

**THE EFFECTS OF FISHING AND FISH TRAPS ON FISH ASSEMBLAGES
WITHIN VIRGIN ISLANDS NATIONAL PARK
AND BUCK ISLAND REEF NATIONAL MONUMENT**

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EXECUTIVE SUMMARY

The results of research from this project, combined with available historical information, yield an alarming view of the degraded condition of fish assemblages in Virgin Islands National Park and Buck Island Reef National Monument. Commercial and personal-use (or sustenance) fishing (primarily trap fishing) is responsible for declining resources. Coastal development and natural disturbance (primarily hurricanes) contribute to ecosystem changes, such as shifts to algal-dominated reefs and low-diversity inshore habitats.

Several results show the impact of trap fishing within park waters. Comparison of fish trap data from one location (the Lameshur Bays, St. John) collected in 1982-3 and 1993-4 show that the preferred fishery species (primarily the predatory groupers and snappers) have declined in relative abundance, whereas, the less preferred species (primarily the herbivorous parrotfishes and surgeonfishes) have increased. This has profound ecological consequences to entire reef communities as well as fish assemblages. Coral reef condition is greatly affected by the fishes which use the coral reef for shelter and food. Shifts in the abundances of predatory and herbivorous fishes may result in algal overgrowth on reefs and may affect the abundance of other organisms. Many fish species have declined in average size. A trapping experiment at this location showed that fishing a small number of traps (8) over a period of six months negatively affected the abundance of fishes on a reef.

Virgin Islands National Park and Buck Island Reef National Monument provide little protection to fisheries resources. Fisheries regulations are rarely enforced and most traps observed during underwater surveys conducted in Virgin Islands National Park were illegal based on defined criteria. The greatest problem is the lack of degradable panels, without which traps continue to kill when lost or abandoned. Another destructive trap problem is small mesh size, which does not allow small fish to escape and grow to reproductive size. Few differences were observed in catch rates, fish species composition and abundances, and fish sizes between park waters and surrounding waters. In fact, catch rates within Virgin Islands National Park were lower than those obtained in a previous study north of St. Thomas. Underwater surveys conducted in Virgin Islands National Park and Buck Island Reef National Monument documented a large number of active fish traps. Three intensive surveys were conducted around St. John, with as many as 58 fish traps with buoys (an unknown number were unbuoyed) observed within Virgin Islands National Park boundaries during one survey. Over 20 fishermen set traps within Virgin Islands National Park and harvest an estimated 12,000 fishes per year from park waters (probably a large underestimate). Approximately 6 trap fishermen operate around Buck Island, St. Croix and set over 40 traps within park boundaries. Commercial fishing is illegal in park waters, but it obviously is occurring.

Decisive management strategies need to be immediately implemented and enforced to reverse the present trend of declining resources within Virgin Islands National Park and Buck Island Reef National Monument. Fish traps are a destructive gear which have been eliminated in many areas, including parks and protected areas (e.g., the entire Florida reef tract). Commercial fishing activity should be eliminated from park waters to ensure sustained resources and a large area should be established as a marine reserve.

INTRODUCTION

Information on the marine resources and resource users in and around Virgin Islands National Park/Biosphere Reserve and Buck Island Reef National Monument has grown steadily during the past two decades. Most early work conducted within Virgin Islands National Park focused on description of resources and basic systematics and ecology of marine organisms. This included the work of John Randall and staff from University of Miami during 1958-1961 and investigations conducted during the Tektite Program in the 1970s. From 1983 to 1987, the National Park Service funded numerous studies to map and characterize the marine and terrestrial communities of St. John, Buck Island (St. Croix) and surrounding areas and to document the use of marine resources, primarily by fishermen. Relevant studies have been synthesized in a comprehensive National Park Service report (Rogers and Teytaud 1988). Subsequent studies on fishes have provided information on differences among sites and ecological zones, trends in fish assemblages, and the impact of large-scale disturbance on the entire reef community (Hurricane Hugo in 1989) around St. John (Beets 1993a) and around Buck Island, St. Croix (Gladfelter et al. 1993). These recent studies used visual census techniques and were not focused on fisheries.

An excellent description of historic and existing fishing around St. John is found in Rogers and Teytaud (1988). The earliest documentation of fishing around St. John has come from archeological investigation of middens produced by native Americans during Pre-ceramic and Ceramic Periods prior to European colonization (Lundberg 1985, Wild 1989, Wild et al. 1991). These early colonists were primarily gatherers who did not appear to have well developed fishing skills. Fishing was probably limited to gleaning in wading depths with intensive harvest of snails and few fish. Following European colonization, small scale fishing was conducted by plantation workers, as described in writings of a few colonists although no formal records exist. Fishing for the plantation was conducted using a few woven traps and handlines. Following decline of the plantation era and slave emancipation in the late 1800s, island people increased their sustenance fishing, which was limited to nearshore waters using woven traps and handlines from small rowboats and sailboats.

The first comprehensive documentation of fishing in the Virgin Islands was conducted in 1931 (Fiedler and Jarvis 1932). Fishing was an extremely important protein source to island people at this time and was conducted using traditional gear. Fish traps constructed of plant material (hoop vines) accounted for most fish landings (40%), followed by handline (30%) and seines (30%). Following World War II, the fishing sector increased the use of new technology available from the United States, which allowed for improved catches. During 1950-1960, tourism increased along with the number of residents in the U.S. Virgin Islands which greatly increased the demand for fisheries resources (finfish, lobster, and conch for food). Improved technology allowed fishermen to meet the increased demand. Older fishermen described fish catches of this period as dominated by large groupers and snappers (deGraf and Moore 1987).

Although fishermen actively debate when fisheries resources began to decline in the US Virgin Islands, nearly everyone agrees that fisheries resources are in decline (Beets 1987). In 1969, investigators documented that demand exceeded supply, with local resources accounting for approximately 60% of local consumption and the remainder imported (Dammann 1969, Swingle et al. 1979). Intensive commercial fishing within the Virgin Islands was estimated to have low potential for sustainable yields (Brownell 1972, Dammann and Sylvester 1977). Several investigations indicated that additional resources, such as deep-water resources, had low potential sustainable yield (Brownell and Rainey 1971, Sylvester 1973, Sylvester and Dammann 1973, 1974, Olsen et al. 1974, 1978). Several investigators have documented increase in effort, especially in terms of fish trap numbers, and decline of catch per unit effort during the past several decades (Dammann 1969, Olsen 1978, CFMC 1985, Appeldoorn et al. 1992). The decline of the preferred Nassau grouper, *Epinephelus striatus*, was documented in 1976 (Olsen and LaPlace 1978) and, during the 1980s, the spawning aggregation was fished to extirpation (Beets and Friedlander 1992). Additional fisheries resources, including other groupers, snappers, and conch, have declined in proportion of landings or in long-term landing trends (USVI DFW annual reports).

Although numerous investigations document the number of resource users and the status of fisheries resources around St. John (Fiedler and Jarvis 1932, Idyll and Randall 1959, Dammann 1969, 1986, Boulon 1986a, b, 1987, Boulon and Clavijo 1986, Boulon et al. 1986, Koester 1986), trends in fisheries resources and the effects of park regulations have not been adequately assessed. The purpose of this investigation was to assess the trends in the finfish fishery around St. John, to obtain information on resource users and their impact on fisheries resources, and to evaluate the effectiveness of park regulation pertaining to fishing in the conservation of the natural resources of Virgin Islands National Park/Biosphere Reserve and Buck Island Reef National Monument.

This investigation was initiated in 1992 and completed in 1995. Success of the project required much coordination and cooperation of the numerous staff scientists, technicians and volunteers in the National Park Service, National Biological Service, and USVI Division of Fish and Wildlife. Many resources were shared to complete the research and monitoring in and around Virgin Islands National Park and Buck Island Reef National Monument.

Fisheries Legislation and Regulations

The existing regulations covering marine resources in the Virgin Islands National Park were issued in the Federal Register in 1964 (Code of Federal Regulations Title 36, Section 7.74). These regulations only include resources within NPS boundaries (Figure 1). Regulations on fish species are limited to 1) no spearfishing or gill net fishing and 2) fishing only with rod or handline except that fish traps of "conventional Virgin Islands design" may be used and that bait fishes may be harvested with nets no greater than 20 ft and 1 in mesh (stretch). Three species of invertebrates are regulated as follows: 1) spiny lobster (*Pamulirus argus*) harvest is limited to two per person per day and no harvest of females with eggs, 2) conch (no species named, but reference is obviously to *Strombus* species) harvest is limited to two per person per day, 3) whelk (no species named, but reference is obviously to *Cittarium pica*) harvest is limited to one gallon per person per day. All other species are given full protection and all species, including those previously

mentioned, are fully protected in Trunk Bay and other waters containing underwater signs and markers.

The enabling legislation for Virgin Islands National Park in 1956 does not adequately define the meaning of "conventional Virgin Islands design" of fish traps which may be used in Virgin Islands National Park. Additionally, there has been no legal opinion on the meaning of "customary uses" which was stated in the enabling legislation for the park in 1956 (70 Stat. 940).

"Sec. 3. Nothing in the Act shall be construed as authorizing any limitation on **customary uses** of or access to the areas specified in section 1 for bathing and fishing (including setting out of fishpots and landing boats), subject to such regulations as the Secretary of the Interior may find reasonable and necessary for protection of natural conditions and prevention of damage to marine life and formations."

When this legislation was established, fishing in the Virgin Islands, especially around St. John, was primarily artisanal (or personal-use), effort was low, traps were constructed of hoop vine or chicken wire, and landings were abundant with large grouper and snappers (deGraf and Moore 1987).

The enabling legislation for Buck Island Reef National Monument, January 4, 1962, 27 F. R. 31, stated that the federal government "shall not adopt or attempt to enforce any rule, regulation or requirement limiting, restricting or reducing the existing fishing... privileges by inhabitants of the Virgin Islands..."

A policy on fishing activities within national parks was established when Title 36, Section 2.3 Fishing was published in the Code of Federal Regulations (48 FR 30282, June 30, 1983, as amended at 52 FR 35240, Sept. 18, 1987).

"(a) Except in designated areas or as provided in this section, fishing shall be in accordance with the laws and regulations of the State within whose exterior boundaries a park area or portion thereof is located. Nonconflicting State laws are adopted as a part of these regulations.

(d) The following are prohibited:

(4) **Commercial fishing**, except where specifically authorized by Federal statutory law."

In 1994, an opinion was written by the US Department of Interior Regional Solicitor (memorandum dated June 30, 1994) supporting concurrent jurisdiction between the Virgin Islands National Park and the Government of the US Virgin Islands. The opinion concluded that territorial legislation and regulations should be enforced within park boundaries. Territorial legislation requires a commercial license for anyone who sells fisheries resources or uses traps for fishing. Territorial legislation imposes gear restrictions on fish traps (mandatory biodegradable panel and mesh size greater than 1.25") and seines (mesh size greater than 1.5" excluding bait nets), bans the use of explosives, and restricts harvest of spiny lobster (no harvest of females with eggs and minimum carapace length of 3.5"). Territorial regulations restrict the harvest of conch and whelk, ban the export of bait fishes, increase the mesh size of fish traps to 2" square or 1.5" in

smallest rectangular dimension for St. Thomas-St. John and 1.5" for St. Croix (until 2000, when the smallest dimension of any trap mesh in the US Virgin Islands must be 2"), provide a closed seasonal area for mutton snapper (*Lutjanus analis*) on St. Croix, and establish marine reserves which restrict harvest on St. Thomas.

The definition of commercial fishermen and commercial gear should be clarified for Virgin Islands National Park and Buck Island Reef National Monument. The opinion on concurrent jurisdiction should apply in all cases. Within the territorial legislation enacted in 1971 (amended 1972, 1973, 1976), a commercial fishing license is required by any individual fishing, except for personal use. Personal use fishing excludes the use of commercial gear [see (k) below].

Virgin Islands Code, Chapter 9A, Title 12, Sec. 311. Fishing

"No person may engage in fishing and no vessel or other fishing device may be used in fishing in the territory unless registered, certified or licensed in accordance with the provisions of this chapter."

Virgin Islands Code, Chapter 9A, Title 12, Sec. 312. Registration, certification and licensing

"(g) No person shall take or attempt to take, with the aid or use of any vessel, and fish by pot, trap, net, seine or other contrivance designed for or adapted to the taking of fish, other than angling, without display the buoy colors used by him in accordance with his license..."

"(k) No license shall be required of those individuals who engage in fishing for the sole purpose of providing food for themselves and their families; Provided, That such fishing is not commercial and does not involve pots, traps, set nets or haul seines."

Federal fisheries regulations, adopted by the Caribbean Fisheries Management Council (CFMC), have been set for federal waters in the Exclusive Economic Zone (beyond the 3-mile territorial sea boundary) in response to declining resources. Harvest or possession of jewfish, Nassau grouper, seahorses, and butterflyfishes are prohibited. Size restrictions exist for yellowtail snapper. Seasonal closed areas (reserves) have been established for the primary grouper and snapper aggregation sites south of St. Thomas and east and south of St. Croix. (Additional fishery reserve sites are being considered by CFMC for St. John, St. Croix and Puerto Rico.) Fish traps must conform to regulations on mesh size and degradable panels.

The lack of concise definition of terms used in legislation and regulations and legal interpretation have confounded adequate enforcement within National Park Service waters. The lack of emphasis on enforcement of fishing regulations has contributed to extensive resource declines and increase in commercial fishing within park boundaries.

METHODS

Several methods were employed to assess the fisheries and fisheries resources around St. John and Buck Island, St. Croix. Investigations were not limited to the area within the boundaries of Virgin Islands National Park/Biosphere Reserve, St. John, and Buck Island Reef National Monument, St. Croix, since many species move among reefs (Figures 1 & 2).

Trends and comparisons for existing data sets were conducted as possible. However, two additional approaches were used: 1) documentation of reef fish characteristics within and outside National Park Service boundaries, and 2) experimental evidence of the effects of fishing on reef fishes. Trap fishing was the emphasis of this investigation since fish traps target reef species and traps are the primary gear in the fishery in the U.S. Virgin Islands.

Historical Trends and Comparisons

1) Fishermen landings

Fishermen landings records have been maintained by the territorial government since 1976. Landings data were not submitted by all fishermen (especially St. John fishermen), intermittently submitted by many fishermen, and the reliability was questionable. However, these data are useful in the establishment of trends. Data were submitted on gross landings, not by species groups, so trends within species groups and changes in species composition were not documented. Historically, landings data were pooled for St. Thomas and St. John, so a primary effort was to summarize archived data for St. John alone.

Fishermen landings were sampled in 1984 in Cruz Bay, St. John, and in 1986 from Buck Island, St. Croix, as part of previous NPS-funded projects (Boulon and Clavijo 1985, Tobias et al. 1988). St. John data were collected during 13-16 samples of three fishermen. These data sets allowed for comparisons with landing samples collected during the present investigation (see "Fishermen landings sampling" below).

2) Comparison of catches from one locality within Virgin Islands National Park:

1982-83 and 1993-94

During 1982-1983, data were collected on the total catch of a fisherman (Bill Harrigan) who set 5-10 traps (usually 8) in the Lameshur Bays for over ten years. This fisherman was the primary, and usually only, fisherman setting traps within these bays. In 1993, eight fish traps of similar design were used in an experiment to evaluate the impact of trap fishing [see "6) Experimental evaluation..." below]. These two data sets, collected over a decade apart, allowed for a comparison of differences in catches at a single site within Virgin Islands National Park.

Present Resource Conditions and Effects of Experimental Trapping

3) Sampling of fishermen landings

Fishermen landings were sampled during 1992-1995 from three primary locations for this study: 1) fishermen who landed catches in Coral Bay, St. John (the eastern end of St. John); 2) fishermen who landed catches on St. Thomas but fished around St. John; and 3) one fisherman

who fished around Buck Island, St. Croix. Samples were collected voluntarily and confidentially in order to maintain rapport and to protect fishermen. Data were recorded on area fished, landing site, gear type and amount, soak time, crew number, boat length and engine power, length (mm) and weight (g) of each fish identified to species. Additional information was noted if volunteered by fishermen.

Samples from St. John fishermen were obtained by Donna Roberts, who sampled fishermen in the Coral Bay area. This information was very useful since it represented St. John fishermen, however, many St. John fishermen, who fish on a larger scale, land at the primary port in Cruz Bay. Sampling in Cruz Bay was unsuccessful due to the lack of fishermen cooperation, although visual inspection of landings showed that fishermen are landing relatively large numbers of fish at this port in comparison to other small landing sites in the Virgin Islands. Some fishermen who land here are known to fish commercially within park boundaries. The small fish cleaning house behind US Customs and Immigration in Cruz Bay is periodically quite active, especially on Saturday mornings when many fishermen land catches. In an effort to obtain samples of catches from around St. John, St. Thomas fishermen, who documented their fishing sites around St. John, were sampled. Attempts were made to sample complete catches although this was difficult due to the large number of landing sites around the islands and unpredictable times of landing.

Discussions with fishermen were conducted to obtain additional information. Information was obtained from St. Thomas fishermen who fish around St. John. On St. John an intensive effort was made to interact with fishermen and the results were presented in a separate report (Smith 1992).

4) Visual census sampling of fishermen traps

During 1992-1995, divers observed the contents of traps set by fishermen around St. John, primarily on those traps used within Virgin Islands National Park. Divers recorded the following data per buoyed trap or trap line: buoy number and colors, number of traps per buoy, depth, substrate, trap design, mesh type and size, dimensions, construction, presence of biodegradable panel, presence and type of bait, location (within or outside park boundaries, number of fish in each trap (species, length). Considerable effort was spent on locating all buoyed traps within park boundaries and outside park boundaries within 0.5 nm of shore.

During 1995, divers used the same method for observations of traps around Buck Islands, St. Croix. Additionally, on eight dates in 1994, observations were made from the tower on Buck Island, which provided an entire view of NPS waters, to record the fishing activity within and outside NPS boundaries. Data were recorded on the number of fishermen and boats, type of activity, and number of traps hauled. Observations were made from sunrise to approximately 10:00 am on Wednesdays and Saturdays, based on results of a previous study (Tobias et al. 1988).

5) Reef fish monitoring using fish traps

Standardized fish trap sampling was used to provide information on catch per unit effort and species composition among bays within Virgin Islands National Park/Biosphere Reserve. This standardized sampling provided information on fish species removed by fishermen from park waters and was modeled after the SEAMAP-Caribbean Reef Fish Program. SEAMAP (Southeast Area Assessment and Monitoring Program) was established by NOAA/National Marine Fisheries Service to monitor fisheries resources in the Gulf of Mexico, South Atlantic, and Caribbean (Eldridge 1988). SEAMAP sampling (using standardized trap design and sampling protocol - see below) was conducted south of St. John during the present investigation and provided comparative data for analysis.

A total of 23 sites was sampled around St. John for fisheries-independent trap sampling. These sites were selected based on presence and extent of reef habitat within bays or surrounding points around St. John. Twelve baited fish traps were placed along reef at randomly selected sites for a soak time of 6 hours. Traps were of antillean design (arrow-head) with mesh size of 31.3 mm (1.25 in), trap dimension of 0.98 x 0.82 x 0.36 m (3.2 x 2.7 x 1.2 ft), and trap volume of 0.3 m³ (10.4 ft³). The fish removed from each trap were recorded by trap. During the soak period, crew members fished using handlines with 3-#6 hooks per line and standardized bait (squid). Data recorded were: date, site fished, trap number, soak time, and data on each fish: species, length (mm), weight (g), sex, and gonadal condition.

6) Experimental evaluation of the effect of trap fishing on Yawzi Point reef

Yawzi Point reef between Greater and Little Lameshur Bay on the south side of St. John was selected for an intensive fish trapping experiment within Virgin Islands National Park. The reasons for selecting this reef were: 1) previous trap data exist for comparison (1982-83); 2) several years of visual census data had been collected on this reef (1989-93); 3) Yawzi Point reef is relatively isolated with an abundance of commercially important species; 4) fishing pressure around the reef has been relatively low for several years with little trapping activity. The trap data for 1982-83 were collected from a fishermen who set 5-10 traps (usually 8) in the Lameshur Bays for over ten years (see Section 2). Three methods were used to assess the effect of fish traps on fishes on Yawzi Point reef: analysis of fish trap data over six months of trapping and two visual census techniques (random point visual census and belt transects).

Fish trap sampling

Eight traps were used for the study because this number had been used by a fisherman at the site for several years and represents a realistic number used by a fisherman in an area. Fish traps were constructed of 37 mm (1.5 in) square mesh wire (16 gauge-vinyl clad) with square dimensions of 1.2 x 1.2 x 0.46 m (4 x 4 x 1.5 ft) and volume of 0.66 m³ (24 ft³), welded steel supports, and degradable panel. This design and construction are typical in the fishery in the US Virgin Islands and has generally replaced the antillean (arrow-head) design which has wood supports. Although the fishermen sampled in 1982-83 used antillean design traps, the traps for this experiment were constructed to similar dimensions and volume and have similar catch rates.

Small buoys were set at selected locations along the reef edge 50 m apart to designate trap sites. Traps were hauled every week from Aug 1993 through Jan 1994 in order to standardize soak time at seven days. Traps were set at bouyed locations along the reef edge in the sand ('halo') zone usually within 3-5 m of the edge in 12-17 m water depth. Fish from each trap were recorded by trap number. Data recorded on each fish per trap haul included: date, soak time, species, length (mm), weight (g), sex, and gonadal condition.

Visual census sampling

Yawzi Point reef was sampled monthly from November 1988 to November 1991 (Beets 1993a) and at least semiannually since 1991, using a random point visual census technique (Bohnsack and Bannerot 1986), with 16-20 censuses per sampling period. In this method all species observed within an imaginary cylinder (7.5 m radius) for 5 min are listed. Following the 5 min listing period, fish within each species were enumerated by species and size class. Sampling was stratified between two habitat types, reef platform and reef edge. Reef platform was defined as the gradually sloping surface of the coral fringing reef. Reef edge was defined as the portion of the coral fringing reef which declined rapidly from the reef platform to the sand/reef interface (halo zone). Monthly (or bi-monthly) samples were conducted on Yawzi Point reef one year prior to intensive fish trap sampling (described above), during and for several months after trap sampling was concluded. A control reef (Cocoloba) was sampled intermittently.

Additionally, a belt transect method was employed at Yawzi Point reef to provide data on predatory fish abundance and density near fish trap sites. Ten 50 m transects were conducted along the reef edge next to trap sites with an additional ten transects conducted on the reef platform. Transects were conducted by recording the number and size of piscivorous fishes within one meter of either side of the transect tape. Swimming speed was standardized so that each transect was completed within 10-15 min. Fishes which crossed the transect line after the observer passed were not counted. Belt transects were conducted seven months prior to and during intensive trap sampling.

Data analysis

Data were analyzed using Quattro Pro, Paradox, Reflex, and Systat on microcomputers. Non-parametric statistics (Mann-Whitney U tests; Kruskal-Wallis tests) were employed for most analyses. Simple linear regression was used for analysis of data collected during the fish trapping experiment. To determine adequate sample size, optimization analyses were conducted using a computer program created by D. Harper, NOAA/NMFS/SEFC Miami Laboratory, based on the statistical technique of Bros and Cowell (1987).

RESULTS

Historical Trends and Comparisons

Fishermen landings records

Fishermen landings records have been maintained and summarized since 1976 (Table 1). Fishermen landings records were submitted annually in June during commercial fishing license renewal. From 1981 to 1993, an average of 56% of licensed fishermen submitted records and the accuracy of these has always been questionable. Several commercial fishermen do not obtain a license, and personal-use fishermen are not required to obtain licenses. Estimates for this component of landing do not exist. Therefore, total landings including undocumented and personal-use fishing can not be estimated.

The number of licensed fishermen and estimated landings for the St. Thomas/St. John area has varied considerably since 1981, although the general trend of reported landings has increased (Table 1). St. John has a much smaller population (3,500 vs 50,000 for St. Thomas) and many fewer licensed fishermen. Most fishermen on St. John fish for personal use and are not licensed. Based on government records during 1985-1993, 30 St. John residents have obtained commercial licenses, however, the number of licensed fishermen varies among years (Table 1). Since enforcement is almost non-existent on St. John, there is little incentive to obtain a license. Of licensed fishermen, only a proportion submit landings reports in a given year (4-13).

To estimate fish landings of St. John fishermen, several assumptions must be made. First, not all commercial fishermen obtain a license, but a conservative estimate of the number of commercial fishermen would be 30 (see above). Second, Virgin Islands fishermen use different amounts of gear and fish different number of days per year (Austin and Hewlett 1988). Third, landings information are considered underestimates, however, using the available information for St. John fishermen, the mean landings per fishermen per year was 878 kg/fisherman/year, based on complete catch information from fishermen who set traps around St. John. This estimate for fishermen landing catches on St. Thomas was 1,501 kg/fisherman/year.

Assuming 878 kg/fisherman/year (based on complete catch data of St. John fishermen sampled during this study) and 30 commercial fishermen for St. John, the estimated total landings per year was 26,340 kg/year. Landings sampling on St. Thomas identified a minimum of 12 St. Thomas fishermen fishing around St. John. At the St. Thomas estimate of 1,501 kg/fisherman/year (based on complete catch data), this would yield an estimate of 18,012 kg/year of fish landed on St. Thomas, but caught around St. John by 12 fishermen. The conservative estimated total landings from St. John would be 44,353 kg/year. This does not include personal-use fishermen which conservatively may account for an additional 50%, although no good data exist for landings estimates of personal-use fishermen.

Using a different approach, the number of traps fished by US Virgin Islands fishermen has been estimated at 20/fisherman (Austin and Hewlett 1988). A few fishermen use greater than 100 traps, so the estimate is conservative. St. Thomas fishermen, especially those fishing around St. John, tend to use more traps. However, assuming 20 traps/fisherman and 42 fisherman (12 from St. Thomas) fishing around St. John with a conservative 7-day soak time (many fishermen use a

3-4 day soak time, Austin and Hewlett 1988), the estimated number of trap hauls per year around St. John was 43,680. Assuming the estimated catch per trap haul for St. John fishermen of 1.8 kg (based on complete catch data for St. John fishermen), the total trap landings estimate from around St. John was 78,624 kg/year, which was much higher than the previous estimate. The difference may be due to several factors: 1) St. John commercial fishermen may not all use traps (or not each year), 2) St. John fishermen may use fewer traps on average, 3) the estimate made from fishermen landings records may be very inaccurate due to low reliability of those data, and 4) the error associated with estimates would be very large.

None of these estimates account for the amount of fish killed in traps without degradable panels which are lost and continue to kill for months. Estimated trap loss is very high, frequently over 100% trap loss/fishermen/year (Austin and Hewlett 1988). Since fishermen do not report where fish are caught and most fishermen do not know the boundaries of the park, there was no possibility of estimating the proportion of fish harvested in park waters from these estimates.

Comparison of catches from one locality within Virgin Islands National Park: 1982-83 and 1993-94

Comparison of trap samples using the same number of traps at Yawzi Point reef between 1982-83 and 1993-94 presented alarming differences in relative abundance of species and families of fishes (Tables 2 & 3; Figure 3). Only three species of the five numerically dominant species sampled in 1982-83 were among the five dominant species in 1993-94. Eleven (11) species sampled in 1982-83 were not captured in 1993-94. Of the nine (9) species of groupers sampled in 1982-83, four (4) species were not captured in 1993-94 (*E. adscensionis*, *E. afer*, *E. morio*, and *Mycteroperca bonaci*). Several preferred species captured in large relative abundance during 1982-93 were in very low abundance in 1993-94 (e.g., *Epinephelus striatus*, *Haemulon sciurus*). Mean length of most species declined between the two periods, with large declines in all eight numerically dominant species (Table 4). Abundance of grunts, porgies, groupers, and snappers declined greatly between the sampling periods, whereas, surgeonfishes, parrotfishes, and squirrelfishes increased (Table 3).

Present Resource Conditions

Fishermen landings sampling

Discussions with fishermen yielded some important information. There was concern for several items, such as pollution, overfishing, baitfish declines, and enforcement/regulations (Smith 1992). Most fishermen stated that they supported National Park Service regulations. Ruth Gomez documented the patterns of fish trap use by St. Thomas fishermen who fished around St. John during this investigation (Figure 4). This information provided by fishermen suggests that some fishermen maintain fish traps with high location fidelity, although many fishermen move traps frequently and among locations (especially among seasons, e.g., fishermen move traps inshore for protection during winter months with increased ground swell).

Twelve fishermen who fished around St. John and landed on St. Thomas were sampled. The rank abundance data for numerically dominant species and families of fishes landed by fishermen who fish around St. John (obtained during this investigation) differed from data collected in 1984 (Tables 5 & 6; Boulon & Clavijo 1986). Red hind (*Epinephelus guttatus*) and

queen triggerfish (*Balistes vetula*), which were the most abundant species in St. John landings in 1984, accounted for a much smaller proportion of landings during this investigation (Table 5). Groupers, triggerfishes, and snappers declined in rank abundance and proportion of landings since 1984 (Table 6). All species sampled in fishermen landings are listed in Appendix 1.

Fishermen landings of St. Thomas fishermen who fished and landed around St. Thomas provided good comparative data (collected under the NOAA/National Marine Fisheries Service State-Federal Biostatistical Program). Species composition between St. Thomas and St. John landings was similar (Table 5). Queen triggerfish (*B. vetula*) and red hind (*E. guttatus*) had higher rankings around St. Thomas and were responsible for the higher rankings of groupers and triggerfishes (Table 6). Four of the six dominant species were larger in St. Thomas landings than from around St. John (Table 7). An equal number of fishes (3 of 6) had larger sizes between Coral Bay, St. John and St. Thomas landings (Table 7).

Although sampling complete catches of fishermen was difficult, the mean catch per trap haul (catch per unit effort) was calculated for fishermen samples available around St. John, within Coral Bay, and around Buck Island, St. Croix (Table 8). The mean number of fish per trap haul (6.7, s.d. = 2.1) and mean weight (1.80 kg, s.d. = 0.57) per trap haul was higher for St. John than for Buck Island (mean number = 3.6, s.d. = 1.4; mean weight = 0.96 kg, s.d. = 0.28). Coral Bay had similar, but lower, mean number of fish per trap haul (6.2, s.d. = 3.4), but much greater mean weight (4.00 kg, s.d. = 2.68) than around St. John.

The rank abundance of species within landings around Buck Island, St. Croix was much different than around St. John and St. Thomas (Table 5). Between the data set collected in 1986 and data from this investigation, queen triggerfish (*B. vetula*) and bluestriped grunt (*Haemulon sciurus*) declined greatly in abundance. Abundance data were available for only six common species for 1986 so family ranks were not calculated. Mean sizes of fishes from around Buck Island were lower than for St. John and St. Thomas (Table 7).

Visual census sampling of fishermen traps

Fishermen move traps over a large area among seasons. Fishermen tend to move traps inshore during winter months due to strong ground swells and currents and disperse traps during the remaining seasons. Within a season, fishermen may set traps among a few small reefs but move traps among reefs and sites. A few fishermen set traps consistently inshore around St. John, within and outside of park boundaries. The results from underwater surveys around St. John were only for buoyed traps set within approximately 0.5 nm of the shoreline of St. John and all waters within park boundaries. The number of traps set without buoys could not be determined.

During three intensive surveys around St. John (Nov 1992, July 1993, and July 1994), 295 traps were inspected. A large percentage (56%) of all traps observed during surveys were illegal with 55% illegal within park boundaries and 57% illegal outside park boundaries (Table 9). At the time of the surveys, US Virgin Islands legislation required that all fish traps have biodegradable panels and mesh size greater than or equal to 1.25 inches (3.1 cm) in smallest dimension. All fish trap buoys must be marked with color combinations assigned by the local government to each licensed fisherman. When fish traps are set in strings (more than one trap per buoy line), traps on

opposing ends of the string are usually buoyed and frequently buoy colors appear on only one set of buoys. Our counts listed traps, or strings of traps, as "improper buoy colors" if no colored buoy was attached to the trap or string. Based on buoy colors, there appears to be at least 20 fishermen setting traps within park boundaries

There has been a shift in the fishery from fish traps constructed with hexagonal mesh and antillean design to square, vinyl-clad mesh and square design, which was apparent among the three intensive survey. Only one trap with rectangular mesh, usually an illegal mesh size of 2 x 1 in (5.1 x 2.5 cm), was observed after the first survey. This shift to different materials and design is due to availability of wire, ease of trap construction, extended trap use, and supposed improvement in catch efficiency. Unfortunately, the new materials also extend the trap integrity if lost resulting in prolonged fish mortality if degradable panels are absent.

Although many traps set within park boundaries are set individually, most traps are set in strings of 4 to 6 and outside park boundaries, 2-8 traps/string. The great variability in the number of traps and buoys per string of traps makes buoy counts for estimation of number of traps very unreliable.

The number of fish observed per trap was quite variable, as expected, especially since soak times (days since set) were unknown. For data on all traps observed (n=322), 1992-1995, the average number of fish observed per trap ranged from 4.7 to 6.5 per sampling period (mean = 5.4 fish/trap) within park boundaries and from 4.3 to 4.4 outside park boundaries. These data would allow a very conservative estimate of 11,887 fish caught by fish traps per year within park boundaries (assuming average trap soak time of 7 days and average number of traps set within park boundaries being 42.3). Assuming, from complete catch fishermen landings sampling, an average weight per fish of 262.3 g, the estimated total biomass of fish removed from within park boundaries per year would be minimally 3,118 kg/year. This is probably an extreme underestimate, especially in view of the estimates presented for the entire island.

Some interesting differences in relative abundance of fishes observed in traps were documented between traps set within Virgin Islands National Park boundaries and outside park boundaries (Table 10 & 11). A greater proportion of porgies and triggerfishes were observed in traps outside park boundaries, whereas, surgeonfishes were of greater proportion within park traps. Although the average lengths of five of the eight numerically dominant species were greater within park waters, three species had greater mean length outside park boundaries (Table 12).

Underwater surveys of fish traps around Buck Island, St. Croix, yielded many differences from St. John. Many traps observed did not have buoys attached since traps are frequently set in shallow water around Buck Island and can be retrieved with boat hooks. During the 11 samples taken in 1994, 242 traps were observed around Buck Island (17-26 traps/sample) indicating the high density of traps fished. Fewer fish per trap were observed around Buck Island (3.2 fish/trap) than around St. John (in park: 5.4, out: 4.4). The relative abundance of fishes was quite different in traps around Buck Island than around St. John (Tables 10 & 11) with a much greater proportion of parrotfishes, grunts, and squirrelfish in Buck Island traps.

Observations of fishermen activities from Buck Island tower, conducted in 1994, documented at least 6 boats setting 42 traps within park waters and a greater number adjacent to park boundaries. This represents a much greater fishing effort per unit area than observed around St. John. The level of fishing activity was much greater to activity reported in 1986 (5 boats and 16 traps; Tobias et al. 1988). During the 9 sampling dates in 1994, 2 incidences of spearfishing, 1 incident of netting, and 1 incident of conch fishing were observed within park boundaries.

Reef fish monitoring using fish traps

At least two fisheries-independent samples using 12 baited traps were taken at each of 26 different sites around St. John during 1993-95 (Table 13). Catch per trap varied greatly among sites both within and outside park boundaries. The rank abundance of species and families of fishes trapped within and outside (nearshore) Virgin Islands National Park boundaries were very similar (Tables 14 & 15). Snappers, primarily yellowtail snapper (*Ocyurus chrysurus*), represented greater proportion of catch outside park boundaries, whereas, parrotfishes represented greater proportion of catch within park boundaries. Four of eight numerically dominant species in catches had greater average length outside park boundaries (Table 16).

The average catch per trap haul was not significantly different (for numbers and weight) within and outside of park boundaries when samples from the Durloe Cays were excluded (M-W U test: $p > 0.05$; Table 17). The catches from the Durloe Cays off the northwest shore of St. John were much greater than other bays. This area is noted for greater current velocity, several habitat types in good condition, and relatively low fishing pressure due to heavy boat traffic. Interestingly, the average catch per trap haul was significantly different (for numbers and weight) between the North side of St. John and the South side (M-W U test: $p < 0.001$; Table 18).

Results of the SEAMAP-Caribbean Program sampling (described above), which was conducted south of St. John using the same methods during the same time period, were compared to data obtained inshore around St. John during this investigation (listed as "Offshore" in Tables 14 - 17). The proportion of groupers and triggerfishes in trap catches were much higher at offshore sites, whereas, the proportion of herbivorous fishes, parrotfishes and surgeonfishes, was much smaller offshore. Although number of fish caught per trap haul offshore was similar to inshore sites, the average weight of fish per trap haul was much greater offshore (Table 17). The differences observed between inshore and offshore sites may be due to habitat differences and ontological movements, but they do demonstrate the lower abundance of predatory fishes inshore. The use of baited traps with short soak time (6 hours) targets mobile predators.

Experimental evaluation of the effect of fish traps on Yawzi Point reef

The six month sampling effort using eight traps around Yawzi Point reef yielded a total of 1,215 fish in 52 species (Appendix 1). The average catch per trap haul over the entire period was 6.9 individuals (s.d. = 8.18).

Regression analyses of fish trap data demonstrated that certain species groups exhibited significant declines in abundance during the period of trapping. Although abundance generally declined for all major groups (Figures 5-8), significant negative regressions existed for total fishes ($p < 0.001$), resident fishes ($p < 0.001$), squirrelfishes ($p < 0.001$), and snappers ($p = 0.001$).

Resident fishes were defined as those species known to shelter in reef structure and demonstrate reef fidelity, such as squirrelfishes, groupers, snappers, and grunts, and excluding jacks, porgies, and goatfishes.

Summaries of visual census data for both point counts and belt transects showed the same trend for declines in abundances of major fish groups between the period before trapping and six months after trapping was initiated (Tables 19 & 20). Point counts yielded significant differences in abundance for total fishes (Mann-Whitney U: $p = 0.028$), predatory fishes ($p = 0.023$), and snappers ($p = 0.012$) on Yawzi Point reef between the month before trapping began and the last month of sampling. Cocoloba reef, which was monitored as a control, yielded no significant differences in abundances between the same periods. Importantly, large individuals did not demonstrate significant changes in seasonal abundance at these sites in a previous study (Beets 1993a). Belt transect data for predatory fishes from Yawzi Point reef demonstrated declines in abundances of all groups examined. However, due high variances no significant differences was obtained during analysis.

DISCUSSION

The Historical View

The scientific consensus is that fisheries in the Virgin Islands have declined in the face of increasing fishing pressure (Dammann 1969, Dammann and Sylvester 1977, CFMC 1985; Bohnsack et al. 1986, Appeldoorn et al. 1992). Although it is difficult for some fishermen to admit and for younger fishermen to observe, many fishermen in the Virgin Islands also recognize declines (deGraf and Moore 1987, Smith 1992). Decreased landings of important species have been documented, especially groupers (Olsen and LaPlace 1978, Beets and Friedlander 1992, Beets et al. 1994). Beets (1993b) provided an analysis of fisheries-independent data which demonstrated differences in species composition and CPUE (catch per unit effort) in an area south of St. John, which had a higher fishing effort, compared to an area north of St. Thomas-St. John, with lower fishing effort.

This is certainly not a unique situation. Most of the world fisheries are overfished, especially tropical fisheries. This is not surprising in view of the high human population growth throughout the tropics and the limited sustainable yield of tropical reef fisheries (reviewed by Russ 1991). Reef environments have high primary productivity and usually high reef fish biomass but are susceptible to depletion by intensive harvest.

Fisheries landings data for the U.S. Virgin Islands have never provided a basis for critical analysis by species group or by effort. It has also been difficult to separate fishery trends for St. John from St. Thomas since fisheries data are reported collectively. Fishermen landings data collection has always been lower on St. John due to the lack of funding for data collection projects, remote location of landing sites from St. Thomas, and lower landings compared to St. Thomas. The same situation exists for Buck Island, St. Croix. The U.S. Virgin Islands Government does not fund fishermen sampling. Landings data are collected as defined in annual

projects funded by NOAA/National Marine Fisheries Service and summaries are reported annually (USVI DFW files).

In 1984, at least seven boats were observed trap fishing within Virgin Islands National Park (Boulon and Clavijo 1986). Presently, the number is at least 12-20. Effort and harvest continue to increase within and around park boundaries. In 1986, observations on at least 12 fishermen in five boats fished 45 traps in or adjacent to Buck Island Reef National Monument boundaries (Tobias et al. 1988). The present effort within park waters around Buck Island is similar to that recorded in 1986.

Even though historical data are meager, comparisons provide a view of declining average sizes of important fisheries species and large changes in species composition. Many of the preferred species, such as triggerfishes, groupers, and snappers, have declined in relative abundance in landings. Major changes among trophic groups have occurred with the herbivorous fishes (surgeonfishes, parrotfishes) having increased in relative abundance in landings as carnivorous fishes (groupers, snappers) have declined.

The Present View

Data collected during this project provided some alarming information. U.S. Virgin Islands legislation designates fish traps as commercial gear and requires that fishermen using traps have a commercial fishing license. Based on information from this investigation, there appears to be at least 20 fishermen who set traps within Virgin Islands National Park boundaries. Buoy colors are assigned by the territorial government to licensed commercial fishermen. Commercial fishing is illegal within national park boundaries (refer to Introduction). Many fish traps within park boundaries are illegal under USVI legislation. Compliance outside park boundaries was low during surveys. The number of fish traps observed within Virgin Islands National Park (25-58 traps, most in strings with one being a trap line of over 20 traps) and the very conservative estimate of nearly 12,000 fish captured by traps within Virgin Islands National Park per year suggest that commercial fishing is quite active within park boundaries.

Fisheries landings data and direct sampling of resources demonstrated that the species composition, catch per unit effort (CPUE), and average size of fishes within park boundaries and outside are not greatly different. In fact, park waters presented poorer conditions for some parameters measured. This suggested that existing park regulations and/or enforcement are not fulfilling the goals of National Park Service policy.

The experimental trapping study at Yawzi Point reef in the Lameshur Bays has provided extremely useful data for documentation of the impact of fish traps on reef fish assemblages. This trapping study, which was based on the known level of effort previously used by a fisherman on this reef, demonstrated significant changes in species composition, declines in species abundances, and declines in average fish size of several important species during the past decade. This level of fishing effort (eight traps) resulted in significant declines in abundances of species groups over a six-month period. Unfortunately catch per unit effort (CPUE) was not available for the 1982-3 data. The CPUE of 6.9 fish/trap haul during the 1993-94 study was similar to the number of fish observed per trap (5.4) during the underwater fishermen trap observations within park

boundaries. These data were lower than the CPUE obtained during the trap study conducted north of St. Thomas during 1989-90 (7.9 fish/trap haul; Beets 1993b). This decline is disturbing considering that the St. Thomas study (1989-90) documented a decline in CPUE of 28.5% from a study conducted in 1975-76 (Olsen and LaPlace 1981).

The results of the experimental trapping study has provided an indication of the impact of trap fishing on a single reef in the Virgin Islands. In reality, fishermen may not usually fish a single reef this intensively. Usually fishermen move traps to different reefs or reef sections. Since the entire insular shelf within the U.S. Virgin Islands is fished, there is little ability to move traps into areas of less fishing pressure or to move traps among areas as occurred historically. The level of effort has resulted in near complete loss of some species within the fishery, general decline in catch per unit effort (CPUE), general decline in size of species captured, and species composition shifts.

The results obtained in this investigation emphasized the value and importance of using a combination of methods in an evaluation and demonstrated the dangers that exist in comparing data collected using a single method. Although species composition was similar between underwater observations of fishermen traps and data from fishermen landings, differences which existed were probably due to individual fisherman behavior. Many fishermen will release small fish and unpreferred species, whereas, other fishermen will land all fishes in their catch. Visual census data differ in comparison to fishermen landings data and trap sampling data due to several factors, such as method bias, the great number of small fishes observed in many species and families but not captured by various gear, effects of fish behavior, etc. Visual census sampling does have the great advantage of providing ecological information, especially on habitat and microhabitat characteristics and differences, which cannot be obtained using other methods.

CONCLUSION

The existing historical information and data presented from this investigation present a clear trend of declining fisheries resources throughout the Virgin Islands. Virgin Islands National Park and Buck Island Reef National Monument have demonstrated these same declines. The patterns of species composition, size structure, and catch rates indicate that the existing National Park Service regulations and/or enforcement provide little to no protection to fisheries species and are not fulfilling the goals of National Park Service policy. This has yielded a very disturbed species complex and has profound implications on the condition of the ecosystems within National Park Service boundaries. These conditions are of great concern in view of the catastrophic ecosystem shifts which can occur (or may have occurred) on reefs in areas which are overfished, especially when additional disturbances occur (Hughes 1994). Over-fishing may accelerate and/or maintain ecosystem changes, such as algal overgrowth of coral on reefs. Such changes could yield a cascade of effects such as coral decline, poor settlement of coral, fishes, and other organisms, reef loss, and diversity loss. Recommendations include clarification of regulations (such as definition of "commercial" designation), strict enforcement of fisheries regulations within park boundaries, elimination of trap fishing, and establishment of large marine reserves. Marine reserves have been recently established by the territorial government for St. Thomas and St. Croix. The National Park Service has the justification and precedence for establishment of reserves on St. John.

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Table 1. Summary of St. Thomas/St. John landings records for 1981-1993 (DFW reports). St. John landings records for available years were calculated from available landings records for comparison. Estimated fish landings were calculated from reported fish landings using total number of licensed fishermen.

Reporting year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
St. Thomas/St. John Landings													
Number of licensed fishermen	258	256	259	255	255	330	329	306	237	198	182	231	212
Number of fishermen reporting	110	122	132	149	159	137	135	131	165	106	131	160	186
Reported fish landings (kg)	172,636	208,191	205,448	237,979	227,582	251,178	233,844	204,629	314,617	182,414	260,439	293,267	352,622
Estimated fish landing (kg)	404,909	436,859	403,114	407,279	364,989	605,028	569,885	477,988	451,904	340,736	361,831	423,418	401,989
St. John Landings Records													
Number of licensed fishermen									12	9	13	25	19
Number of fishermen reporting									8	4	9	13	9
Reported fish landings (kg)									16,285	1,799	8,175	10,415	1,763
Estimated fish landing (kg)									24,427	4,048	11,808	20,028	3,722

Table 2. Rank abundance of 22 numerically dominant fish species sampled during 1982-83 from one fisherman's trap catches and during 1993-94 from experimental trap sampling from around Yawzi Point reef, St. John. Five most abundant species captured during 1993-94 are denoted in parentheses. *Calamus* spp. includes several species and has inflated single taxon ranking. The fourth ranked species for 1993-94 was *Sparisoma chrysopterum* (76).

Scientific name	Common name	1982-83	1993-94
<i>Haemulon sciurus</i>	bluestriped grunt	147	33
<i>Acanthurus coeruleus</i>	blue tang	146	301 (1)
<i>Haemulon plumieri</i>	white grunt	141	74 (5)
<i>Acanthurus bahianus</i>	ocean surgeonfish	129	194 (2)
<i>Calamus</i> spp.	porgies	127	32
<i>Pseudupeneus maculatus</i>	spotted goatfish	56	31
<i>Acanthurus chirurgus</i>	doctorfish	53	44
<i>Lutjanus apodus</i>	schoolmaster snapper	41	13
<i>Sparisoma aurofrenatum</i>	redband parrotfish	39	92 (3)
<i>Ocyurus chrysurus</i>	yellowtail snapper	36	34
<i>Lutjanus synagris</i>	lane snapper	35	14
<i>Epinephelus afer</i>	mutton hamlet	32	
<i>Epinephelus striatus</i>	Nassau grouper	30	4
<i>Holocentrus adscensionis</i>	squirrelfish	25	20
<i>Sparisoma viride</i>	stoplight parrotfish	25	7
<i>Gerres cinereus</i>	yellowfin mojarra	19	1
<i>Epinephelus cruentatus</i>	graysby	18	16
<i>Mulloidichthys martinicus</i>	yellow goatfish	15	13
<i>Epinephelus adscensionis</i>	rock hind	14	
<i>Lutjanus jocu</i>	dog snapper	12	
<i>Lutjanus analis</i>	mutton snapper	12	2
<i>Holacanthus ciliaris</i>	queen angelfish	12	9

Table 3. Rank abundance of 10 numerically dominant fish families sampled during 1982-83 from one fisherman's trap catches and during 1993-94 from experimental trap sampling from around Yawzi Point reef, St. John. The percentage of fishes in each family of the total number of fish caught are in parentheses. Five most abundant families captured during 1993-94 are denoted in brackets.

Family	Common name	1982-83	1993-94
Acanthuridae	surgeonfishes	328 (25.7)	539 (45.2) [1]
Haemulidae	grunts	294 (23.1)	135 (11.3) [2]
Sparidae	porgies	127 (10.0)	32 (3.5)
Serranidae	groupers	112 (8.8)	57 (4.7)
Lutjanidae	snappers	103 (8.1)	65 (5.5) [4]
Mullidae	goatfishes	71 (5.6)	44 (3.7)
Scaridae	parrotfishes	69 (5.4)	184 (15.4) [3]
Ostraciidae	boxfishes	30 (2.5)	7 (0.6)
Holocentridae	squirrelfishes	25 (2.0)	64 (5.4) [5]
Pomacanthidae	angelfishes	14 (1.1)	24 (2.2)

Table 4. Mean length (mm) of eight numerically dominant fish species sampled during 1982-83 from one fisherman's trap catches and during 1993-94 from experimental trap sampling from around Yawzi Point reef, St. John. Data presented are average lengths (in mm) and total number of fishes captured (in parentheses).

Scientific name	Common name	1982-83	1993-94
<i>Haemulon sciurus</i>	bluestriped grunt	256.7(147)	199.2(33)
<i>Acanthurus coeruleus</i>	blue tang	176.7(146)	143.6(301)
<i>Haemulon plumieri</i>	white grunt	233.4(141)	203.1(74)
<i>Acanthurus bahianus</i>	ocean surgeon	184.7(129)	154.1(194)
<i>Pseudupeneus maculatus</i>	spotted goatfish	248.6(56)	209.7(31)
<i>Acanthurus chirurgus</i>	doctorfish	199.4(53)	158.4(44)
<i>Lutjanus apodus</i>	schoolmaster snapper	259.6(41)	195.4(13)
<i>Sparisoma aurofrenatum</i>	redband parrotfish	244.5(39)	202.6(92)

Table 5. Rank abundance of 20 numerically dominant fish species sampled in fishermen trap landings during 1992-94 from around St. John, St. Thomas, and Buck Island, St. Croix. Samples collected during 1984 from St. John (Boulon and Clavijo 1986) and during 1986 for Buck Island (only 6 species; Tobias et al. 1988) are listed for comparison. Five most abundant species in landings for St. John (1984), St. Thomas and Buck Island, St. Croix are denoted in parentheses. *Calamus* spp. and *Holocentrus* spp. include several species and have inflated single taxon rankings. Species which have deflated rankings due to some generic identifications for St. John (1984) are denoted by an asterisk (*). ** denotes an inflated ranking. The fourth species rank for trap samples around Buck Island, St. Croix was *Ocyurus chrysurus* (90).

Scientific name	Common name	St. John	St. John (1984)	St. Thomas	Buck Island	Buck Island (1986)
<i>Calamus</i> spp.	porgies	273	224	263 (2)	1	
<i>Haemulon plumieri</i>	white grunt	263	144	190	120 (2)	105 (1)
<i>Balistes vetula</i>	queen triggerfish	237	470 (2)	589 (1)	25	
<i>Acanthurus coeruleus</i>	blue tang	211	225*(5)	182	43	29 (3)
<i>Pomacanthus arcuatus</i>	gray angelfish	196	56*	106	1	
<i>Sparisoma chrysopterygum</i>	redtail parrotfish	124	117*	204 (5)	102 (3)	41 (2)
<i>Epinephelus guttatus</i>	red hind	96	480 (1)	241 (3)	35	
<i>Holocentrus</i> spp.	squirrelfishes	71	284 (4)	206 (4)	65	
<i>Sparisoma viride</i>	stoplight parrotfish	69	29*	145	9	28 (4)
<i>Haemulon sciurus</i>	bluestriped grunt	52	121	84	6	15
<i>Holacanthus ciliaris</i>	queen angelfish	51	2*	57		
<i>Acanthurus chirurgus</i>	doctorfish	43	85	71	8	
<i>Lactophrys polygonia</i>	honeycomb cowfish	41	413**(3)	50		
<i>Lactophrys quadricornis</i>	scrawled cowfish	38		51		
<i>Acanthurus bahianus</i>	ocean surgeonfish	37	152*	56	79 (5)	21 (5)
<i>Lutjanus synagris</i>	lane snapper	36	63	72	2	
<i>Sparisoma aurofrenatum</i>	redband parrotfish	33	17*	61	137 (1)	
<i>Mulloidichthys martinicus</i>	yellow goatfish	31	16*	29	5	
<i>Lutjanus buccanella</i>	blackfin snapper	26	11		1	
<i>Epinephelus fulvus</i>	coney	26	109	140	66	

Table 6. Rank abundance of 12 numerically dominant fish families sampled in fishermen trap landings from around St. John (1992-94), St. John (1984), St. Thomas, and Buck Island, St. Croix (1992-94). Five most abundant families in landings for St. John (1984), St. Thomas and Buck Island, St. Croix are denoted in parentheses.

Family	Common name	St. John	St. John (1984)	St. Thomas	Buck Island
Haemulidae	grunts	351	421 (4)	418 (3)	142 (2)
Sparidae	porgies	292	224	300	1
Acanthuridae	surgeonfishes	291	610 (2)	309 (5)	130 (3)
Pomacanthidae	angelfishes	283	151	233	4
Balistidae	triggerfishes	250	471 (3)	590 (1)	28
Scaridae	parrotfishes	238	274	437 (2)	264 (1)
Serranidae	groupers	129	626 (1)	399 (4)	101 (4)
Ostraciidae	boxfishes	105	413 (5)	146	
Lutjanidae	snappers	82	235	290	97 (5)
Holocentridae	squirrelfishes	81	284	266	65
Mullidae	goatfishes	42	38	48	67
Chaetodontidae	butterflyfishes	9		5	

Table 7. Mean length (mm) of six important fish species sampled in fishermen trap landings from around St. John, within the Coral Bay, St. John area, around St. Thomas, and around Buck Island, St. Croix. Sample sizes are given in parentheses.

Scientific name	Common name	St. John	Coral Bay	St. Thomas	Buck Island
<i>Haemulon plumieri</i>	white grunt	241.2(263)	274.1(30)	241.7(190)	220.2(120)
<i>Balistes vetula</i>	queen triggerfish	286.0(235)	377.4 (7)	273.0(589)	256.0(25)
<i>Acanthurus coeruleus</i>	blue tang	181.8(211)	176.5(30)	191.4(182)	181.6(43)
<i>Pomacanthus arcuatus</i>	gray angelfish	206.0(196)	391.4(35)	243.6(106)	377.0(1)
<i>Sparisoma chrysopteron</i>	redtail parrotfish	273.6(124)	184.2 (2)	274.4(204)	262.9(102)
<i>Epinephelus guttatus</i>	red hind	300.8 (96)	279.1(18)	314.7(241)	253.5(35)

Table 8. Mean catch per trap haul of fishermen fishing around St. John, within the Coral Bay, St. John area, and around Buck Island, St. Croix. Only complete samples were included in calculations. Catch per unit effort was not calculated for St. Thomas fishermen due to only two complete samples. Standard deviations are given in parentheses.

	St. John	Coral Bay	Buck Island
Number of samples	8	15	6
Mean number of traps	11.5 (3.6)	2.7 (0.9)	41.0 (5.7)
Mean number of fish	6.7 (2.1)	6.2 (3.4)	3.6 (1.4)
Mean weight (kg)	1.80 (0.57)	4.00 (2.68)	0.96 (0.28)

Table 9. Summary of the data collected on fish traps observed underwater around St. John and Buck Island, St. Croix. Traps were classified as illegal if they did not meet any one of the criteria listed in the Virgin Islands Code. Observations of the three primary criteria are presented for traps observed around St. John. Data on degradable panels and bouys were not collected around Buck Island. Underwater observations were conducted Nov 1992, July 1993, and July 1994 around St. John and May - Dec 1994 around Buck Island.

Virgin Islands National Park

	Number of traps observed	Illegal traps	<u>Criteria observed</u>		
			No degradable panel	Mesh size < 1.25 in	Illegal bouys
Within Park Boundaries	127	70 55%	57 48%	2 2%	42 33%
Outside Park Boundaries	168	96 57%	93 55%	10 6%	27 16%

Buck Island Reef National Monument

Within/outside Boundaries	242			26 11%	
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Table 10. Rank abundance of 20 numerically dominant fish species sampled during underwater observations of fishermen traps around St. John, Oct. 1992-July 1995 (VINP - traps observed within boundaries of Virgin Islands National Park; Outside - outside park boundaries), and around Buck Island, 1995 (within and outside of Buck Island National Monument boundaries). Data presented are the total number of fishes observed within traps. The six most abundant species from observations taken outside Virgin Islands National Park boundaries and around Buck Island are denoted in parentheses. The fifth species rank for Buck Island was *Haemulon flavolineatum* (48).

Scientific name	Common name	VINP	Outside	Buck Island
<i>Acanthurus coeruleus</i>	blue tang	164	89(2)	92(2)
<i>Pomacanthus arcuatus</i>	gray angelfish	79	54(3)	10
<i>Lactophrys quadricornis</i>	scrawled cowfish	51	29(6)	6
<i>Ocyurus chrysurus</i>	yellowtail snapper	47	19	22
<i>Calamus calamus</i>	saucereye porgy	40	104(1)	24
<i>Acanthurus bahianus</i>	ocean surgeonfish	39	20	98(1)
<i>Haemulon plumieri</i>	white grunt	37	28	51(3)
<i>Epinephelus guttatus</i>	red hind	32	8	8
<i>Holocentrus adscensionis</i>	squirrelfish	28	12	42(6)
<i>Lactophrys triqueter</i>	smooth trunkfish	24	34(5)	15
<i>Lactophrys polygonia</i>	honeycomb cowfish	23	19	7
<i>Sparisoma aurofrenatum</i>	redband parrotfish	20	19	51(3)
<i>Scarus croicensis</i>	striped parrotfish	19	1	17
<i>Lactophrys bicaudalis</i>	spotted trunkfish	18	10	8
<i>Scarus taeniopterus</i>	princess parrotfish	16	4	19
<i>Lutjanus synagris</i>	lane snapper	15	17	6
<i>Balistes vetula</i>	queen triggerfish	15	46(4)	6
<i>Holacanthus ciliaris</i>	queen angelfish	14	10	2
<i>Chaetodon striatus</i>	banded butterflyfish	13	8	13
<i>Acanthurus chirurgus</i>	doctorfish	13	9	2

Table 11. Rank abundance of 12 numerically dominant fish families sampled during underwater observations of fishermen traps around St. John, Oct. 1992-July 1995 (VINP - traps observed within boundaries of Virgin Islands National Park; Outside - outside park boundaries), and around Buck Island (within and outside of Buck Island National Monument boundaries). Data presented are the total number of fishes observed within traps. The six numerically dominant families from observations taken outside Virgin Islands National Park boundaries and around Buck Island are denoted in parentheses.

Family	Common name	VINP	Outside	Buck Island
Acanthuridae	surgeonfishes	216	118(1)	192(1)
Ostraciidae	boxfishes	116	92(3)	22
Pomacanthidae	angelfishes	103	71(4)	19
Scaridae	parrotfishes	75	38	135(2)
Lutjanidae	snappers	70	48(6)	42(5)
Haemulidae	grunts	57	38	110(3)
Sparidae	porgies	46	108(2)	0
Serranidae	groupers	42	15	36
Holocentridae	squirrelfishes	32	12	45(4)
Balistidae	triggerfishes	24	58(5)	6
Chaetodontidae	butterflyfishes	22	21	38(6)
Carangidae	jacks	9	18	4

Table 12. Mean length (mm) of eight numerically dominant fish species sampled during underwater observations of fishermen traps around St. John, Oct. 1992-July 1995, (VINP - traps observed within boundaries of Virgin Islands National Park; Outside - outside park boundaries), and around Buck Island, 1995 (within and outside of Buck Island National Monument boundaries). Data presented are the estimated average lengths (in mm) and total number of fishes observed within traps (in parentheses).

Scientific name	Common name	VINP	Outside	Buck Island
<i>Acanthurus coeruleus</i>	blue tang	199.2(164)	193.8(89)	161.0(92)
<i>Pomacanthus arcuatus</i>	gray angelfish	247.0 (79)	240.6(54)	
<i>Lactophrys quadricornis</i>	scrawled cowfish	245.1 (51)	247.6(29)	261.4 (7)
<i>Ocyurus chrysurus</i>	yellowtail snapper	278.5 (47)	321.0(19)	234.5(22)
<i>Calamus calamus</i>	saucereye porgy	284.4 (40)	263.2(104)	
<i>Acanthurus bahianus</i>	ocean surgeon	212.8 (39)	193.0(20)	150.8(98)
<i>Haemulon plumieri</i>	white grunt	310.5 (37)	274.6(28)	201.0(51)
<i>Epinephelus guttatus</i>	red hind	301.7 (32)	303.8(20)	213.3 (9)

Table 13. Mean number and weight (kg) of fish captured per trap haul during reef fish monitoring at 23 sites around St. John. Each site was sampled with 10-12 baited traps on two dates, except for Anna Point, Great Lameshur Bay, and Steven's Cay, which were sampled on three dates. Numbers in parentheses are standard deviations.

Site	Mean number of fish per trap haul	Mean weight of fish per trap haul
North Side of St. John		
<u>In Park</u>		
Durloe Cays	6.7(1.88)	0.66(0.06)
Hawksnest Bay	1.4(1.26)	0.28(0.11)
Cinnamon Bay	0.3(0.14)	0.07(0.04)
Francis Bay	1.9(2.26)	0.22(0.23)
Whistling Cay	0.9(0.35)	0.14(0.11)
Anna Point	1.6(0.50)	0.26(0.10)
Brown Bay	0.6(0)	0.13(0.12)
Mennebeck Bay	1.5(0.06)	0.15(0.01)
Haulover Bay	0.6(0)	0.06(0.02)
<u>Outside Park</u>		
Steven's Cay	1.6(0.68)	0.30(0.17)
Newfound Bay	1.0(0.07)	0.12(0.04)
Privateer Bay	1.6(1.56)	0.23(0.23)
South Side of St. John		
<u>In Park</u>		
Reef Bay	0.2(0.12)	0.05(0.06)
Great Lameshur Bay	0.4(0.17)	0.08(0.04)
Cabritte Horn Point	0.1(0.17)	0.02(0.02)
Booby Rock	1.8(0.35)	0.33(0.08)
Drunk Bay	1.9(0.18)	0.31(0.19)
<u>Outside Park</u>		
Bovocoap Point	0.2(0.10)	0.07(0.08)
LeDuck Island	1.3(0)	0.17(0.01)
Harbor Point	0.2(0)	0.02(0.03)
Turner Point	0.4(0.29)	0.08(0.09)
Eagle Shoal	0.9(1.29)	0.11(0.16)

Table 14. Rank abundance of 20 numerically dominant fish species sampled from standardized trap sampling around reefs within Virgin Islands National Park, St. John (Park), around nearshore reefs outside park boundaries (Outside), and offshore south of St. John (Offshore). Five most abundant species in samples are in parentheses.

Scientific name	Common name	Park	Outside	Offshore
<i>Chaetodon capistratus</i>	foureye butterflyfish	99	33 (2)	29 (4)
<i>Sparisoma aurofrenatum</i>	redband parrotfish	36	21 (3)	2
<i>Acanthurus bahianus</i>	ocean surgeonfish	36	12 (4)	9
<i>Ocyurus chrysurus</i>	yellowtail snapper	33	38 (1)	13
<i>Scarus taeniopterus</i>	princess parrotfish	27	7	1
<i>Lutjanus synagris</i>	lane snapper	26	6	
<i>Epinephelus cruentatus</i>	graysby	25	9 (5)	7
<i>Epinephelus guttatus</i>	red hind	16	5	43 (3)
<i>Holocentrus rufus</i>	longspine squirrelfish	15	6	24 (5)
<i>Haemulon aurolineatum</i>	tomtate	14		
<i>Chaetodon striatus</i>	banded butterflyfish	14	7	1
<i>Acanthurus coeruleus</i>	blue tang	13	1	
<i>Epinephelus fulvus</i>	coney	11	6	131 (1)
<i>Haemulon flavolineatum</i>	french grunt	10	2	5
<i>Hypoplecterus</i> sp.	hamlet	7		
<i>Cantherhines pullus</i>	orangespotted filefish	7	6	
<i>Halichoeres bivittatus</i>	slippery dick	6		1
<i>Sparisoma chrysopteron</i>	redtail parrotfish	6		1
<i>Epinephelus striatus</i>	Nassau grouper	5		1
<i>Balistes vetula</i>	queen triggerfish	5	5	45 (2)

Table 15. Rank abundance of 15 numerically dominant fish families sampled from standardized trap sampling around reefs within Virgin Islands National Park, St. John (Park), around nearshore reefs outside park boundaries (Outside), and offshore south of St. John (Offshore). Five most abundant families in samples are in parentheses.

Family	Common name	Park	Outside	Offshore
Chaetodontidae	butterflyfishes	114	40 (2)	30 (3)
Scaridae	parrotfishes	73	29 (3)	4
Lutjanidae	snappers	66	46 (1)	14
Serranidae	groupers	66	27 (4)	190 (1)
Acanthuridae	surgeonfishes	49	14 (5)	12
Haemulidae	grunts	26	4	6
Holocentridae	squirrelfishes	16	7	27 (4)
Balistidae	triggerfishes	13	6	47 (2)
Carangidae	jacks	7		3
Labridae	wrasses	7		2
Mullidae	goatfishes	5	1	24 (5)
Pomacentridae	damsel-fishes	2		
Sciaenidae	drums	2	1	
Pomacanthidae	angelfishes	1		3
Sparidae	porgies	1	4	1

Table 16. Mean length (mm) of eight numerically dominant fish species sampled in standardized trap sampling around reefs within Virgin Islands National Park, St. John (Park), around nearshore reefs outside park boundaries, and offshore south of St. John. Sample sizes are given in parentheses.

Scientific name	Common name	Park	Outside	Offshore
<i>Chaetodon capistratus</i>	foureye butterflyfish	106.6(99)	104.3(33)	90.9(29)
<i>Acanthurus bahianus</i>	ocean surgeon	140.1(36)	142.7(12)	168.1(9)
<i>Sparisoma aurofrenatum</i>	redband parrotfish	197.8(36)	193.2(21)	189.5(2)
<i>Ocyurus chrysurus</i>	yellowtail snapper	227.2(33)	215.9(37)	235.8(13)
<i>Scarus taeniopterus</i>	princess parrotfish	205.0(27)	219.1 (7)	180.0(1)
<i>Lutjanus synagris</i>	lane snapper	187.4(26)	230.0 (6)	
<i>Epinephelus cruentatus</i>	graysby	242.2(25)	250.9 (9)	230.8(7)
<i>Epinephelus guttatus</i>	red hind	290.2(16)	278.4 (5)	331.8(43)

Table 17. Mean catch per trap from standardized trap sampling around reefs within Virgin Islands National Park, St. John (Park), around nearshore reefs outside park boundaries (Outside), and offshore south of St. John (Offshore). Standard deviations are given in parentheses.

	Park	Outside	Offshore
Number of trap hauls	320	217	407
Mean number of fish (including Durloe Cays)	0.98 (2.08) 1.34 (2.91)	0.83 (1.72)	0.90 (2.38)
Mean weight (kg) (including Durloe Cays)	156.1 (331.8) 187.1 (372.6)	132.0 (326.8)	246.9 (614.2)

Table 18. Mean catch per trap from standardized trap sampling around nearshore reefs off the northern (North) and southern (South) shores of St. John. Standard deviations are given in parentheses.

	North	South
Number of trap hauls	294	264
Mean number of fish	1.22 (2.32)	0.61 (1.40)
Mean weight (kg)	188.1 (103.1)	103.1 (257.6)

Table 19. Mean number (and standard error) of fish observed per point count twelve months before trapping (BEFORE) and six months during trapping (DURING) on Yawzi Point reef. Reef edge refers to the reef zone next the sand zone (where traps were set). Reef platform refers to the gradually sloping reef zone at least 10 m from the edge which had lower topographic complexity and lower number of fishes than the edge. Six to eleven (6-11) censuses per zone were conducted per sampling date.

	<u>REEF EDGE</u>		<u>REEF PLATFORM</u>	
	BEFORE	DURING	BEFORE	DURING
TOTAL FISH (excluding <i>Coryphopterus personatus</i>)	207.86 (74.45)	186.91 (97.47)	120.95 (27.50)	95.24 (19.34)
PREDATORS	14.92 (11.32)	6.65 (1.83)	3.93 (2.18)	2.71 (1.57)
HOLOCENTRIDAE squirrelfishes	2.83 (1.16)	1.62 (0.65)	1.10 (1.08)	0.20 (0.33)
SERRANIDAE groupers	1.02 (0.37)	1.15 (0.32)	1.00 (0.48)	0.88 (0.56)
LUTJANIDAE snappers	2.12 (1.14)	1.20 (0.86)	0.81 (1.38)	0.51 (1.09)
HAEMULIDAE grunts	15.14 (9.10)	10.88 (9.20)	1.63 (2.36)	0.41 (0.81)
SCARIDAE parrotfishes	42.73 (8.14)	35.44 (5.48)	28.12 (7.78)	22.24 (4.85)
ACANTHURIDAE surgeonfishes	12.35 (9.56)	6.09 (0.97)	6.47 (1.57)	7.10 (1.28)

Table 20. Mean number (and standard error) of predatory fish observed per transect eight months before trapping (BEFORE) and six months during trapping (DURING) on Yawzi Point reef. Only predators observed in transects which were also captured in traps were included in this analysis. Six to thirteen (6-13) transects per zone were conducted per sampling date.

	<u>REEF EDGE</u>		<u>REEF PLAT FORM</u>	
	BEFORE	DURING	BEFORE	DURING
PREDATORS	5.99 (0.94)	4.88 (0.99)	5.33 (1.27)	2.10 (0.49)
HOLOCENTRIDAE squirrelfishes	3.34 (0.70)	2.55 (0.69)	2.04 (0.64)	0.59 (0.32)
SERRANIDAE groupers	1.27 (0.13)	1.15 (0.16)	1.30 (0.23)	0.80 (0.15)
LUTJANIDAE snappers	0.35 (0.19)	0.28 (0.02)	0.73 (0.22)	0.21 (0.13)

Appendix 1. Number of fish sampled in St. John fishermen landings, visual trap sampling, reef fish trap sampling, and Yawzi Reef trap sampling. Sample sizes are denoted by n.

Scientific name	Common name	St. John Fishermen Landings	Visual Trap Sampling n = 322	Reef fish Trap Sampling n = 569	Yawzi Reef Trap Sampling n = 179
Rhincodontidae					
<i>Ginglymostoma cirratum</i>	nurse shark		2		1
Belonidae					
<i>Tylosurus crocodilus</i>	houndfish	1			
Holocentridae					
<i>Holocentrus adscensionis</i>	longjaw squirrelfish	31	12		20
<i>H. marianus</i>	longspine squirrelfish				4
<i>H. rufus</i>	squirrelfish			1	8
<i>Holocentrus spp.</i>	unid. squirrelfishes	27		4	27
<i>Myripristis jacobus</i>	blackbar soldierfish				5
Serranidae					
<i>Epinephelus adscensionis</i>	rock hind	10			
<i>E. cruentatus</i>	graysby	3		9	16
<i>E. fulvus</i>	coney	6	4	1	11
<i>E. guttatus</i>	red hind	56	8	7	25
<i>E. striatus</i>	Nassau grouper	8	3		4
<i>Mycteroperca venenosa</i>	yellowfin grouper	4			1
Grammistidae					
<i>Rypticus saponaceus</i>	greater soapfish				1
Priacanthidae					
<i>Priacanthus cruentatus</i>	glasseye	3			1
Echeneidae					
<i>Remora remora</i>	remora				1
Carangidae					
<i>Caranx bartholomaei</i>	yellow jack		3		1
<i>C. latus</i>	horse-eye jack			1	
<i>C. ruber</i>	bar jack	6	15	3	1
Lutjanidae					
<i>Lutjanus analis</i>	mutton snapper	17	5		2
<i>L. apodus</i>	schoolmaster	2	3	2	13
<i>L. buccanella</i>	blackfin snapper	6			
<i>L. griseus</i>	gray snapper		4		
<i>L. jocu</i>	dog snapper	9		1	
<i>L. mahogoni</i>	mahogany snapper	2			2
<i>L. synagris</i>	lane snapper	18	17	24	14
<i>L. vivanus</i>	silk snapper			5	
<i>Ocyurus chrysurus</i>	yellowtail snapper	13	19	12	34
Gerreidae					
<i>Eucinostomus argenteus</i>	spotfin mojarra				1
<i>Gerres cinereus</i>	yellowfin mojarra		2		1

Appendix 1. cont.

Haemulidae					
<i>Anisotremus surinamensis</i>	black margate	3			
<i>A. virginicus</i>	porkfish	5			
<i>Haemulon album</i>	margate	2			
<i>H. aurolineatum</i>	tomtate			14	
<i>H. flavolineatum</i>	french grunt	32		3	28
<i>H. macrostomum</i>	spanish grunt	1			
<i>H. melanurum</i>	cottonwick	1			
<i>H. parrai</i>	sailor's choice		2		
<i>H. plumieri</i>	white grunt	92	28		74
<i>H. sciurus</i>	bluestriped grunt	28	8		33
Sparidae					
<i>Calamus bajonado</i>	jolthead porgy	2			
<i>C. calamus</i>	saucereye porgy	33	104	1	8
<i>C. pennatula</i>	pluma	1	4		1
<i>Calamus spp.</i>	unid. porgies	121		4	23
Sciaenidae					
<i>Equetus acuminatus</i>	highhat				3
<i>E. punctatus</i>	spotted drum				4
Mullidae					
<i>Mulloidichthys martinicus</i>	yellow goatfish	35	3	1	13
<i>Pseudupeneus maculatus</i>	spotted goatfish	11		1	31
Kyphosidae					
<i>Kyphosus sectatrix</i>	chub, bermuda	2			
Chaetodontidae					
<i>Chaetodon capistratus</i>	four-eye butterflyfish	6	9	7	3
<i>C. sedentarius</i>	reef butterflyfish				
<i>C. striatus</i>	banded butterflyfish		8	6	31
<i>Chaetodon spp.</i>	unid. butterflyfishes	9			
Pomacanthidae					
<i>Holacanthus ciliaris</i>	queen angelfish	30	10		9
<i>H. tricolor</i>	rock beauty	5	5		14
<i>Pomacanthus arcuatus</i>	gray angelfish	131	54		1
<i>P. paru</i>	french angelfish	8	2		
Pomacentridae					
	damselfishes	1			
Sphyraenidae					
<i>Sphyraena barracuda</i>	great barracuda	3			
Labridae					
<i>Bodianus rufus</i>	spanish hogfish	2			
<i>Halichoeres radiatus</i>	puddingwife	2			
<i>Lachnolaimus maximus</i>	hogfish	3			
Scaridae					
<i>Scarus coeruleus</i>	blue parrotfish	1			
<i>S. croicensis</i>	striped parrotfish	1	1	1	1
<i>S. guacamaia</i>	rainbow parrotfish	2			
<i>S. taeniopterus</i>	princess parrotfish	2	4	4	7
<i>S. vetula</i>	queen parrotfish	3			1
<i>Sparisoma aurofrenatum</i>	redband parrotfish	11	19	18	92
<i>S. chrysopteron</i>	redtail parrotfish	59	8	1	76
<i>S. viride</i>	stoplight parrotfish	36	6	1	7

Appendix 1. cont.

Acanthuridae

<i>Acanthurus bahianus</i>	ocean surgeonfish	13	20	8	194
<i>A. chirurgus</i>	doctorfish	41	9		44
<i>A. coeruleus</i>	blue tang	140	89	5	301

Scombridae

<i>Thunnus atlanticus</i>	blackfin tuna	9			
<i>Euthynnus alletteratus</i>	little tunny	5			

Bothidae

<i>Bothus lunatus</i>	peacock flounder		1		2
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Balistidae

<i>Aluterus scriptus</i>	scrawled filefish		2	1	
<i>Balistes vetula</i>	queen triggerfish	69	46	2	4
<i>Cantherhines macroceros</i>	whitespotted filefish				
<i>Cantherhines pullus</i>	orangespot filefish	7	3		8

Ostraciidae

<i>Lactophrys bicaudalis</i>	spotted trunkfish	6	10	1	2
<i>L. polygonia</i>	honeycomb cowfish	12	19		
<i>L. quadricornis</i>	scrawled cowfish	16	29		
<i>L. triqueter</i>	smooth trunkfish	6	34		5
<i>L. trigonus</i>	trunkfish	5			

Diodontidae

<i>Chilomyterus antennatus</i>	bridles burrfish		2		
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INVERTEBRATES

<i>Panulirus argus</i>	spiny lobster	18			
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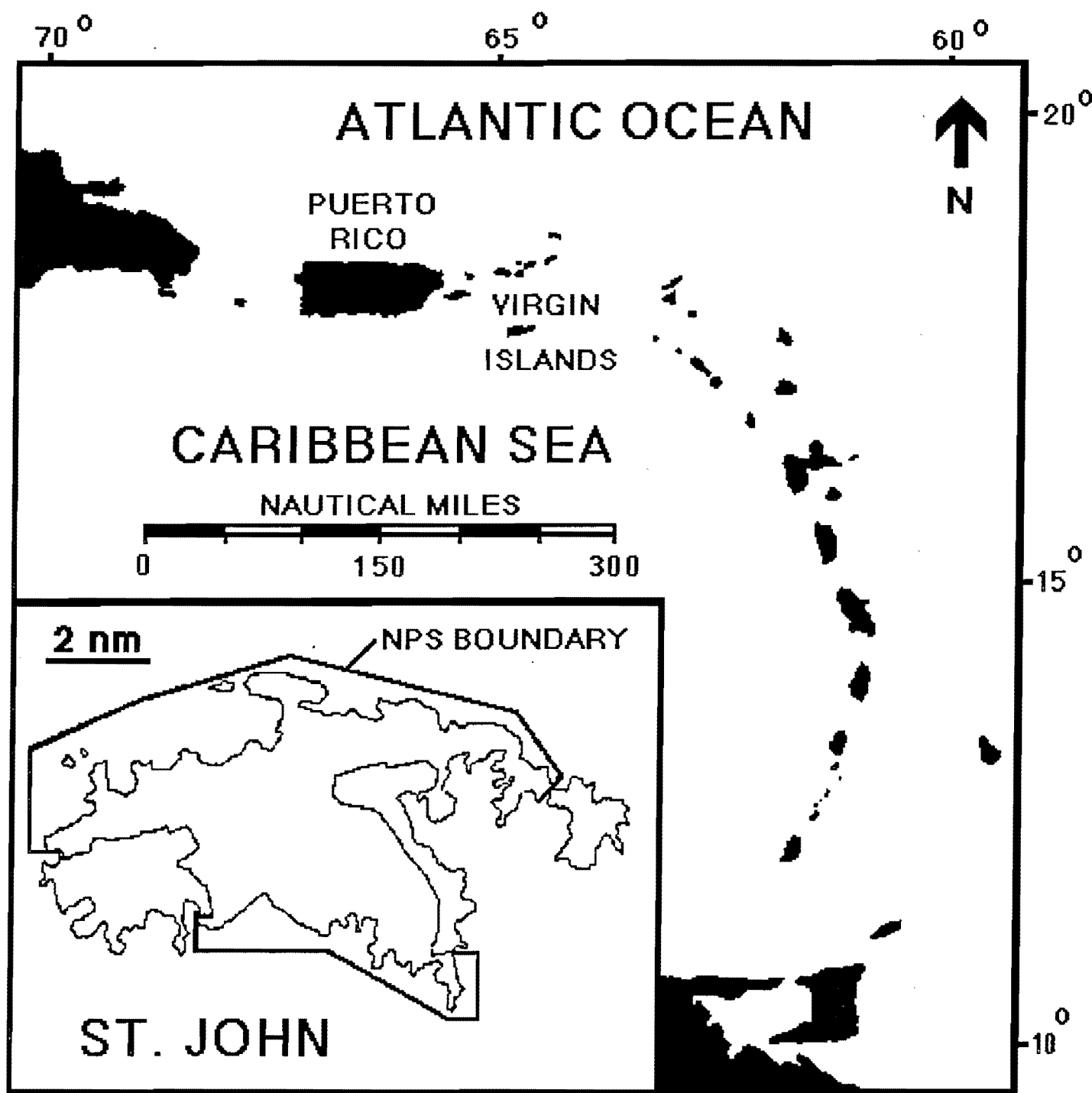


Figure 1. Map of St. John, U.S. Virgin Islands with boundaries of Virgin Islands National Park.

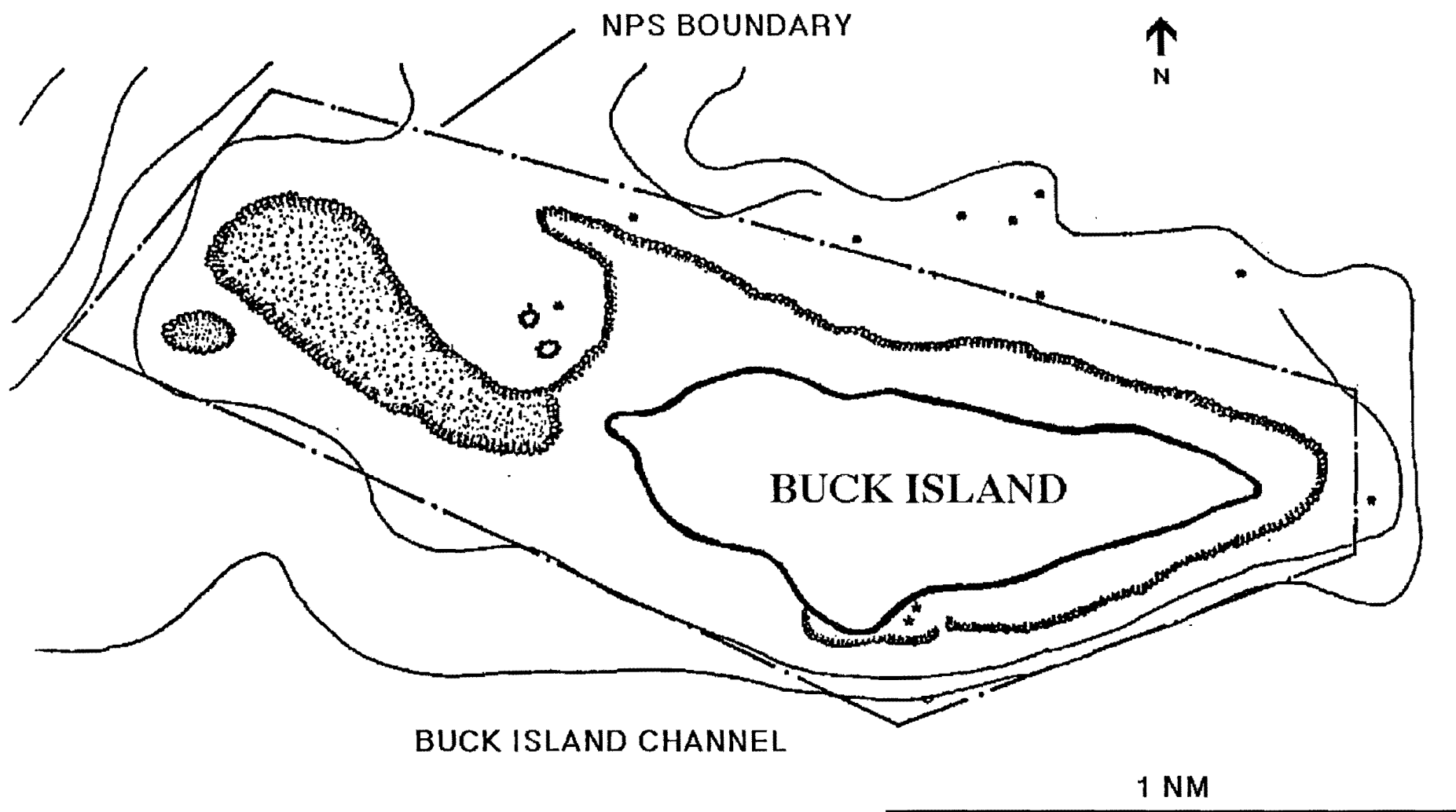


Figure 2. Map of Buck Island National Monument off the northern shore of St. Croix, US Virgin Islands.

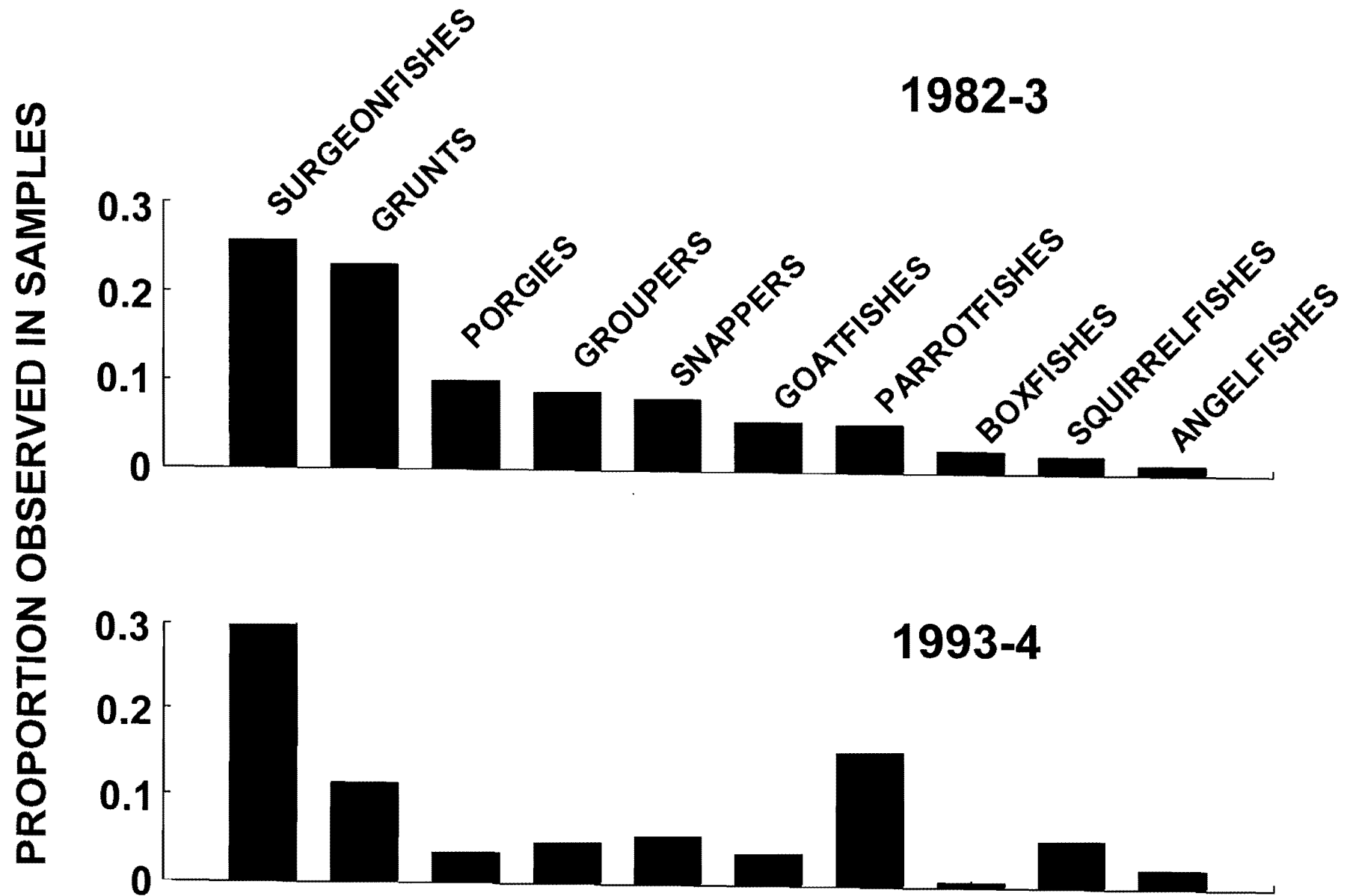


Figure 3. Species composition of fishes in fish trap samples from Yawzi Point reef, St. John in 1982-3 and 1993-4.

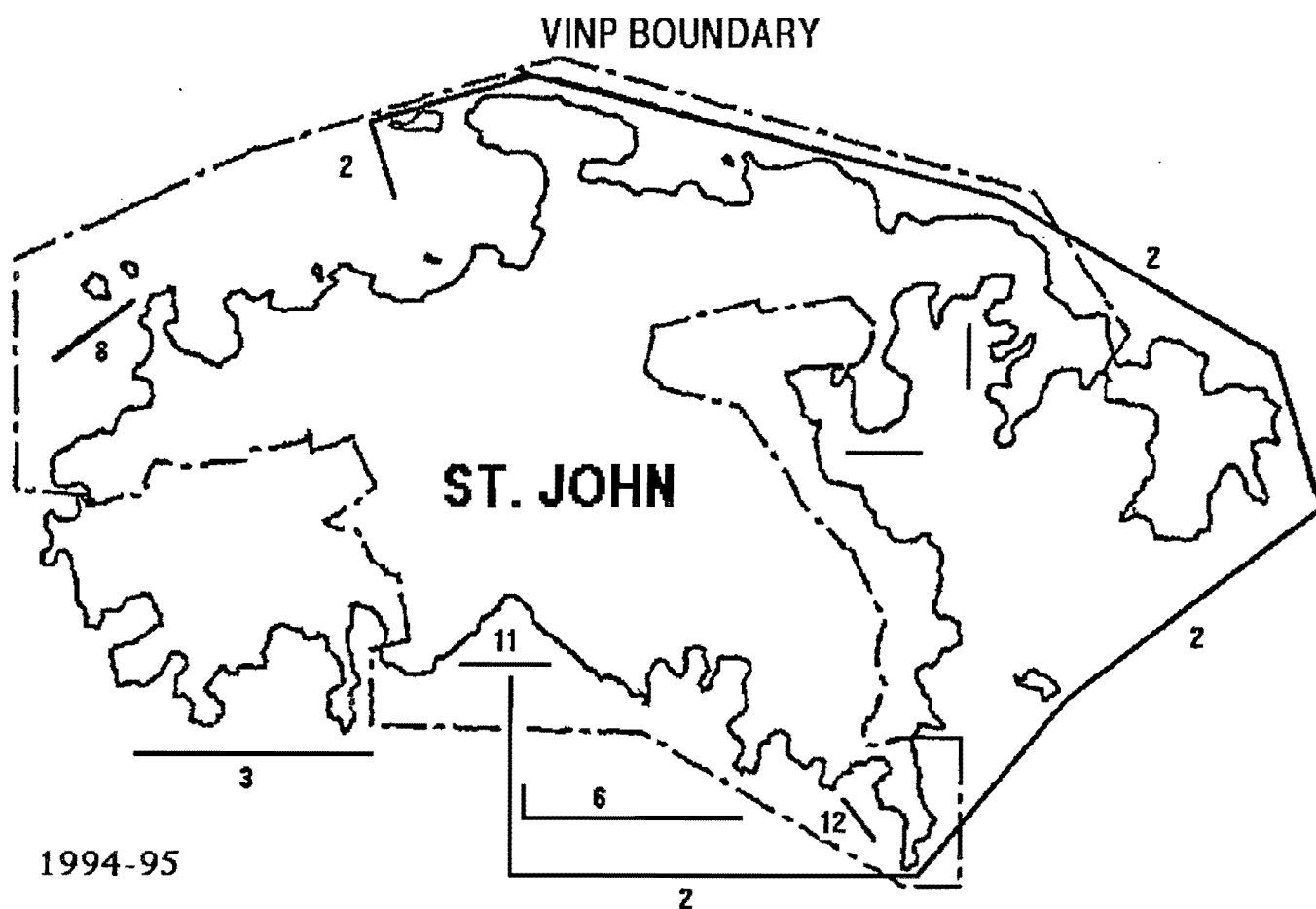
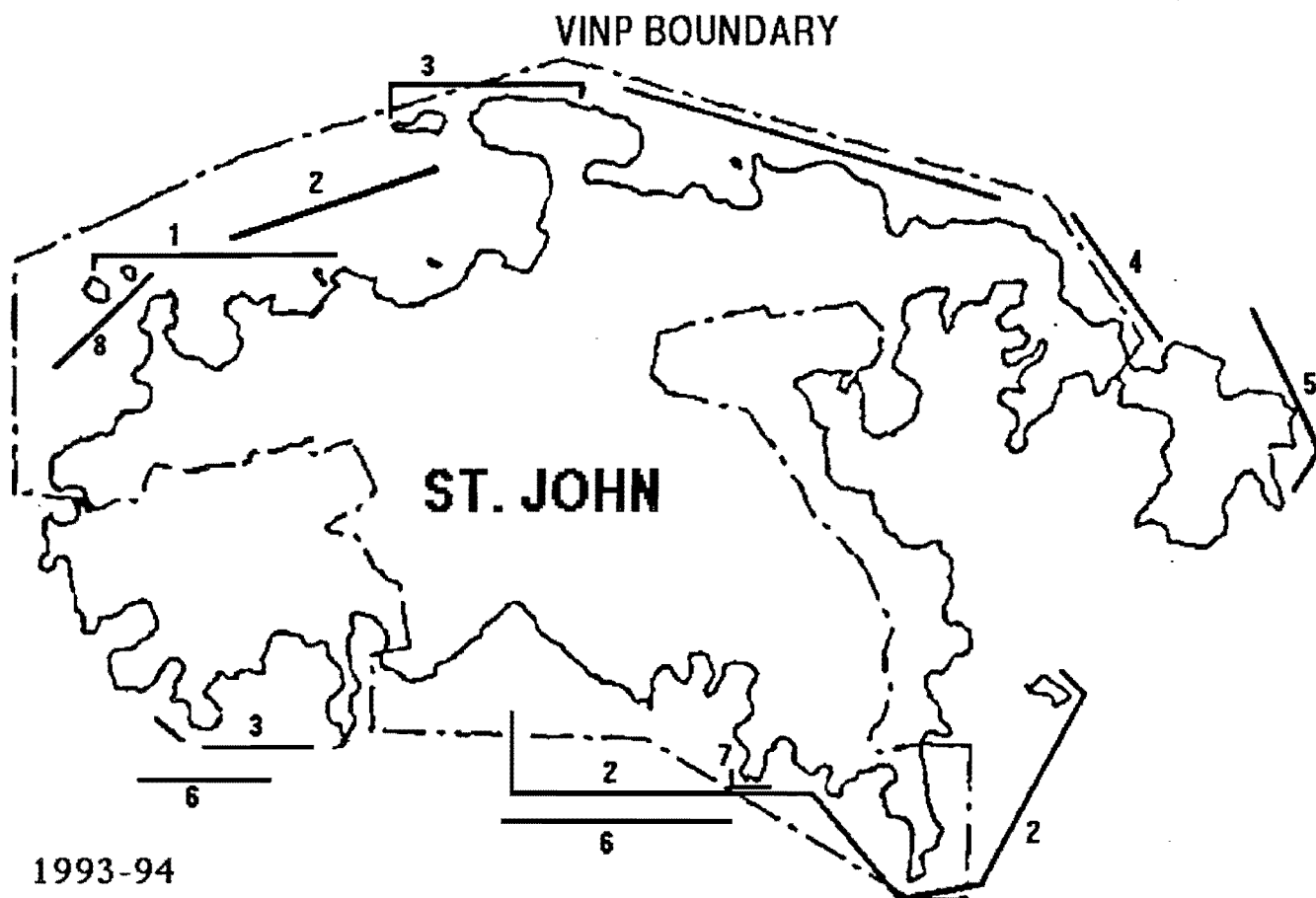


Figure 4. Location of traps set by fishermen, 1993-1995.
Each number denotes a specific fisherman.

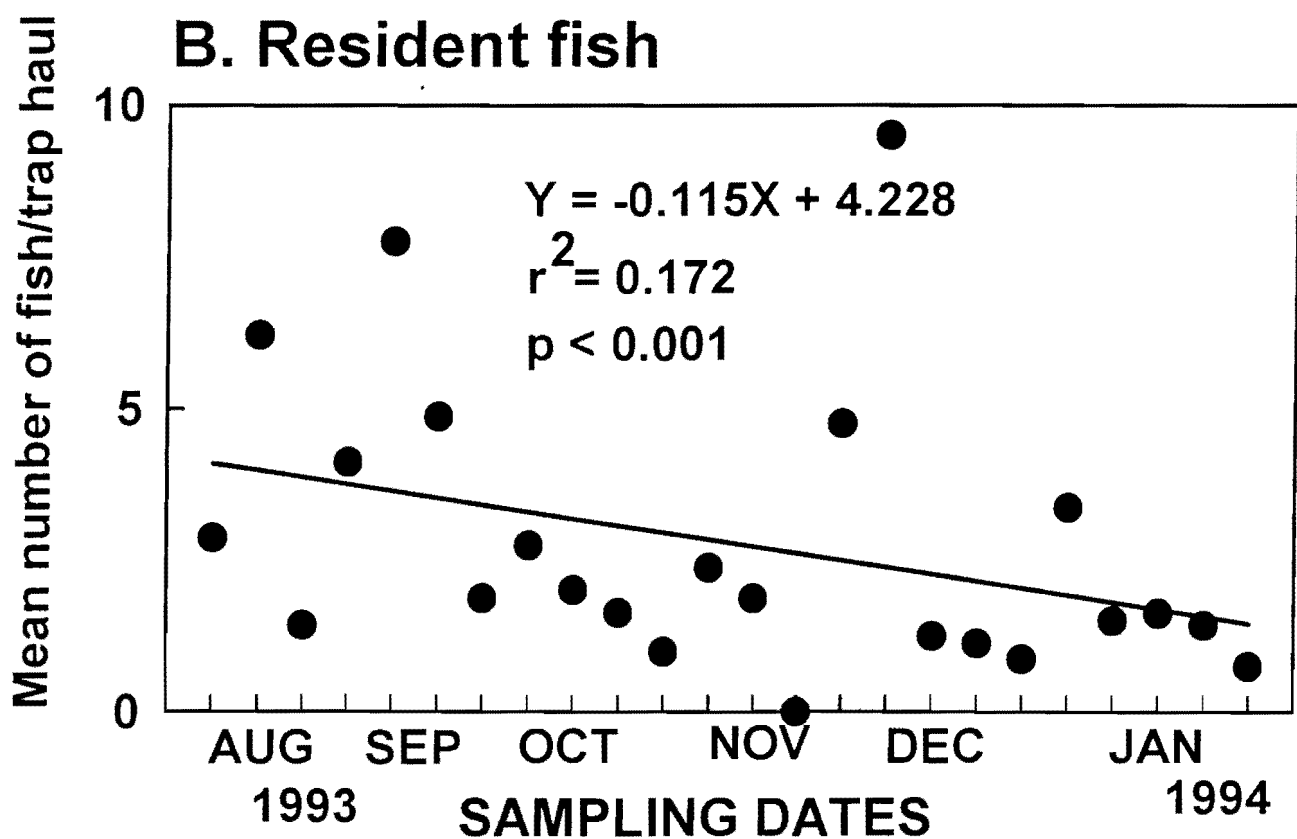
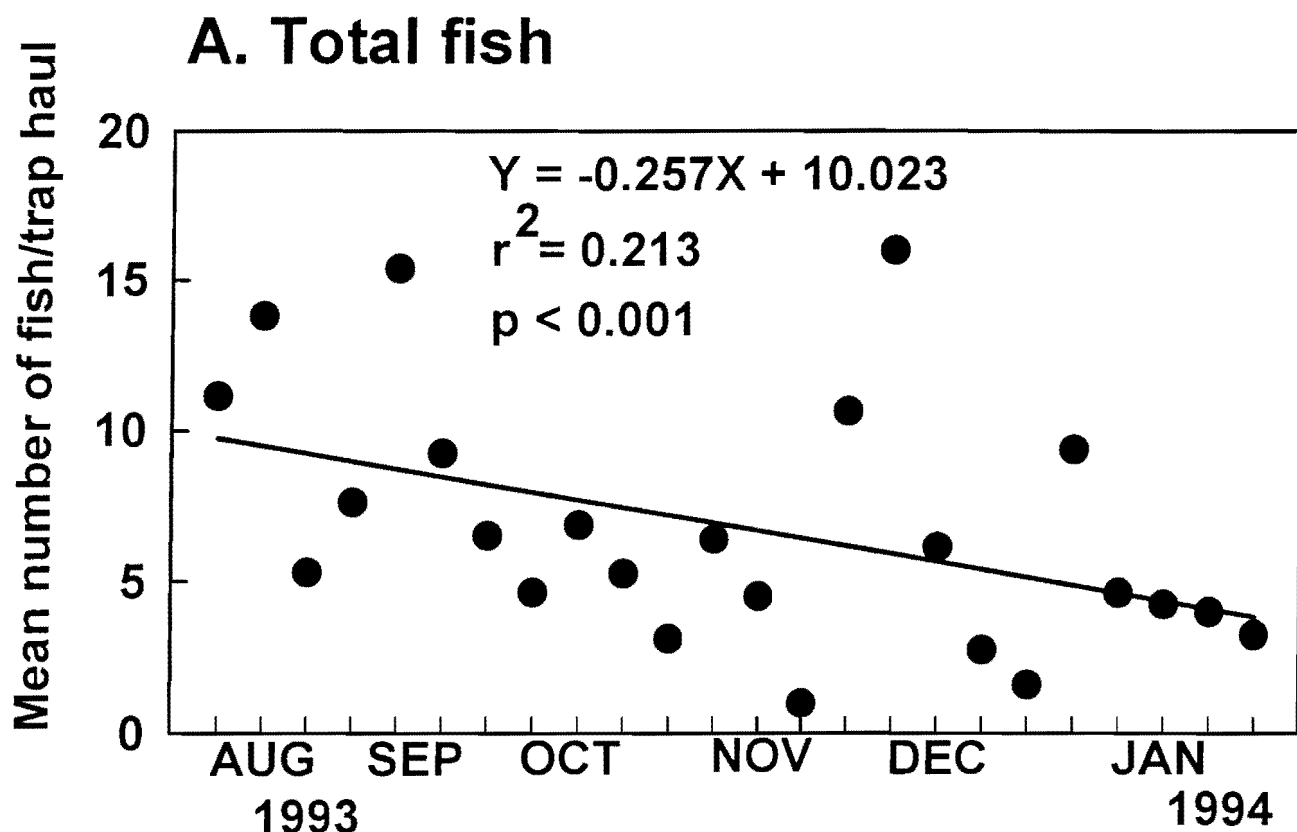


Figure 5. Results of regression analyses for the fish trap experiment conducted at Yawzi Point reef, Aug 1993-Jan 1994, for a) total fish and b) resident fish.

Mean number of fish/trap haul



Y = -0.039X + 0.865
 $r^2 = 0.322$
 $p < 0.001$

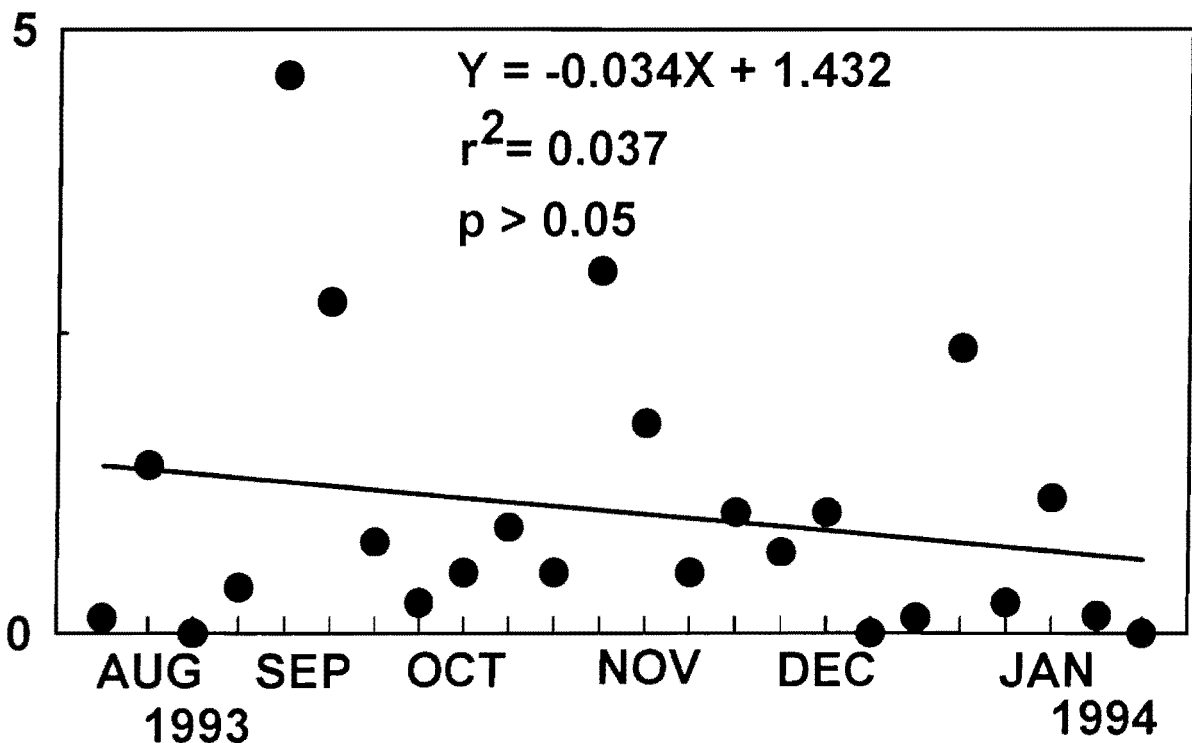
SAMPLING DATES

1993 1994

Figure 6. Results of regression analyses for the fish trap experiment conducted at Yawzi Point reef, Aug 1993-Jan 1994, for a) snappers and b) squirrelfishes.

Mean number of fish/trap haul

A. Parrotfishes



Mean number of fish/trap haul

B. Surgeonfishes

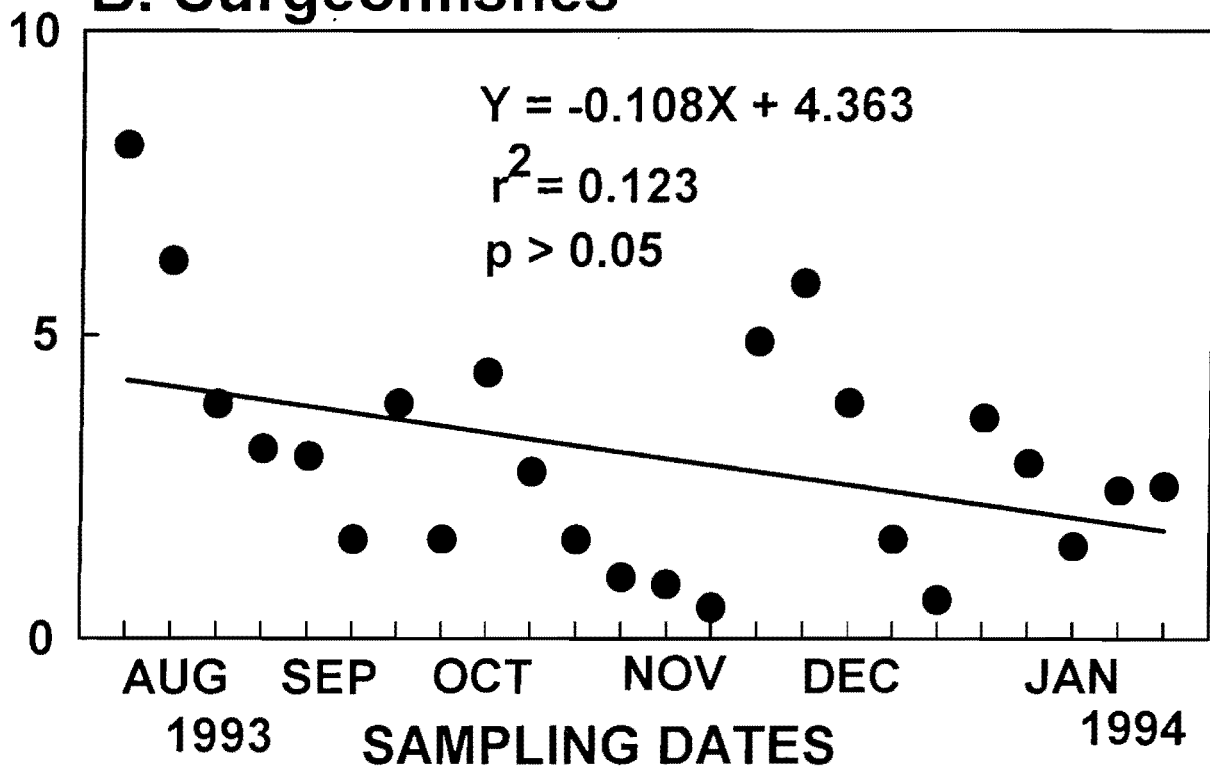


Figure 7. Results of regression analyses for the fish trap experiment conducted at Yawzi Point reef, Aug 1993-Jan 1994, for a) parrotfishes and b) surgeonfishes.

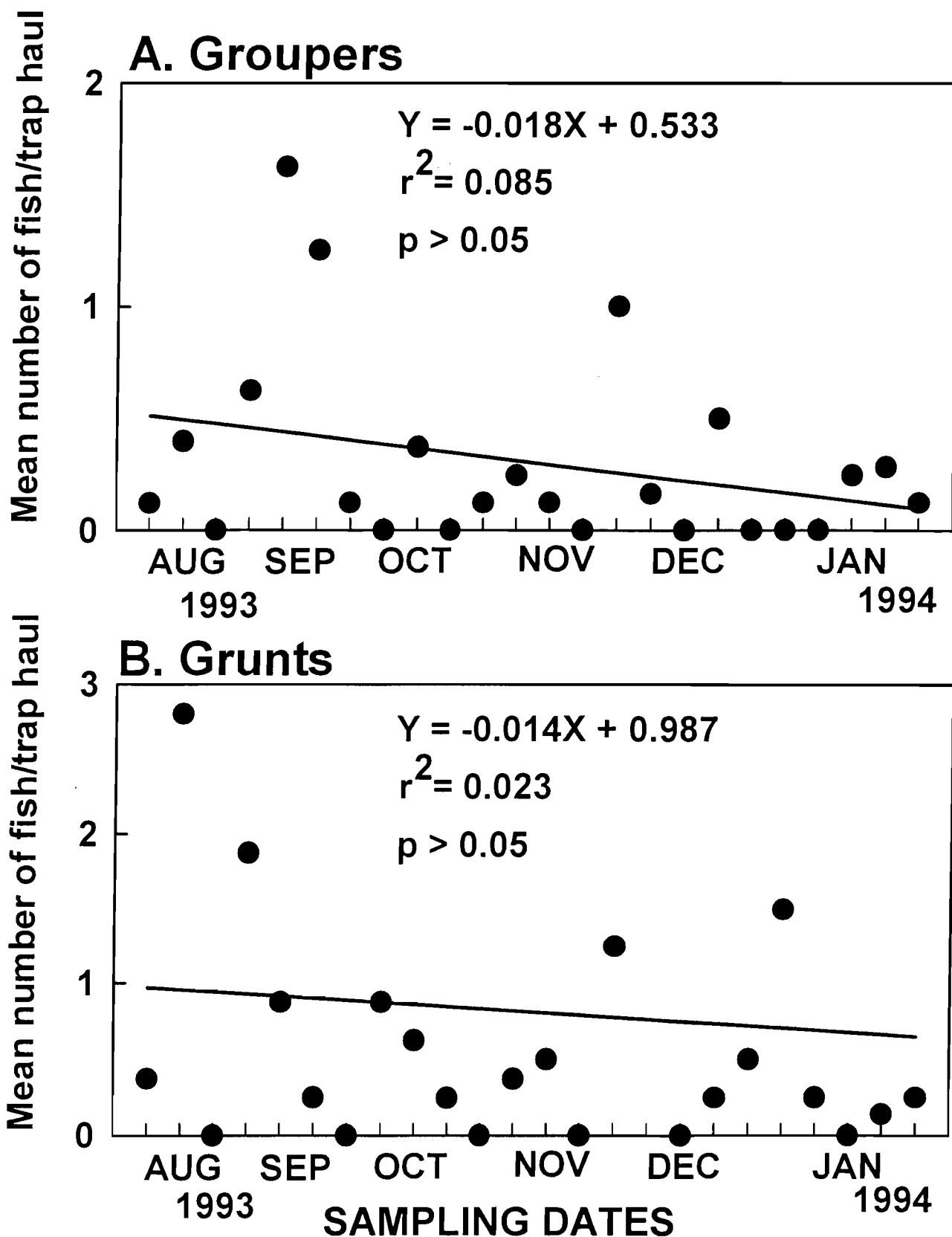


Figure 8. Results of regression analyses for the fish trap experiment conducted at Yawzi Point reef, Aug 1993-Jan 1994, for a) groupers and b) grunts.