.33	16.67	2.86	0.57
Caranx bartholomaei	Yellow jack	100		0.60					
Cephalopholis cruentatus	Graysby	100		2.38		100		0.57	
Cephalopholis fulvus	Coney	94.12	5.88	38.10	2.38	93.44	6.56	32.57	2.29
Chaetodon capistratus	Foureye butterflyfish		100		11.31		100		16.00
Chaetodon sedentarius	Reef butterflyfish						100		5.14
Chaetodon striatus	Banded butterflyfish						100		9.14
Epinephelus guttatus	Red hind	100		1.19		100		2.86	
Haemulon flavolineatum	French grunt	100		2.38		100		4.00	
Haemulon plumieri	White grunt		100		1.19		100		0.57
Halichoeres garnoti	Yellowhead wrasse		100		0.60				
Holocanthus tricolor	Rock beauty		100		0.60				
Holocentrus spp	Squirrelfish					100		0.57	
Holocentrus adscensionis	Squirrelfish	100		1.19					
Holocentrus rufus	Longspine squirrelfish	20.0	80.0	0.60	2.38	18.18	81.82	1.14	5.14
Kyphosus incisor	Chub						100		0.57
Lactophrys triqueter	Smooth trunkfish	100		0.60					
Lutjanus buccanella	Blackfin snapper					100		1.71	
Malacanthus plumieri	Sand tilefish		100		1.19				
Mulloidichthys martinicus	Yellow goatfish	100		0.60					
Ocyurus chrysurus	Yellowtail snapper	60.0	40.0	1.79	1.19	100		0.57	
Pseudupeneus maculatus	Spotted goatfish	78.26	21.74	10.71	2.98	100		0.57	
Scarus taeniopterus	Princess parrotfish		100		0.60	100		1.71	
Sparisoma aurofrenatum	Redband parrotfish	100		1.19		100		0.57	
TOTAL				67.26	32.74			57.14	42.86

Table 7. Composition of marketable catch and bycatch from hook & line fishing in 1993/4 and 2002 in St. Croix. Percentages are based on the weight (kg) of the catch.

		1993/4 % of total catch		2002 % of total catch	
		catch	bycatch	catch	bycatch
Balistes vetula	Queen triggerfish	2.43			
Caranx crysos	Blue runner	5.60		9.23	
Carcharhinus limbatus	Blacktip shark		8.21		
Cephalopholis cruentatus	Graysby			0.97	
Cephalopholis fulvus	Coney	40.21	1.87	54.44	3.92
Epinephelus guttatus	Red hind	4.66		9.03	0.10
Gymnothorax moringa	Spotted moray				0.51
Gymnothorax ocellatus	Ocellated moray		1.87		
Haemulon plumieri	White grunt	2.80		0.17	
Halichoeres poeyi	Blackear wrasse				0.51
Holocentrus spp	Squirrelfish				0.1
Holocentrus rufus	Longspine squirrelfish	0.75			0.31
Lactophrys bicaudalis	Spotted trunkfish			0.37	
Lactophrys quadricornis	Scrawled cowfish			0.66	
Lactophrys trigonus	Trunkfish			0.65	
Lutjanus buccanella	Blackfin snapper			0.15	
Malacanthus plumieri	Sand tilefish		23.69		18.79
Remora remora	Remora		7.09		
Scarus taeniopterus	Princess parrotfish			0.08	
Synodus foetens	Lizardfish		0.84		
TOTAL		56.44	43.56	75.75	24.25

Table 8. Composition of marketable catch and bycatch from hook & line fishing in 1993/4 and 2002 in St. Croix. Percentages are based on the frequency of the catch.

		1993/4 % of total catch		2002 % of total catch	
		catch	bycatch	catch	bycatch
Balistes vetula	Queen triggerfish	1.10			
Caranx crysos	Blue runner	2.20		5.73	
Carcharhinus limbatus	Blacktip shark		1.10		
Cephalopholis cruentatus	Graysby			1.51	
Cephalopholis fulvus	Coney	59.34	4.40	65.16	7.99
Epinephelus guttatus	Red hind	4.40		6.03	0.15
Gymnothorax moringa	Spotted moray				0.30
Gymnothorax ocellatus	Ocellated moray		1.10		
Haemulon plumieri	White grunt	2.20		0.15	
Halichoeres poeyi	Blackear wrasse				0.15
Holocentrus spp	Squirrelfish				0.15
Holocentrus rufus	Longspine squirrelfish	1.10			0.45
Lactophrys bicaudalis	Spotted trunkfish			0.15	
Lactophrys quadricornis	Scrawled cowfish			0.15	
Lactophrys trigonus	Trunkfish			0.15	
Lutjanus buccanella	Blackfin snapper			0.15	
Malacanthus plumieri	Sand tilefish		19.78		11.31
Remora remora	Remora		2.20		
Scarus taeniopterus	Princess parrotfish			0.15	
Synodus foetens	Lizardfish		1.10		
TOTAL		70.33	29.67	79.34	20.66

Table 9. Total captured biomass (kg) of each species from all gear types south of St. John in 1992/3, 1994/5 and 1999/2000. Species are ordered according to rank position in 1992/3.

	1992/3			1994/5			1999/2000		
	Biomass	%	Rank	Biomass	%	Rank	Biomass	%	Rank
Epinephelus guttatus	63.20	26.13	1	37.99	29.77	1	68.48	20.82	3
Canthidermis sufflamen	59.60	24.64	2	7.60	5.96	4			
Balistes vetula	39.33	16.26	3	25.83	20.24	2	75.86	23.06	1
Cephalopholis fulva	23.87	9.87	4	16.52	12.94	3	75.23	22.87	2
Ocyurus chrysus	22.89	9.46	5	2.22	1.74	12	16.38	4.98	4
Mycteroperca veneosa	5.00	2.07	6	6.22	4.87	5	1.56	0.48	20
Haemulon plumieri	3.74	1.55	7	0.70	0.55	17	0.89	0.27	30
Cephalopholis cruentatus	2.57	1.06	8	3.13	2.45	8	6.55	3.85	9
Holocentrus rufus	2.19	0.91	9	3.06	2.40	9	2.89	0.88	12
Calamus spp.	2.18	0.90	10	1.9	1.49	13			
Lutjanus apodus	2.06	0.85	11	0.53	0.42	20	0.78	0.24	32
Epinephelus striatus	1.80	0.74	12	2.27	1.78	11			
Aluterus monocerus	1.80	0.74	13						
Xantjichthys ringens	1.23	0.51	14						
Halichoeres radiatus	1.23	0.51	15				0.17	0.05	42
Holocentrus adscensionis	1.17	0.48	16	0.50	0.39	21	2.92	0.89	11
Acanthurus chirurgus	0.99	0.41	17				2.11	0.64	15
Lutjanus jocu	0.76	0.31	18	1.50	1.17	15			
Malacanthus plumieri	0.71	0.29	19	0.19	0.15	28			
Melichthys niger	0.68	0.28	20	3.41	2.67	7	1.64	0.50	19
Caranx crysos	0.55	0.23	21				14.24	4.33	5
Scarus taeniopterus	0.55	0.23	22				2.66	0.81	13
Calamus calamus	0.54	0.22	23				7.38	2.24	8
Aluterus schoepfi	0.40	0.17	24						
Haemulon aurolineatum	0.36	0.15	25						
Mulloidichthys martinicus	0.33	0.13	26						
Chaetodon capistratus	0.28	0.11	27	0.11	0.09	30	1.56	0.47	21
Scarus croicensis	0.26	0.11	28				0.92	0.28	29
Lutjanus synagris	0.25	0.10	29				0.40	0.12	36
Rypticus saponaceus	0.23	0.09	30				0.48	0.15	35
Acanthurus coerulus	0.20	0.08	31				1.72	0.52	18
Haemulon flavolinatum	0.20	0.08	32	0.23	0.18	24	4.80	1.46	10
Holocanthus tricolor	0.17	0.07	33						
Sparisoma chrysopterum	0.14	0.06	34						
Caranx ruber	0.12	0.05	35	0.20	0.16	25	0.83	0.25	31
Myripristis jacobus	0.09	0.04	36						
Chaetodon striatus	0.05	0.02	37						
Alectis ciliaris				5.85	4.58	6			
Haemulon album				2.60	2.04	10			
Remora remora				1.88	1.48	14			
Sphyraena barracuda				0.72	0.56	16			
Calamus penna				0.58	0.45	18			
Lujanus buccanella				0.57	0.44	19	0.51	0.16	34
Acanthurus bahianus				0.40	0.31	22	0.38	0.12	38
Sparidae spp				0.27	0.21	23			
Halichoeres bivittatus				0.20	0.16	26	0.27	0.08	40
Pomacanthus arcuatus				0.19	0.15	27	8.33	2.53	7
Haemulon striatus				0.12	0.10	29			
Lactophrys quadricornis				0.06	0.05	31			

Hypoplectrus nigricans	0.04	0.03	32			
Chaetodon striatus	0.04	0.03	33	1.97	0.60	16
Lutjanus vivanus				12.66	3.85	6
Holocentrus spp.				2.32	0.70	14
Pomacanthus paru				1.90	0.58	17
Lutjanus griseus				1.42	0.43	22
Haemulon sciurus				1.33	0.40	23
Halichoeres poeyi				1.24	0.38	24
Aluterus scriptus				1.21	0.37	25
Sparisoma aurofrenatum				1.14	0.35	26
Baslistes capriscus				1.12	0.34	27
Scarus vetula				1.00	0.30	28
Sparisoma viride				0.62	0.19	33
Mycteroperca rubra				0.39	0.12	37
Hemipteronatus splendens				0.30	0.08	39
Chaetodon sedentarius				0.23	0.07	41
Hypoplectrus unicolor				0.12	0.04	43

Table 10. Frequency of each species captured from all gear types south of St. John in 1992/3, 1994/5 and 1999/2000. Species are ordered according to rank position in 1992/3.

	1992/3			1994/5			1999/2000		
	Frequency	%	Rank	Frequency	%	Rank	Frequency	%	Rank
Cephalopholis fulva	133	26.71	1	61	23.74	2	213	29.38	1
Epinephelus guttatus	117	23.49	2	64	24.90	1	78	10.76	2
Balistes vetula	54	10.84	3	37	14.40	3	74	10.21	3
Ocyurus chrysus	45	9.04	4	6	2.33	6	36	4.97	6
Canthidermis sufflamen	40	8.03	5	6	2.33	6			
Cephalopholis cruentatus	15	3.01	6	17	6.61	5	18	2.48	10
Chaetodon capistratus	11	2.21	7	4	1.56	9	46	6.34	4
Mycteroperca veneosa	10	2.01	8	4	1.56	9	3	0.41	25
Haemulon plumieri	10	2.01	8	2	0.78	11	1	0.14	32
Holocentrus adscensionis	9	1.81	10	2	0.78	11	24	3.31	9
Holocentrus rufus	7	1.41	11	24	9.34	4	8	1.10	17
Haemulon aurolineatum	5	1.00	12						
Calamus spp.	5	1.00	12	1	0.39	17			
Scarus taeniopterus	4	0.80	13				10	1.38	14
Lutjanus apodus	3	0.60	15	1	0.39	17	2	0.28	28
Acanthurus chirurgus	3	0.60	15						
Aluterus schoepfi	3	0.60	15						
Epinephelus striatus	2	0.40	18	1	0.39	17			
Malacanthus plumieri	2	0.40	18	1	0.39	17			
Halichoeres radiatus	2	0.40	18				1	0.14	32
Aluterus monocerus	2	0.40	18						
Myripristis jacobus	1	0.20	22						
Rypticus saponaceus	1	0.20	22				2	0.28	28
Caranx crysos	1	0.20	22				11	1.52	13
Caranx ruber	1	0.20	22	1	0.39	17			
Lutjanus jocu	1	0.20	22	1	0.39	17			
Lutjanus synagris	1	0.20	22				1	0.14	32
Acanthurus coerulus	1	0.20	22				15	2.07	11
Haemulon flavolinatum	1	0.20	22	2	0.78	11	40	5.52	5
Calamus calamus	1	0.20	22				12	1.66	12
Mulloidichthys martinicus	1	0.20	22						
Chaetodon striatus	1	0.20	22						
Holocanthus tricolor	1	0.20	22						
Scarus croicensis	1	0.20	22				4	0.55	20
Sparisoma chrysopterum	1	0.20	22						
Xantjichthys ringens	1	0.20	22						
Melichthys niger	1	0.20	22	5	1.95	8	1	0.14	32
Alectis ciliaris				2	0.78	11			
Acanthurus bahianus				2	0.78	11	4	0.55	20
Haemulon striatus				2	0.78	11			
Sphyraena barracuda				1	0.39	17			
Hypoplectrus nigricans				1	0.39	17			
Remora remora				1	0.39	17			
Lujanus buccanella				1	0.39	17	2	0.28	28
Haemulon album				1	0.39	17			
Calamus penna				1	0.39	17			
Chaetodon striatus				1	0.39	17	25	3.45	8
Halichoeres bivittatus				1	0.39	17	1	0.14	32
Pomacanthus arcuatus				1	0.39	17	5	0.69	19

Sparidae spp	1	0.39	17			
Lactophrys quadricornis	1	0.39	17			
Lutjanus vivanus				35	4.85	7
Holocentrus spp.				10	1.38	14
Chaetodon sedentarius				6	0.83	18
Pomacanthus paru				1	0.14	32
Haemulon sciurus				4	0.55	20
Sparisoma aurofrenatum				4	0.55	20
Halichoeres poeyi				3	0.41	25
Scarus vetula				3	0.41	25
Sparisoma viride				2	0.28	28
Lutjanus griseus				1	0.14	32
Aluterus scriptus				1	0.14	32
Baslistes capriscus				1	0.14	32
Mycteroperca rubra				1	0.14	32
Hemipteronatus splendens				1	0.14	32
Hypoplectrus unicolor				1	0.14	32

Table 11. Composition of marketable catch and bycatch from traps fished in St John between 1992-93 and 1994-95. Percentages are based on the weight (kg) of the catch.

		1992-1993				1994-1995			
		% of species catch		% of total catch		% of species catch		% of total catch	
		catch	bycatch	catch	bycatch	catch	bycatch	catch	bycatch
Acanthurus bahianus	Ocean surgeon					100		0.79	
Acanthurus coeruleus	Blue tang	100		0.33					
Acanthurus chirurgus	Doctorfish	100		1.62					
Aluterus schoepfi	Orange filefish		100		0.65				
Balistes vetula	Queen triggerfish	96.56	3.44	36.62	1.31	95.69	4.31	20.64	0.93
Calamus spp	Porgy	79.23	20.77	1.19	0.31	100		3.80	
Caranx ruber	Bar jack	100		0.19		100		0.40	
Cephalopholis cruentatus	Graysby	100		1.03		100		1.20	
Cephalopholis fulvus	Coney	100		6.87		99.74	0.26	19.18	0.05
Chaetodon capistratus	Foureye butterflyfish		100		0.45		100		0.22
Chaetodon striatus	Banded butterflyfish		100		0.08		100		0.08
Epinephelus guttatus	Red hind	99.41	0.59	21.71	0.16	100		29.01	
Epinephelus striatus	Nassau grouper		100		0.70		100		4.54
Haemulon aurolineatum	Tomtate	100		0.22					
Haemulon flavolineatum	French grunt						100		0.19
Haemulon plumieri	White grunt	100		1.77					
Halichoeres bivittatus	Slippery dick						100		0.40
Holocanthus tricolor	Rock beauty		100		0.27				
Holocentrus adscensionis	Squirrelfish	100		0.82		100		0.99	
Holocentrus rufus	Longspine squirrelfish	100		2.18		100		3.89	
Lactophrys quadricornis	Scrawled cowfish					100		0.12	
Lutjanus apodus	Schoolmaster		100		0.62		100		1.06
Mycteroperca venenosa	Yellowfin grouper	78.62	21.38	6.44	1.75	100		9.51	
Ocyurus chrysurus	Yellowtail snapper	70.85	29.15	3.56	1.46	79.60	20.40	0.94	0.24
Pomacanthus arcuatus	Gray angelfish						100		0.38
Rypticus saponaceus	Soapfish		100		0.37				
Scarus croicensis	Striped parrotfish		100		0.42				
Scarus taeniopterus	Princess parrotfish		100		0.70				
Sparisoma chrysopterum	Yellowtail parrotfish		100		0.22				
Sphyraena barraccuda	Barracuda						100		1.43
TOTAL				90.53	9.47			90.48	9.52

Table 12. Composition of marketable catch and bycatch from traps fished in St John between 1999-2000. Percentages are based on the weight (kg) of the catch.

		% of species catch		% of total catch	
		catch	bycatch	catch	bycatch
Acanthurus bahianus	Ocean surgeon		100		0.18
Acanthurus coeruleus	Blue tang		100		0.80
Acanthurus chirurus	Doctorfish	86.37	13.63	0.84	0.13
Aluterus scriptus	Scrawled filefish	100		0.56	
Balistes vetula	Queen triggerfish	99.14	0.86	25.39	0.22
Calamus calamus	Sheepshead porgy	93.68	6.32	2.14	0.14
Caranx crysos	Blue runner	100		0.53	
Caranx ruber	Bar jack	100		0.39	
Cephalopholis cruentatus	Graysby	100		1.16	
Cephalopholis fulvus	Coney	100		28.22	
Chaetodon capistratus	Foureye butterflyfish		100		0.72
Chaetodon sedentarius	Reef butterflyfish		100		0.11
Chaetodon striatus	Banded butterflyfish		100		0.91
Epinephelus guttatus	Red hind	99.55	0.45	15.64	0.07
Haemulon flavolineatum	French grunt		100		2.22
Haemulon plumieri	White grunt	100		0.41	
Haemulon sciurus	Bluestriped grunt	100		0.61	
Halichoeres bivittatis	Slippery dick		100		0.13
Halichoeres poeyi	Blackear wrasse		100		0.18
Halichoeres radiatus	Puddingwife		100		0.08
Hemipteronotus splendens	Green razorfish		100		0.14
Holocentrus spp	Squirrelfish	100		0.21	
Holocentrus adscensionis	Squirrelfish	100		1.30	
Holocentrus rufus	Longspine squirrelfish	100		0.35	
Hypoplectrus unicolor	Butter hamlet		100		0.06
Lutjanus apodus	Schoolmaster		100		0.36
Lutjanus buccanella	Blackfin snapper	68.55	31.45	0.16	0.07
Lutjanus synagris	Lane snapper	100		0.19	
Mycteroperca venenosa	Yellowfin grouper	72.11	27.89	0.52	0.20
Mycteroperca rubra	Comb grouper		100		0.18
Ocyurus chrysurus	Yellowtail snapper	62.33	37.67	4.24	2.56
Pomacanthus arcuatus	Gray angelfish	100		3.85	
Pomacanthus paru	French angelfish	100		0.88	
Rypticus saponaceus	Soapfish		100		0.22
Scarus croicensis	Striped parrotfish		100		0.43
Scarus taeniopterus	Princess parrotfish		100		1.23
Scarus vetula	Queen parrotfish	100		0.46	
Sparisoma aurofrenatum	Redband parrotfish	45.70	54.30	0.24	0.29
Sparisoma viridae	Stoplight parrotfish	100		0.29	
TOTAL				88.38	11.62

Table 13. Composition of marketable catch and bycatch from traps fished in St John between 1992-93 and 1994-95. Percentages are based on the frequency of the catch.

		1992-1993				1994-1995			
		% of species catch		% of total catch		% of species catch		% of total catch	
		catch	bycatch	catch	bycatch	catch	bycatch	catch	bycatch
Acanthurus bahianus	Ocean surgeon					100		1.67	
Acanthurus coeruleus	Blue tang	100		0.48					
Acanthurus chirurgus	Doctorfish	100		1.45					
Aluterus schoepfi	Orange filefish		100		1.45				
Balistes vetula	Queen triggerfish	84.85	15.45	13.53	2.42	85.71	14.29	15.00	2.50
Calamus spp	Porgy	50.00	50.00	0.48	0.48	100		0.83	
Caranx ruber	Bar jack	100		0.48		100		0.83	
Cephalopholis cruentatus	Graysby	100		1.45		100		1.67	
Cephalopholis fulvus	Coney	100		31.40		97.06	2.94	27.50	0.83
Chaetodon capistratus	Foureye butterflyfish		100		5.31		100		3.33
Chaetodon striatus	Banded butterflyfish		100		0.48		100		0.83
Epinephelus guttatus	Red hind	97.30	2.70	17.39	0.48	100		20.83	
Epinephelus striatus	Nassau grouper		100		0.48		100		0.83
Haemulon aurolineatum	Tomtate	100		0.97					
Haemulon flavolineatum	French grunt						100		0.83
Haemulon plumieri	White grunt	100		1.45					
Halichoeres bivittatus	Slippery dick						100		0.83
Holocanthus tricolor	Rock beauty		100		0.48				
Holocentrus adscensionis	Squirrelfish	100		2.42		100		1.67	
Holocentrus rufus	Longspine squirrelfish	100		2.90		100		12.50	
Lactophrys quadricornis	Scrawled cowfish					100		0.83	
Lutjanus apodus	Schoolmaster		100		0.48		100		0.83
Mycteroperca venenosa	Yellowfin grouper	60.00	40.00	2.90	1.93	100		2.50	
Ocyurus chrysurus	Yellowtail snapper	50.00	50.00	2.90	2.90	50.00	50.00	0.83	0.83
Pomacanthus arcuatus	Gray angelfish						100		0.83
Rypticus saponaceus	Soapfish		100		0.48				
Scarus croicensis	Striped parrotfish		100		0.48				
Scarus taeniopterus	Princess parrotfish		100		1.45				
Sparisoma chrysopterum	Yellowtail parrotfish		100		0.48				
Sphyraena barraccuda	Barracuda						100		0.83
TOTAL				80.19	19.81			86.67	13.33

Table 14. Composition of marketable catch and bycatch from traps fished in St John between 1999-2000. Percentages are based on the frequency of the catch.

		% of species catch		% of total catch	
		catch	bycatch	catch	bycatch
Acanthurus bahianus	Ocean surgeon		100		0.72
Acanthurus coeruleus	Blue tang		100		2.71
Acanthurus chirurus	Doctorfish	80.00	20.00	1.44	0.36
Aluterus scriptus	Scrawled filefish	100		0.18	
Balistes vetula	Queen triggerfish	98.21	1.79	9.93	0.18
Calamus calamus	Sheepshead porgy	77.78	22.22	1.26	0.18
Caranx crysos	Blue runner	100		0.18	
Caranx ruber	Bar jack	100		0.72	
Cephalopholis cruentatus	Graysby	100		1.62	
Cephalopholis fulvus	Coney	100		31.23	
Chaetodon capistratus	Foureye butterflyfish		100		8.30
Chaetodon sedentarius	Reef butterflyfish		100		1.08
Chaetodon striatus	Banded butterflyfish		100		4.51
Epinephelus guttatus	Red hind	97.56	2.44	7.22	0.18
Haemulon flavolineatum	French grunt		100		7.22
Haemulon plumieri	White grunt	100		0.18	
Haemulon sciurus	Bluestriped grunt	100		0.72	
Halichoeres bivittatis	Slippery dick		100		0.18
Halichoeres poeyi	Blackear wrasse		100		0.36
Halichoeres radiatus	Puddingwife		100		0.18
Hemipteronotus splendens	Green razorfish		100		0.18
Holocentrus spp	Squirrelfish	100		0.36	
Holocentrus adscensionis	Squirrelfish	100		4.15	
Holocentrus rufus	Longspine squirrelfish	100		0.54	
Hypoplectrus unicolor	Butter hamlet		100		0.18
Lutjanus apodus	Schoolmaster		100		0.36
Lutjanus buccanella	Blackfin snapper			0.18	0.18
Lutjanus synagris	Lane snapper	100		0.18	
Mycteroperca venenosa	Yellowfin grouper	66.67	33.33	0.36	0.18
Mycteroperca rubra	Comb grouper		100		0.18
Ocyurus chrysurus	Yellowtail snapper	57.14	42.86	3.61	2.71
Pomacanthus arcuatus	Gray angelfish	100		0.90	
Pomacanthus paru	French angelfish	100		0.18	
Rypticus saponaceus	Soapfish		100		0.36
Scarus croicensis	Striped parrotfish		100		0.72
Scarus taeniopterus	Princess parrotfish		100		1.81
Scarus vetula	Queen parrotfish	100		0.54	
Sparisoma aurofrenatum	Redband parrotfish	50.00	50.00	0.36	0.36
Sparisoma viridae	Stoplight parrotfish	100		0.36	
TOTAL				66.43	33.57

Table 15. Composition of marketable catch and bycatch from hook & line fishing in 1992/3, 1994/5 and 1999/2000 in St. John. Percentages are based on the total weight (kg) of the catch in each year class.

		1992/3		1994/5		1999/2000	
		% catch	% bycatch	% catch	% bycatch	% catch	% bycatch
Alectis ciliaris	African pompano				7.54		
Aluterus monocerus	Unicorn leatherjacket		1.47				
Balistes capriscus	Gray triggerfish						1.00
Balistes vetula	Queen triggerfish	8.97		19.38		18.60	
Calamus spp	Porgy	0.51					
Calamus calamus	Sheepshead porgy	0.44				2.17	
Calamus penna	Saucereye porgy			0.75			
Canthidermis sufflamen	Ocean triggerfish		37.80		9.80		
Caranx crysos	Blue runner	0.45				11.61	
Cephalopholis cruentatus	Graysby	1.13		3.26		3.60	
Cephalopholis fulvus	Coney	7.13		8.89		12.60	
Epinephelus guttatus	Red hind	29.38		30.26		30.61	
Haemulon album	White margate			3.36			
Haemulon flavolinatum	French grunt				0.17		
Haemulon plumieri	White grunt	1.76		0.90			
Haemulon striatus	Striped grunt				0.16		
Halichoeres poeyi	Blackear wrasse						0.77
Halichoeres radiatus	Puddingwife		1.00				
Holocentrus adscensionis	Squirrelfish	0.55				1.74	
Holocentrus rufus	Longspine squirrelfish	0.70		1.21	0.23	1.73	0.16
Hypoplectrus nigricans	Black hamlet				0.05		
Lutjanus apodus	Schoolmaster		1.37				
Lutjanus buccanella	Blackfin snapper			0.73			
Lutjanus griseus	Gray snapper						1.26
Lutjanus jocu	Dog snapper		0.62		1.93		
Lutjanus synagris	Lane snapper	0.20					
Lutjanus vivanus	Silk snapper					11.23	
Malacanthus plumieri	Sand tilefish		0.37		0.24		
Melichthys niger	Black durgon		0.56		4.39		1.45
Mycteroperca venenosa	Yellowfin grouper			1.88			
Myripistis jacobus	Blackbar soldierfish		0.08				
Ocyurus chrysus	Yellowtail snapper	4.52		1.93	0.17	1.48	
Remora remora	Remora				2.43		
Xanthichthys ringens	Sargassum triggerfish		1.00				
TOTAL		55.74	44.26	72.55	27.45	95.36	4.64

Table 16. Composition of marketable catch and bycatch from hook & line fishing in 1992/3, 1994/5 and 1999/2000 in St. John. Percentages are based on the frequency of the catch in each year class.

		1992/3		1994/5		1999/2000	
		% catch	% bycatch	% catch	% bycatch	% catch	% bycatch
Alectis ciliaris	African pompano				1.46		
Aluterus monocerus	Unicorn leatherjacket		1.12				
Balistes capriscus	Gray triggerfish						0.58
Balistes vetula	Queen triggerfish	6.74		11.68		10.53	
Calamus spp	Porgy	0.56					
Calamus calamus	Sheepshead porgy	0.56				1.75	
Calamus penna	Saucereye porgy			0.73			
Canthidermis sufflamen	Ocean triggerfish		16.85		4.38		
Caranx crysos	Blue runner	0.56				5.85	
Cephalopholis cruentatus	Graysby	3.93		10.95		5.26	
Cephalopholis fulvus	Coney	17.42		19.71		23.39	
Epinephelus guttatus	Red hind	34.27		28.47		21.64	
Haemulon album	White margate			0.73			
Haemulon flavolinatum	French grunt				0.73		
Haemulon plumieri	White grunt	3.37		1.46			
Haemulon striatus	Striped grunt				1.46		
Halichoeres poeyi	Blackear wrasse						0.58
Halichoeres radiatus	Puddingwife		1.12				
Holocentrus adscensionis	Squirrelfish	2.25				5.26	
Holocentrus rufus	Longspine squirrelfish	0.56		5.11	1.46	2.34	0.58
Hypoplectrus nigricans	Black hamlet				0.73		
Lutjanus apodus	Schoolmaster	1.12					
Lutjanus buccanella	Blackfin snapper			0.73			
Lutjanus griseus	Gray snapper						0.58
Lutjanus jocu	Dog snapper		0.56		0.73		
Lutjanus synagris	Lane snapper	0.56					
Lutjanus vivanus	Silk snapper					20.47	
Malacanthus plumieri	Sand tilefish		0.56		0.73		
Melichthys niger	Black durgon		0.56		3.65		
Mycteroperca venenosa	Yellowfin grouper			0.73			0.58
Myripistis jacobus	Blackbar soldierfish		0.56				
Ocyurus chrysus	Yellowtail snapper	6.18		2.19	0.73	0.58	
Remora remora	Remora				0.73		
Xanthichthys ringens	Sargassum triggerfish		0.56				
TOTAL		76.97	23.03	82.28	17.52	97.08	2.92

Table 17. Mean (± SD) fork length (FL) of each fish species captured using traps and hook & line during 6 fishing days in 1993-4 and eight fishing days in 2002 in St. Croix. Only species with > 5 captures across all years are included.

		1993/4		2002	
		Fork Length (mm)	N	Fork Length (mm)	N
Acanthurus bahianus	Ocean surgeon	158.9 ± 25.3	7	166.4 ± 23.3	12
Acanthurus coeruleus	Blue tang	-	0	151.9 ± 37.4	7
Balistes vetula	Queen triggerfish	205.9 ± 49.1	16	259.2 ± 52.2	6
Caranx crysos	Blue runner	383.5 ± 132.2	2	263.4 ± 38.5	38
Cephalopholis cruentatus	Graysby	199.0 ± 22.3	4	209.1 ± 13.4	11
Cephalopholis fulvus	Coney	217.2 ± 27.0	126	214.2 ± 28.4	546
Chaetodon capistratus	Foureye butterflyfish	105.8 ± 7.3	19	100.9 ± 22.4	28
Chaetodon sedentarius	Reef butterflyfish	-	0	111.7 ± 25.4	9
Chaetodon striatus	Banded butterflyfish	-	0	125.6 ± 7.9	16
Epinephelus guttatus	Red hind	281.3 ± 30.3	6	273.4 ± 47.5	46
Haemulon flavolineatum	French grunt	185.8 ± 3.4	4	182.1 ± 5.7	7
Haemulon plumieri	White grunt	201.3 ± 68.1	4	197.5 ± 46.0	2
Holocentrus rufus	Longspine squirrelfish	200.0 ± 23.2	6	155.1 ± 65.3	14
Malacanthus plumieri	Sand tilefish	355.2 ± 41.6	20	346.6 ± 80.0	75
Ocyurus chrysurus	Yellowtail snapper	209.8 ± 35.7	5	270.0	1
Pseudupeneus maculatus	Spotted goatfish	197.3 ± 21.5	23	245.0	1
Scarus taeniopterus	Princess parrotfish	180.0	1	202.3 ± 2.9	4

Table 18. Mean (± SD) fork length (FL) of each fish species captured using traps and hook & line during 25 fishing days in 1992-3, 25 fishing days in 1994-5 and 16 fishing days between 1999-2000. Only species with > 5 captures across all years are included.

		1992-1993		1994-1995		1999-2000	
		Fork Length (mm)	N	Fork Length (mm)	N	Fork Length (mm)	N
Acanthurus bahianus	Ocean surgeon	-	0	200.5 ± 21.9	2	157.5 ± 13.1	4
Balistes vetula	Queen triggerfish	299.0 ± 63.7	54	286.4 ± 57.8	37	268.5 ± 44.9	74
Calamus calamus	Saucereye porgy	-	0	-	0	224.0 ± 38.1	12
Canthidermis sufflamen	Ocean triggerfish	401.3 ± 38.9	40	390.3 ± 33.0	6	-	0
Caranx crysos	Blue runner	308.0	1	-	0	324.6 ± 25.8	11
Caranx ruber	Bar jack	204.0	1	230.0	1	236.8 ± 11.6	4
Cephalopholis cruentatus	Graysby	218.1 ± 37.1	15	226.6 ± 44.0	17	240.67 ± 25.6	18
Cephalopholis fulvus	Coney	242.0 ± 32.7	133	256.9 ± 43.4	61	242.8 ± 28.4	213
Chaetodon capistratus	Foureye butterflyfish	96.2 ± 5.9	11	98.5 ± 4.0	4	94.4 ± 6.1	46
Chaetodon sedentarius	Reef butterflyfish	-	0	-	0	105.0 ± 10.5	6
Chaetodon striatus	Banded butterflyfish	124.0	1	107.0	1	118.9 ± 6.4	25
Epinephelus guttatus	Red hind	320.9 ± 55.2	117	340.1 ± 53.7	64	329.1 ± 50.2	78
Epinephelus striatus	Nassau grouper	326.5 ± 157.7	2	476.0	1	-	0
Haemulon flavolineatum	French grunt	185.0	1	176.0 ± 15.6	2	168.0 ± 13.7	40
Haemulon plumieri	White grunt	259.9 ± 28.3	9	253.5 ± 19.1	2	260.0	1
Holocentrus spp.	Squirrelfish	-	0	-	0	178.9 ± 27.8	10
Holocentrus adscensionis	Squirrelfish	199.5 ± 26.5	8	223.5 ± 16.3	2	186.0 ± 12.5	24
Holocentrus rufus	Longspine squirrelfish	218.7 ± 35.1	7	189.1 ± 27.7	24	211.3 ± 106.2	8
Lutjanus apodus	Schoolmaster	199.7 ± 194.2	3	344.0	1	266.0 ± 43.8	2
Lutjanus vivanus	Silk snapper	-	0	-	0	216.6 ± 13.2	35
Melichthys niger	Black durgon	298.0	1	293.8 ± 15.3	5	308.0	1
Mycteroperca venenosa	Yellowfin grouper	325.2 ± 58.1	10	465.5 ± 89.6	4	262.7 ± 136.6	3
Ocyurus chrysurus	Yellowtail snapper	313.6 ± 95.0	45	274.7 ± 67.5	6	255.4 ± 35.3	36
Pomocanthus arcuatus	Gray angelfish	-	0	182.0	1	355.4 ± 31.0	5
Scarus taeniopterus	Princess parrotfish	192.3 ± 19.3	4	-	0	223.5 ± 14.7	10

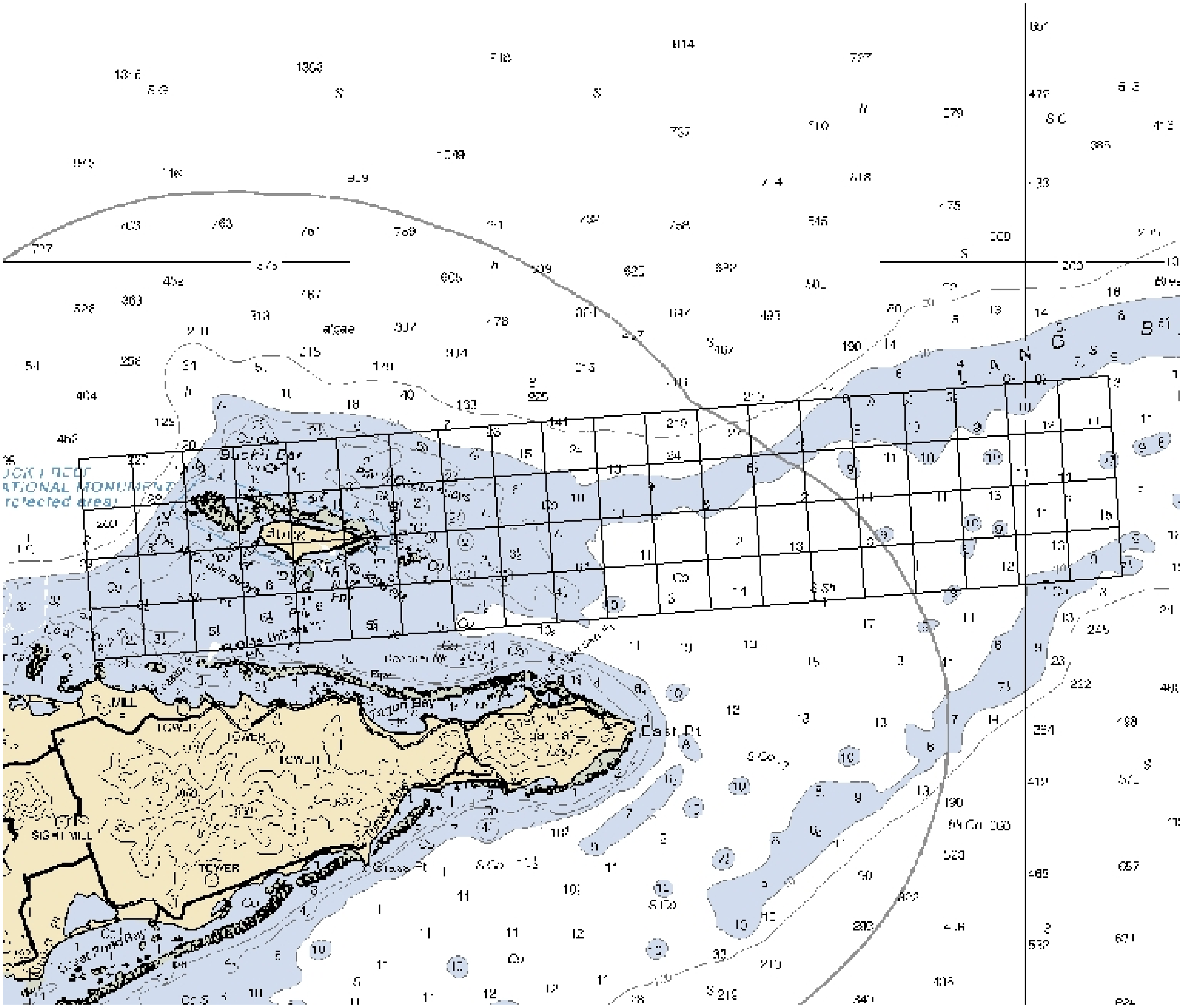

Figure 1. Location of the sampling area north-east of St. Croix, USVI, divided into quadrants and sub-quadrants.

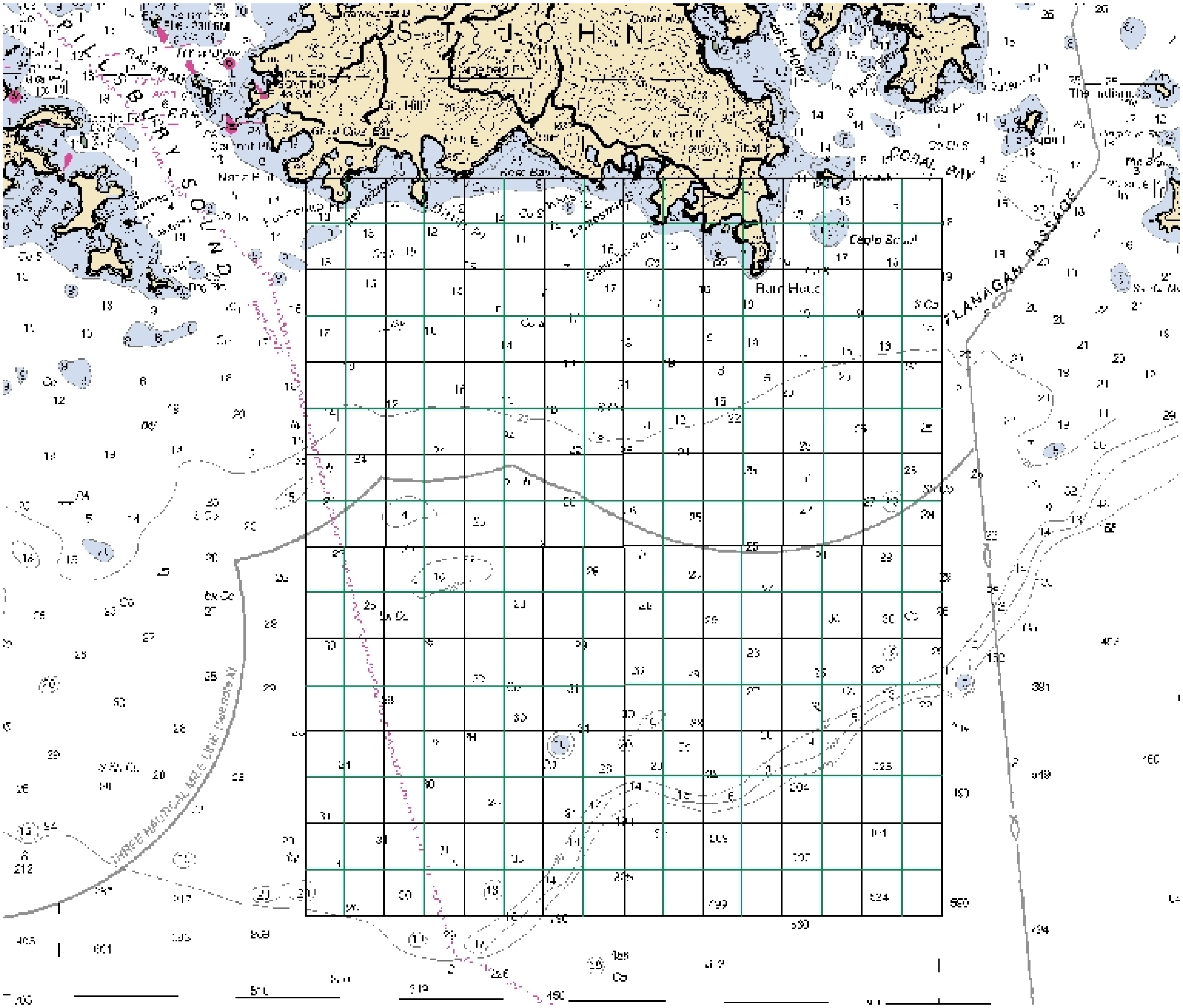

Figure 2. Location of the sampling area south of St. John, USVI divided into quadrants and sub-quadrants.

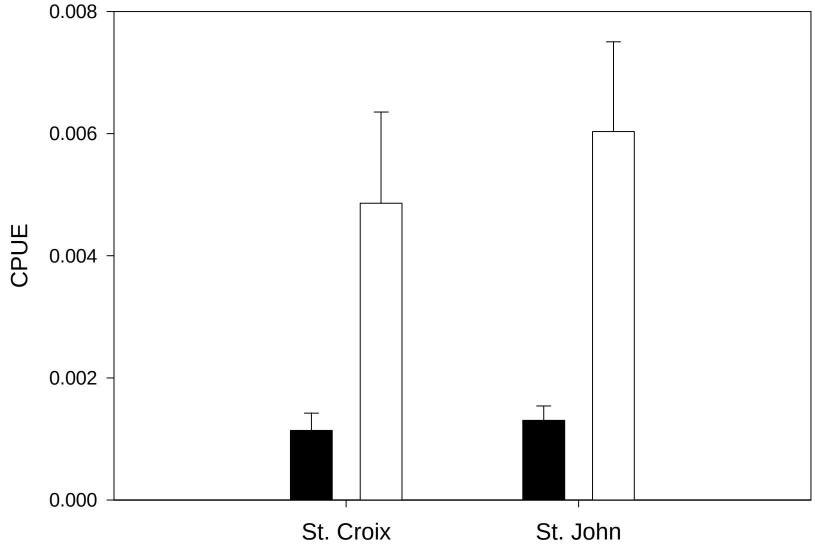

Figure 5. Catch weight (kg) per minute fished (CPUE) using traps (black bars) and hook & line (white bars) in St. Croix and St. John across all sample days. Means are presented ±1S.E.

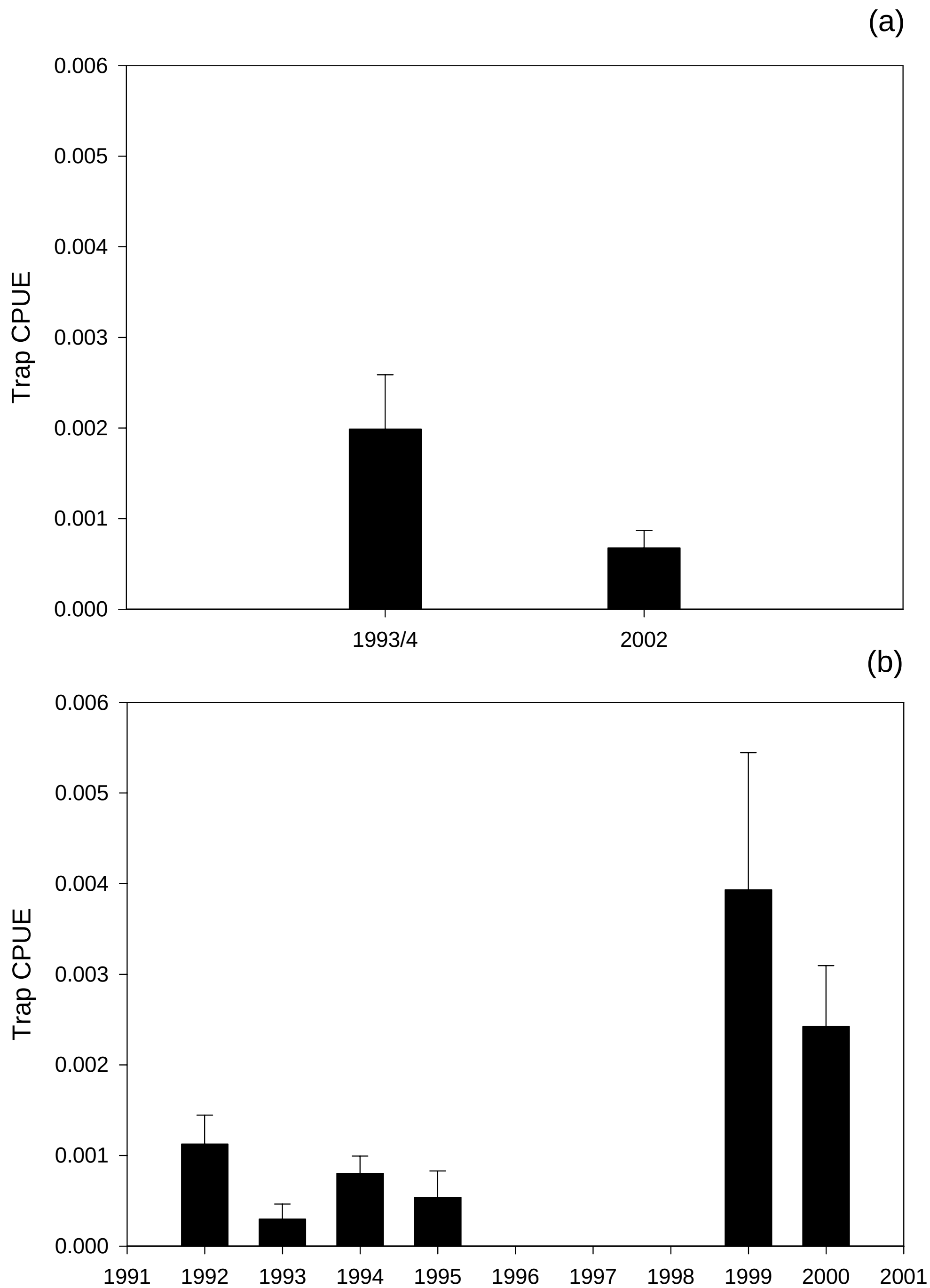

Figure 6. Catch weight (kg) per minute fished (CPUE) from traps for each year of sampling in (a) St. Croix and (b) St. John. Means are presented ±1S.E.

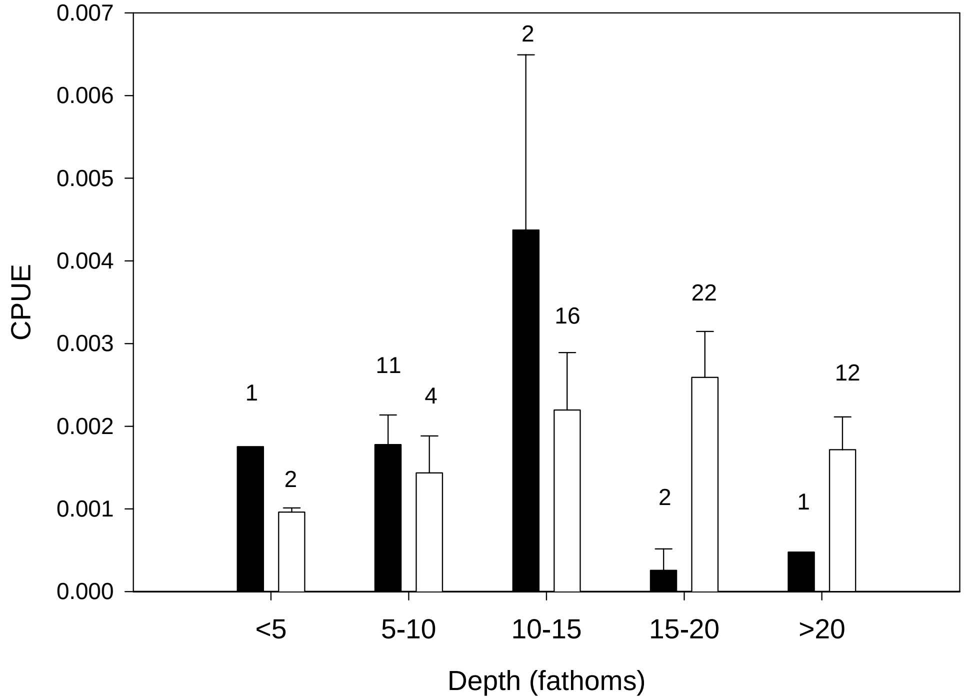

Figure 7. Catch weight (kg) per minute fished from all gear types at each depth class in St. Croix (black bars) and St. John (white bars). Means are presented ±1S.E. Numbers above the bars refer to the number of sample days in each category.

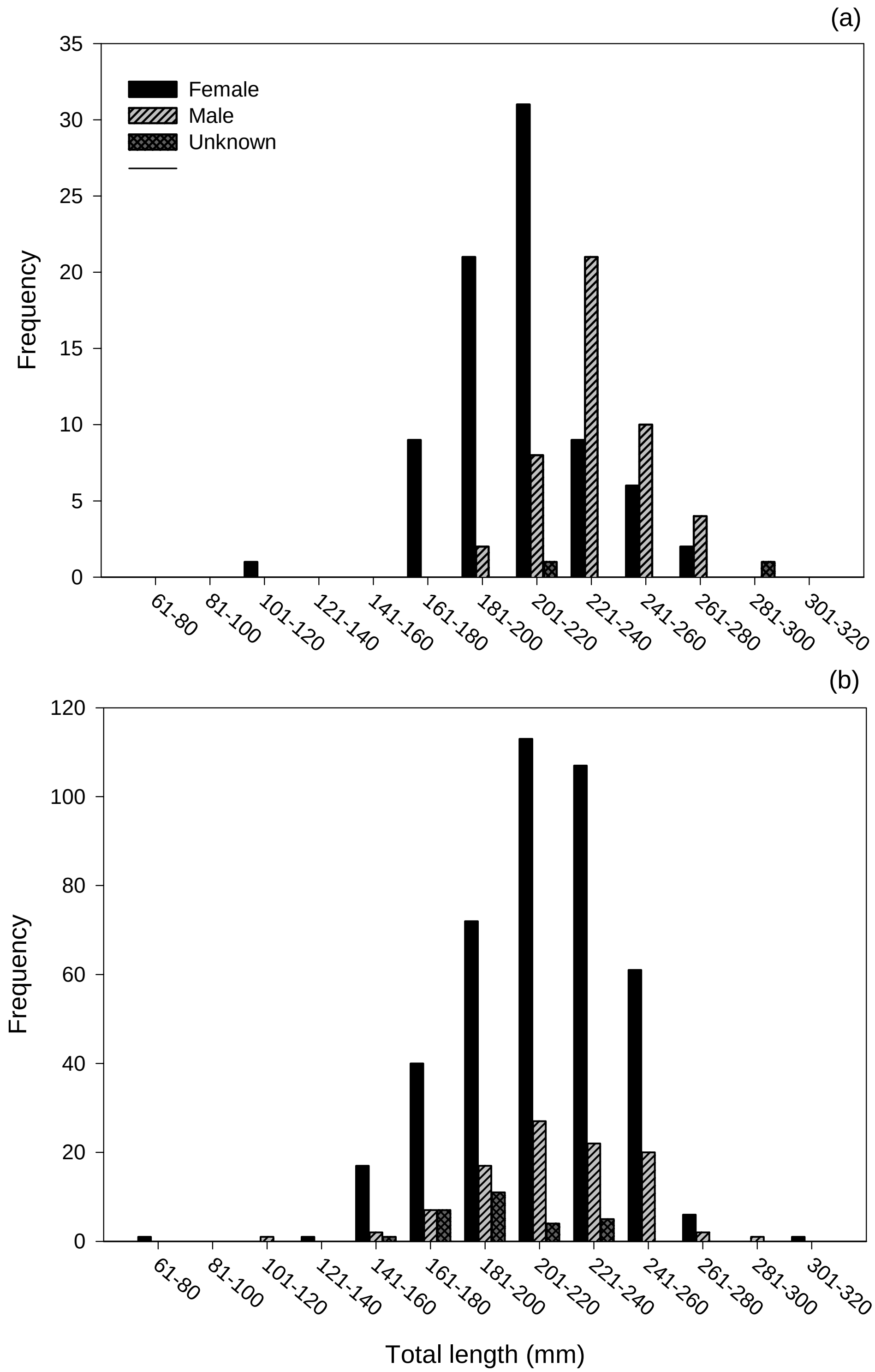

Figure 10. Frequency of female, male and unknown sex coney (*C. fulva*) in (a) 1993/4 and (b) 2002 captured in St. Croix.

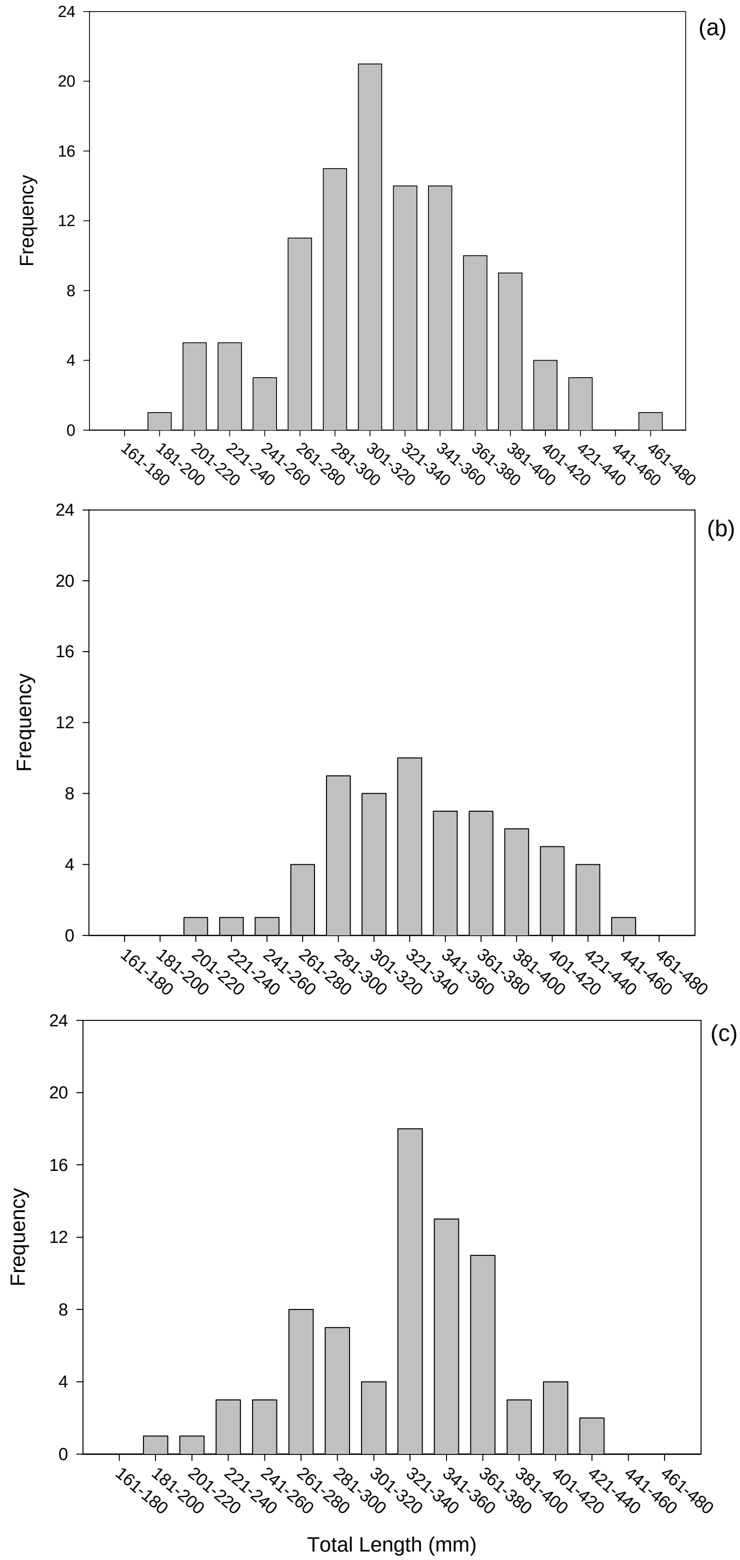

Figure 12. Frequency of all red hind (*E. guttatus*) in (a) 1992/3, (b) 1994/5 and (c) 1999/2000 captured in St. John.

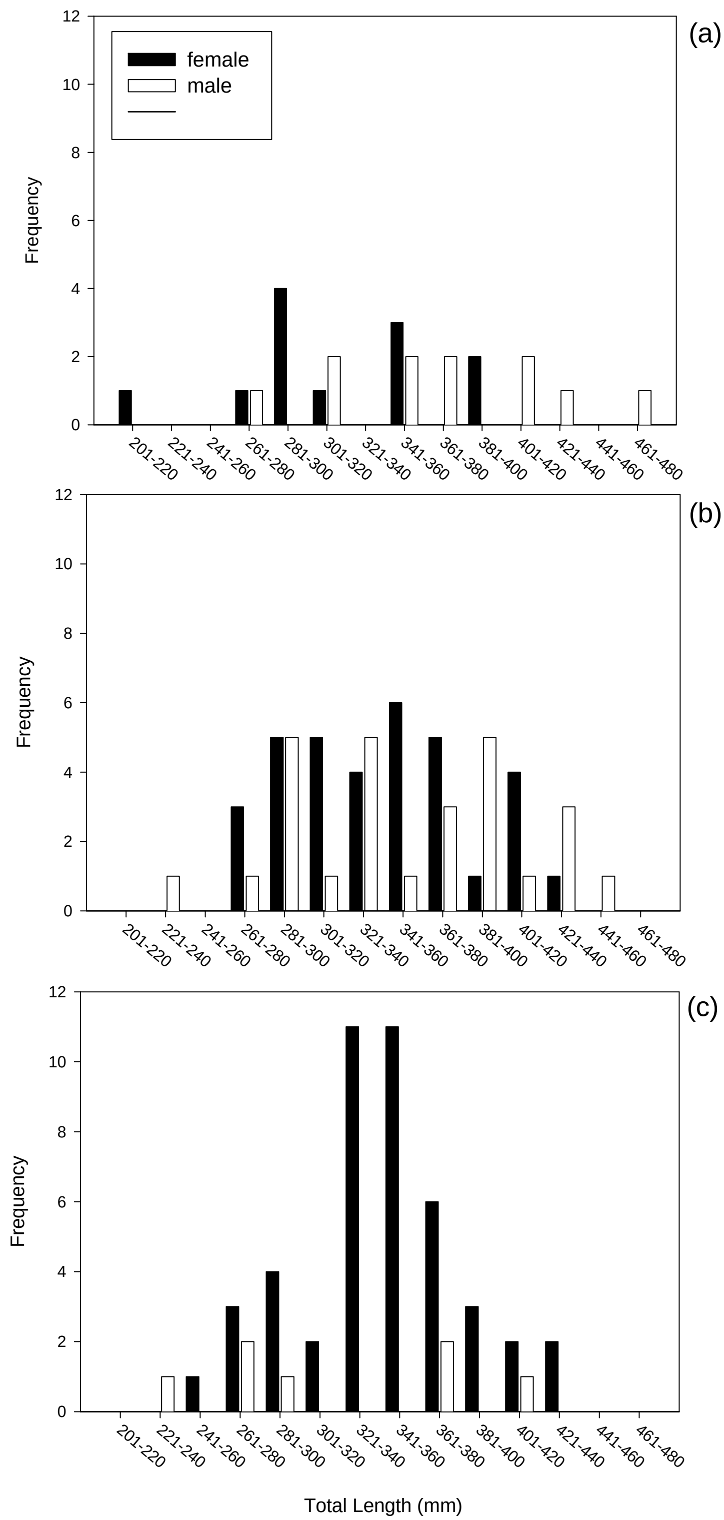

Figure 13. Frequency of female and male red hind (*E. guttatus*) in (a) 1992/3, (b) 1994/5 and (c) 1999/2000 captured in St. John.

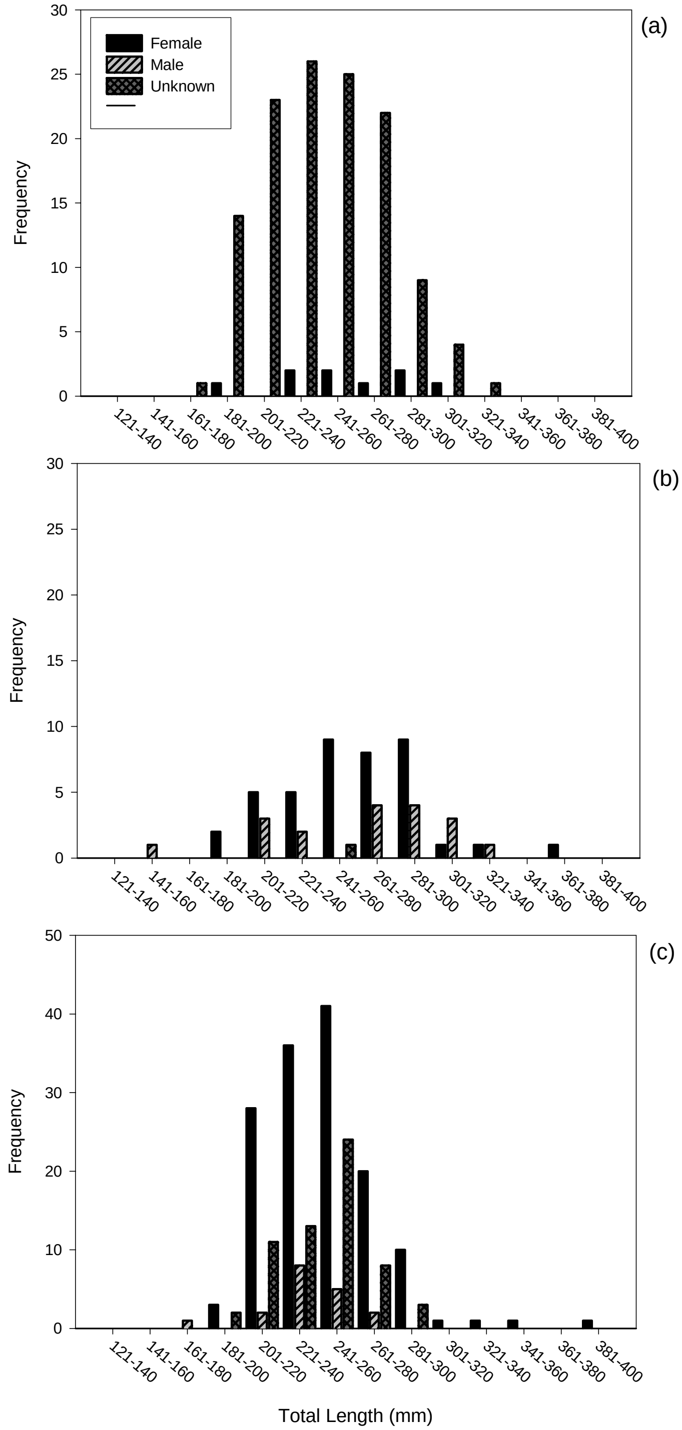

Figure 15. Frequency of male, female and unknown sex coney (*C. fulva*) captured in St. John in (a) 1992-93, (b) 1994-95 and (c) 1999-2000.

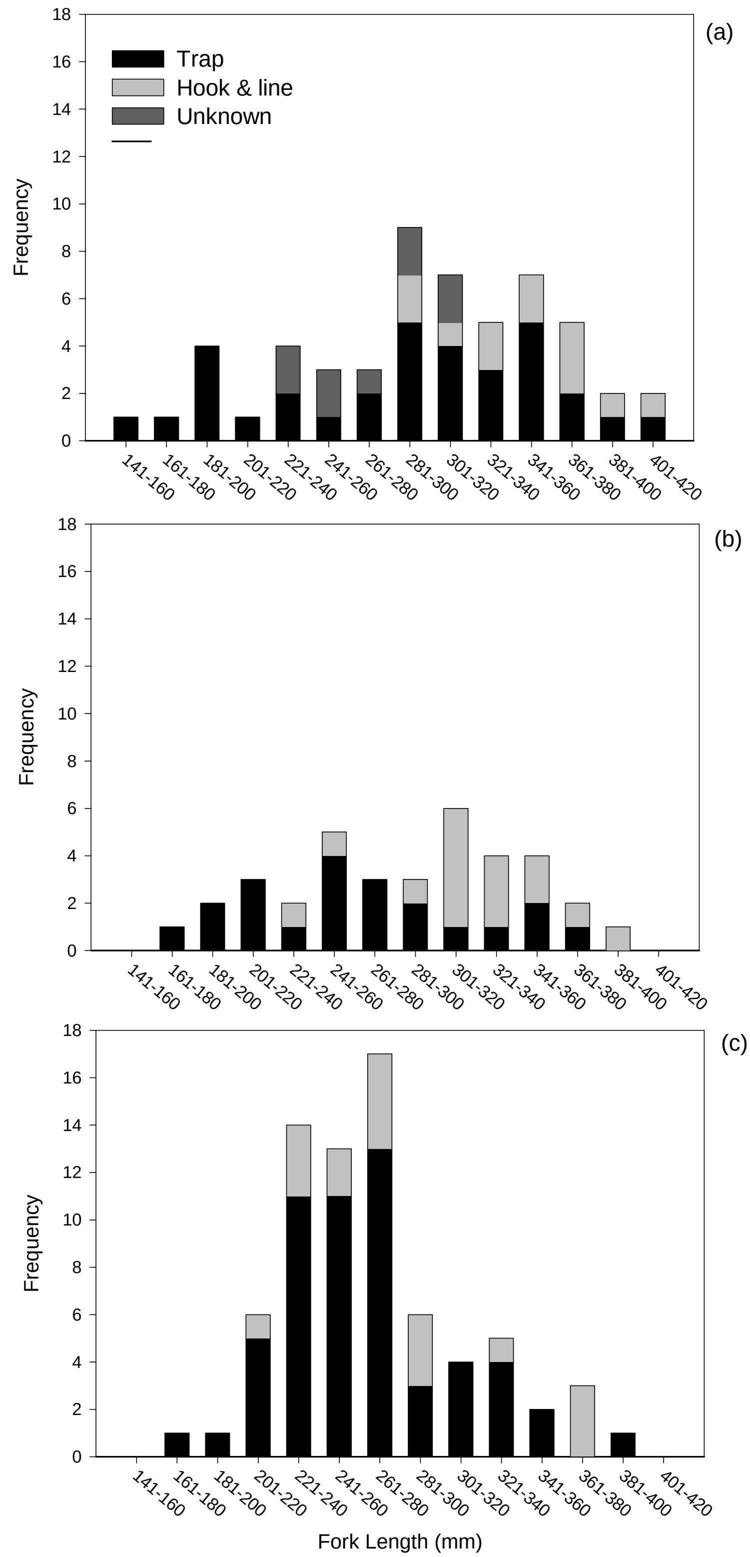

Figure 17. Frequency of queen triggerfish (*B. vetula*) captured south of St. John in (a) 1992/3, (b) 1994/5 and (c) 1999/2000.

APPENDIX 1.

Sampling methodology

The broad sampling methodology for this study is described below to allow a valid interpretation of the data analysis. Methods were summarised from Gomez (2000) and Tobias *et al*. (2002). However, owing to boat logistics, weather and other field conditions, many of the original features of the sampling design were subsequently altered between islands and years. Additional details can be found in the above reports.

(i) Site selection

Two areas were chosen for sampling, one to the northeast of St. Croix and a second south of St. John. In St. Croix, a 20 square mile area was selected that extends from 1.5 nautical miles (nm) west of Buck Island to 5.5 nm northeast of Buck Island onto Lang Bank. The sampling area overlays the insular shelf platform ranging in depth from 4.5-20.0 m to the shelf edge where it slopes precipitously from 28-50 m to 406 m in depth (Figure 1). A similar area covering the insular shelf was also selected south of St. John. This area covers 64 square miles and extends 11 km from shore to the shelf edge. Depths on the shelf range from 3.0-25.0 m while the shelf edge ranges from 25.0-50.0 m before descending to >200 m (Figure 2).

(ii) Fishing methods

Each area was divided into 2 x 2 nautical mile quadrats, five in St. Croix and 16 in St. Thomas. Each quadrat was then further divided into sixteen 0.5 x 0.5 nautical mile sub-quadrats (Figures 1 & 2). Sample days consisted of a day spent fishing within a single sub-quadrat. Quadrats and sub-quadrats were selected randomly and physically located using a GPS. From 1999 onwards, the sampling area was stratified into three depth classes: (1) 0-10 fathoms, (2) 11-20 fathoms and (3) > 20 fathoms. Sampling frequency was designed to reflect the relative area of each depth strata.

On each sampling day, 9-12 square traps constructed of wire mesh were deployed. Samples prior to March 1994 followed local mesh size regulations and traps were constructed with 1.25 inch mesh. However, following a change in the local regulations, all traps fished from June 1994 onwards were constructed with a larger 1.5 inch mesh. Traps were baited with blue fry (*Jenkensia* spp). Distances between traps were approximately 50 m and each trap was soaked for up to six hours. During the sampling period between 1992 and 2002 traps deployment varied between sets of three traps on a string or single trap sets.

During the trap soak period, fish were captured using hand lines baited with squid. In St Croix, hook & line fishing was conducted while drifting within the defined sub-quadrat. By comparison, all hook & line fishing in St. John was conducted while the fishing boat was anchored. For each trip the location, time, depth, total number of traps and soak time was recorded for each trap and the number of hand lines and total fishing time by hook & line was recorded for each fisherman.

Fish caught by hand line were separated by fisherman and retained on ice. Fish caught in traps were identified and recorded by individual trap number. Total or fork length (mm), weight (kg) and sex of each fish was later recorded in the laboratory. Individual fish were also scored according to the developmental stage of their gonads.