

AN ANALYSIS OF THE ST. THOMAS FISHERY WITH SPECIAL REFERENCE TO THE
SOUTH WEST ROADS AREA

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ABSTRACT

The following report is a summary of the St. Thomas-St. John fishery with special reference to the area of Southwest Roads where a proposed project to dredge sand for construction may take place. The fishery in this area relies primarily on the use of West Indian fish traps although there is an increasing amount of lobster traps and diving for lobster. Secondary fishing methods include handline fishing for both pelagic and benthic species and some use of haul seines.

Current landings of finfish from St. Thomas are in the vicinity of 1.6 million pounds while lobster landings are around 120,000 lbs. This catch appears to have been relatively stable since 1974 when the Virgin Islands government began to keep catch records. Lobster landings, on the other hand have been increasing. The catch reporting area which includes the Southwest Roads accounts for nearly 50% of the finfish landings and over 36% of the lobster landings. A survey of the fishermen who fish in Southwest Roads indicated that approximately 27.6% of the finfish which are landed in this reporting area come from the Southwest Roads. The fishermen in the survey reported landing nearly 200% of the reported lobster landings for the entire reporting area from the Southwest Roads.

Species composition of the commercial catch is very similar to the Virgin Islands ichthyofauna since Virgin Islands consumers purchase most species. This is particularly true for the trap catch. The species diversity of the trap catch is equivalent to the general figures for the area which appear in the literature. There is no apparent depression of species diversity effected by trap fishing. Other fishing methods are more selective.

Seasonal trends are not pronounced within the landings. This is particularly true for the trap fishery although the hook and line and net fisheries exhibit some seasonality. The reasons may lie in the fact that, because of the many species involved, shifts in abundance and catchability may cancel and create relatively even overall catch throughout the year.

The recreational fishery within Southwest Roads is relatively small and totals less than 33,000 lbs. An estimated 30 boats use the area and may spend up to 8900 person days (throughout the entire catch reporting area).

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INTRODUCTION

The fisheries of the Virgin Islands have a long history of technological adaptation to the diverse nature of the tropical resources of the Caribbean region. Early accounts of visits by scientists (St. Thomas Tidende, 1906) provided descriptions of a fishery which was similar to that employed since the time of first contact with Columbus (Price, 1966). Early discoverers describe the hook and line fishing skills of the Caribs, their use of fish poisons, and traps (Price, 1966). This same author also describes the Indians' diving skills and the use of birds and scoop nets for fishing. Indeed, it appears that the Carib Indians employed many of the same techniques currently in use in the Virgin Islands (Price, 1966). The reasons for this apparent lack of technological evolution are based in the complex nature of the fishery resources of the region. It is a well documented fact of biogeography that the tropics contain greater diversity of forms than temperate regions (MacArthur and Wilson, 1967). This diversity precludes high levels of technological investment in the harvest of one or several species. Consequently, harvest in these regions must be based upon an understanding of the behaviour of the many fishery organisms and the use of appropriate technologies for their harvest.

From this early account, one can see that the aboriginal people of the region were admirably equipped to harvest the full range of resources available to them within the Caribbean area. Subsequent modifications to this array of fishing technology have been primarily in the direction of refinements and introduction of technological analogs. It was not until the discovery of significant deep water snapper and grouper resources (Dammann, 1969; Brownell and Rainey, 1971) that substantial new technologies were suggested for introduction (Olsen, et al., 1974).

The fishery today is in a very dynamic period. Until the middle portion of the 1970's, the boats, fishermen and techniques being utilized were nearly identical to those in reports from as early as 1917 (U.S. Census). This lack of change can be traced through earlier reports (Fiedler and Jarvis, 1932; Hill, 1969; Dammann, 1969; Olsen, 1978) until the period beginning around 1975 when fisherman began to invest in larger boats, storefront marketing began, and mainland ("Continental") fishermen began to come down to the Virgin Islands to compete with local fishermen for resources which most fishery management personnel felt were already fully exploited (Caribbean Fishery Management Council, (CFMC) 1978a; 1978b). These forces for change have yet to reach an equilibrium point with the politico-developmental pressures upon the land and marine resource base.

The following report is an attempt to supply detailed information regarding the fishery of the St. Thomas-St. John shelf with particular reference to the Southwest Roads area (Figure 1) of St. Thomas where a proposed demonstration project for offshore sand dredging may take place. It is perhaps appropriate that land based pressures in St. Thomas must force consideration between the relative value of fishery and sand resources for construction in this area. The information contained here will hopefully enable project planners to evaluate the potential impact of such dredging activities upon the fishery resources. If a decision is made to dredge, then perhaps the information can be used to minimize these impacts through temporal and spatial planning.

The organization of this report emphasizes general aspects of the fishery such as history of landings, seasonality, and areal distribution of the catch. Following the general discussion, specific information is presented regarding the Southwest Roads area.

Figure 1. Map of St. Thomas, U.S., Virgin Islands showing location of Proposed Sand Dredging Area, Artificial Reef, and area (Control Area) where the fishermen employed by this project hauled non-project traps.

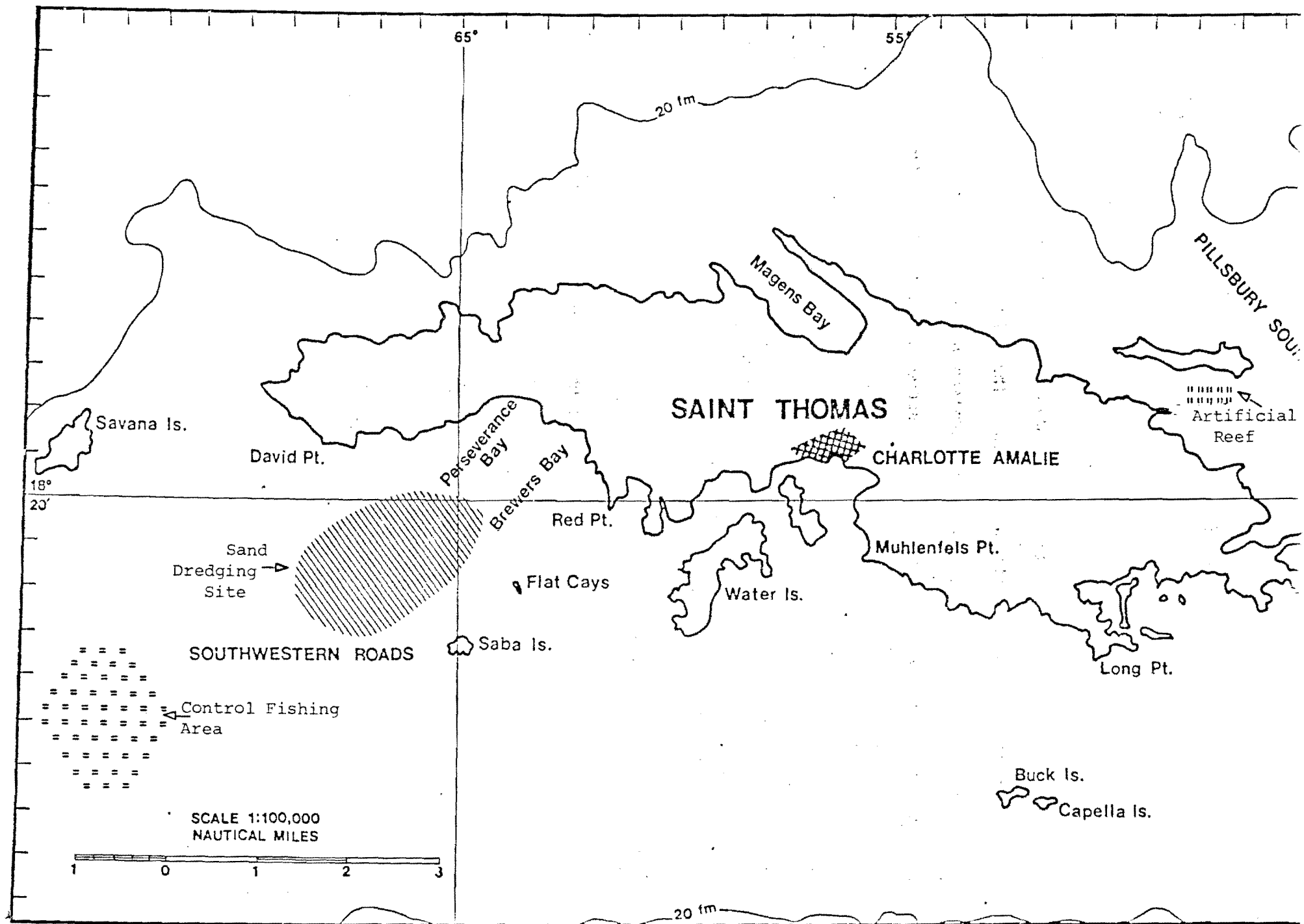


Figure 1. Proposed pilot sand mining area on the southern shelf of St. Thomas.

The reason for this sequence is that there is a relative dearth of information on this area so that discussion, of necessity, has to draw upon the more general data for support.

DATA RESOURCES

The data discussed in the following report come from a variety of sources. They have been described below so that an abbreviated form of referral can be used throughout the report.

1. DCCA CATCH REPORTS. Virgin Islands Act 3330 requires that all commercial fisherman submit a summary of their landings on an annual basis. These data have been summarized in a series of reports (Olsen, et al., 1975c; Sylvester, 1976; Sylvester, et al., 1977; Coleman, et al., 1979; Mudre, 1979b). Compliance with this requirement has been poor and the authors listed above have all expressed doubts about the accuracy of the data. For this report we have analyzed these results to account for some of the deficiencies (Annex I) and these results are referred to as the Adjusted Catch Reports.
2. ARTIFICIAL REEF. The DCCA has maintained fish traps at the site of an artificial reef northeast of St. Thomas (Figure 1). These traps were hauled 503 times in the period between 1974 and 1979. The catch was sorted by species. On 107 occasions the catch was returned to the lab and weighed. A total of 3362 fish (77 species) were caught and the average catch was 5.5 lbs. per one week set.
3. FISHERMAN'S COOPERATIVE. Sixty-one catches landed at the St. Thomas-St. John Fisherman's Cooperative were sorted by species and weighed. The average weight per catch was 125.5 lbs. and the total poundage was 7654 lbs.. The survey took place between January 1980 and June 1980. The Cooperative catch records were collected and are presented in Annex V by month. The survey results are presented in Annex II by month.
4. SAND DREDGING SITE. Four traps were set in an area of proposed sand dredging (Figure 1). They were hauled a total of 78 times, caught 478 lbs. of fish. The fisherman who carried out this effort also recorded his catch from an area outside the proposed dredge site where he had set fish traps. The traps from the Sand Dredging Site averaged 5.4 lbs. per set while the traps away from the dredge area averaged 9.2 lbs. per set. These latter traps are referred to as Control Area Traps. The make up of the sand dredging site catch by month is presented in Annex III. The species composition of the Control Area catch was not determined.
5. Other sources of data have also been used and are described in text.

FISHING METHODS EMPLOYED

The West Indian fish trap is the basic unit of gear in the Virgin Islands and throughout the Eastern Caribbean where substantial shelf areas exist (Brownell, 1971; Sylvester and Dammann, 1972). The traps of today are more similar to the forms used by negro fishing slaves (Price, 1966) than their Carib predecessors. Traps were originally platted from vegetable material but are currently constructed of poultry mesh.

Fish traps harvest most of the species present which are associated with the reef and benthic environment. Extensive work by Munro (1974) on the method of operation indicates that there is a continual ingress into and egress out of the traps; maximum catches are obtained with set periods of 4-6 days. Fish traps generally account for between 85 and 90% of all of the finfish landings in the St. Thomas-St. John fishery as shown by Department of Conservation and Cultural Affairs (DCCA) catch records from 1975 to present.

Historically, it is evident that hook and line techniques were more important than other fishing methods (Census, 1917; Price, 1966). Current trends in technological introduction have emphasized long-line and handline techniques for reasons of cost-efficiency and protection from gear loss (Olsen and LaPlace, et al., 1981). Hook and line techniques have also been emphasized to provide access to deep water snapper and grouper resources (Sylvester and Dammann, 1972; Brownell, 1971). Handline fishing currently accounts for approximately 5% of the total finfish landings in the Virgin Islands.

Hook and line techniques are used to exploit both the benthic and pelagic fishery resources which are seasonally abundant in the St. Thomas area. They may be employed either from anchored or moving boats.

Bottom fishing generally utilizes two or three hooks and catches many species of reef fish. Preferred baits are "sprat" (Harengula sp.), fry (Anchoa sp.), squid or octopus. Fishing lines are pulled by hand with the exception of some use of hydraulic and electric reels for the deep water (over 40 fathoms) shelf edge.

The other form of handline fishing is for the more pelagic species (jack, tunas) and particularly yellowtail snapper. In fishing, "fry" is ground up with sand and used as chum (mash). A ball of mash is formed around the single hook baited with fry and let back into the current. When it reaches the desired depth, a jerk on the line disperses the mash and serves to attract the fish to the hook. Most of this fishing is done at night.

There is also some trolling for kingfish (Scomberomorus cavalla) during the winter and spring months using either artificial baits or ballyhoo (Hemiramphus sp.).

Spiny lobster (Panulirus argus) has been a targeted species since pre-Columbian days (Price, 1966). Lobsters have been primarily a by-catch from fish traps with some caught by free diving. In recent years, however, there has been some substantial introduction of a directed fishery utilizing wooden Florida-type traps (Olsen, et al., 1975a).

Additionally, the introduction of SCUBA diving techniques has opened up much of the shelf to exploitation by divers. Currently, most of the lobster catch comes from these latter, directed, fishing methods.

Another significant contribution to the Virgin Islands landings has come from haul seine fishing, primarily by fishermen of French extraction. Normally, these fishermen land between 5 and 10% of the total catch of finfish. This technique involves careful study of the feeding habits of migratory schools of jacks (Caranx sp.), bonitos (Euthynnus alleteratus), yellowtail snappers (Ocyurus chrysurus), or gars (Tylosurus sp.).

Once the temporal and spatial feeding patterns of a particular school are studied, the fishermen wait in an appropriate cove and surround the school with the seine net, which is then worked in such a manner as to concentrate the fish and brail them out into the net skiff. There has also been some recent use of gill nets in St. Thomas.

Other traditional fisheries in the Virgin Islands include the conch (Strombus gigas) and the West Indian top shell (Cittarium pica).

On the St. Thomas shelf, both of these are under heavy exploitation although the landings of both are not significantly reported in the DCCA catch reports. Presently, the shelf appears to be saturated with fishing gear and gear conflicts are frequent. This has prompted some fishermen to push for legislation to limit the amount of fish traps placed throughout the shelf.

Information developed by the Caribbean Fishery Management Council for its reef fish management plan (CFMC, 1978a and b) indicates that there is little, if any, potential for expansion of landings from the resource. Their estimate of the maximum sustainable yield (the amount of harvest which can be taken without damaging the ability of the resource to replenish itself) is approximately 1.530 million lbs. for the St. Thomas-St. John shelf. Current estimates of the commercial catch (Table 1) indicates that this is very close to the existing harvest levels. If the recreational catch is considered, total catch more than likely exceeds the maximum sustainable yield of the shelf.

SPECIES COMPOSITION OF THE CATCH

Data for the composition of the finfish catch comes from a variety of sources that have been previously described.

TABLE I. Summary of St. Thomas-St. John Commercial fish landings.

VARIABLE	1917 ^b	1930 ^c	1968 ^d	1974-5 ^e	1975-6 ^e	1976-7 ^e	1977-8 ^e	1978-9 ^e	1979-8
# Fishermen ^a	65	102	134	230	165	172	162	161	
# Boats	106	99	134	200	165	165	183	171	
# Traps/Fisherman	5.4	6.5	6.1	16.7	17.0	17.0	25.3	25.3	
Total Traps	351	663	817	3,523	2,805	2,924	4,098	4,073	
Total Fish Landings ^f	350.5	327.0	810.8	1,540.4	1,136.4	1,272.8	1,648.8	1,600.9	
Lobster Landings	NA	NA	49.8	31.2	12.8	75.2	120.1	122.1	
Price (\$/lb., fish)	0.06	0.06	0.80	1.00	1.25	1.35	1.35	1.65	1.91
Price (\$/lb., lobster)	NA	NA	0.85	2.00	2.25	2.25	2.50	3.50	5
CPUE (/fisherman) ^g	5.39	3.21	5.98	4.18	2.77	3.99	3.92	4.86	
CPUE (/trap) ^g	1.00	0.49	0.98	0.25	0.16	0.23	0.15	0.19	
# Helpers/fisherman	NA	NA	0.72	0.90	0.90	0.90	NA	NA	

a. Excluding helpers. There is normally one helper per boat.

b. Census of the Virgin Islands (1917)

c. Fiedler and Jarvis (1932)

d. Dammann (1969) and Swingle, et al., (1969)

e. DCCA catch reports (various authors) as reanalyzed in Annex I. Figures given are average high & low estimates.

f. Fish landings are in 1000s of lbs. and include trap, net and line fishing. The figures given are the average of the range of values from the readjusted figures from Annex I.

g. CPUE is given in 1000s of lbs. per year.

These data furnish an indication of some overlap between different harvesting methods with regards to the species harvested (Annex IV). The serranids (groupers) and yellowtail snappers are particularly subject to harvest by multiple methods. This overlap can be clearly seen in that the survey of the Fisherman's Cooperative landings contained over 64% of the species which were harvested in the traps from the artificial reef (Table II). This figure would very likely increase if the cooperative survey would be continued for a full annual cycle.

Trap Catch

The trap fishery harvests most of the species of fish from the reefs that are large enough to be retained by the mesh size of the trap wire. Dammann (1969) reported the results of two (2) poisonings of a small reef in Chocolate Hole, St. John. Between 67 and 83% of the fish collected by him were species which are used in the commercial fishery. Olsen, et al. (1978) has shown that a mesh size of less than the 1.5 in. diameter hexagonal poultry netting normally used in the Virgin Islands retains large numbers of small species and juveniles. His data indicates that there is variability in species composition between samples from area to area. Table II indicates this diversity of species. Triggerfish (Balistidae) and Groupers (Serranidae) make up nearly 50% of the landings.

Seine Net Catch

The species composition of the catch by fishermen utilizing haul seines is known from a census of 100 catches totaling 53,100 lbs., undertaken as part of a DOCA port sampling project (Mudre, in progress).

TABLE II. Species composition of St. Thomas fish catch from three sources. Units are in percent of total fish for the artificial reef and percent of total pounds for the other two sources.

SPECIES	Artificial Reef	Fishermen's Cooperative	Sand Dredging Site
Family Dasyatidae			
<u>Dasayatis americana</u> - Southern Stringray	—	—	0.63
Family Orectolobidae			
<u>Ginglymostoma cirratum</u> - Nurse shark	0.06	—	—
Family Belonidae			
<u>Tylosurus crocodilus</u> - Gar (Houndfish)	—	0.45	—
Family Holocentridae - Squirrelfishes			
<u>Holocentrus adscensionis</u> - Longjaw squirrelfish	0.62	—	—
<u>Adioryx coarctatus</u> - Reef squirrelfish	0.65	—	—
<u>H. rufus</u> - Squirrelfish	1.07	—	—
Family Serranidae -Sea Basses & Grouper			
<u>Alphistes afer</u> - Mutton hamlet	—	0.60	—
<u>Cephalopholis fulva</u> - Coney	0.15	2.37	0.22
<u>Epinephelus adscensionis</u> - Rock Hind	0.06	2.31	—
<u>E. guttatus</u> - Red hind	2.79	8.71	0.34
<u>E. striatus</u> - Nassau grouper	0.21	2.25	0.35
<u>E. morio</u> - Red grouper	—	0.84	0.74
<u>Mycteroperca venenosa</u> - Yellowfin grouper	0.18	0.58	—
<u>Hypoplectrus nigricans</u> - Black hamlet	0.03	0.60	—
<u>Petrometopon cruentatum</u> - Graysby	0.21	—	—

TABLE II. CONTINUED

Family Carangidae - Jacks and Pompanos

<u>Caranx latus</u> - Horse-eye jack	0.12	0.37	0.53
<u>C. ruber</u> - Bar jack	0.68	0.75	7.58
<u>C. fusus</u> - Blue runner or Hardnose	—	—	1.29

Family Scombridae

<u>Scomberomorus cavalla</u> - Kingfish	—	2.34	—
<u>Euthynnus alletteratus</u> - Bonito	—	3.43	—

Family Lutjanidae - Snapper

<u>Apsilus dentatus</u> - Black silk snapper	—	0.07	0.35
<u>Lutjanus analis</u> - Mutton snapper	0.18	0.13	1.96
<u>L. apodus</u> - Schoolmaster	1.49	0.28	—
<u>L. campechanus</u> - Red snapper	0.06	—	—
<u>L. synagris</u> - Lane snapper	0.01	0.03	22.95
<u>L. griseus</u> - Gray snapper	0.09	0.76	—
<u>L. jocu</u> - Dog snapper	0.36	0.45	—
<u>L. buccanella</u> - Blackfin snapper	—	0.81	—
<u>L. mahogoni</u> - Mahogany snapper	0.03	—	—
<u>Ocyurus chrysurus</u> - Yellowtail snapper	0.98	2.89	—
<u>Pristipomoides aquilonaris</u> - Silk	0.01	1.92	2.19

Family Muraenidae - Moray eels

<u>Gymnothorax funebris</u> - Green moray	0.06	—	—
<u>G. moringa</u> - Spotted moray	0.01	—	—

Family Pomadasyidae - Grunts (unidentified)

<u>Anisotremus surinamensis</u> - Black margate	0.27	6.61	—
<u>A. virginicus</u> - Porkfish	0.06	—	—
<u>Haemulon aurolineatum</u> - Tomtate	0.12	—	—
<u>H. flavolineatum</u> - French grunt	3.72	0.07	—
<u>H. melanurum</u> - Cottonwick	0.03	0.04	—
<u>H. plumieri</u> - White grunt	1.78	0.35	—
<u>H. sciurus</u> - Bluestriped grunt	3.36	0.05	—
<u>H. album</u> - Margate	—	1.06	—
<u>H. bonariense</u> - Black grunt	0.03	—	—

Family Sparidae - Porgies (unidentified)

<u>Calamus calamus</u> - Saucereye porgy	0.56	3.48	11.83
<u>C. penna</u> - Sheephead porgy	—	0.15	—

TABLE II CONTINUED

<u>C. pennatula</u> - Pluma	8.21	—	—
Family Mullidae - Goatfishes			
<u>Mulloidichthys martinicus</u>	0.95	0.25	—
<u>Pseudupeneus maculatus</u> - Spotted goatfish	1.28	0.74	—
Family Chaetodontidae - Angelfish			
<u>Chaetodon capistratus</u> - Foureye butterflyfish	2.23	—	—
<u>C. striatus</u> - Banded butterflyfish	0.21	—	—
<u>C. sedentarius</u> - Reef butterflyfish	2.59	—	—
<u>Holacanthus isabelita</u> - Blue angelfish	—	0.07	—
<u>H. ciliaris</u> - Queen angelfish	0.12	0.20	—
<u>H. tricolor</u> - Rock beauty	0.56	0.20	—
<u>Pomacanthus arcuatus</u> - Gray angelfish	2.76	3.03	.24
<u>P. paru</u> - French angelfish	1.49	0.53	1.83
Family Scaridae - Parrotfishes			
<u>Scarus vetula</u> - Queen parrotfish	—	0.10	—
<u>S. coeruleus</u> - Blue parrotfish	—	1.84	—
<u>S. croicensis</u> - Striped parrotfish	0.29	0.12	—
<u>S. taeniopterus</u> - Princess parrotfish	7.49	0.09	—
<u>Sparisoma aurofrenatum</u> - Redband parrotfish	2.44	0.19	—
<u>S. chrysoternum</u> - Redtail parrotfish	1.46	1.47	.11
<u>S. rubripinne</u> - Yellowtail parrotfish	0.50	—	—
<u>S. radians</u> - Bucktooth parrotfish	0.24	—	—
<u>S. viride</u> - Stoplight parrotfish	4.69	3.99	—
Family Labridae			
<u>Bodianus rufus</u> - Spanish hogfish	—	0.12	—
<u>Lachnolaimus maximus</u> - Hogfish	0.71	1.06	—
<u>Halichoeres radiatus</u> - Puddingwife	—	—	—
Family Acanthuridae - Surgeonfishes			
<u>Acanthurus bahianus</u> - Ocean surgeon	16.33	0.12	—
<u>A. chirurgus</u> - Doctorfish	5.56	3.73	—
<u>A. coeruleus</u> - Blue tang	11.39	0.02	—

TABLE II CONTINUED

Family Sphyraenidae - Barracudas

<u>Sphyraena barracuda</u> - Great barracuda	0.03	—	—
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Family Scorpaenidae - Scorpionfishes

<u>Scorpaena plumieri</u> - Spotted scorpionfish	0.09	—	—
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Family Bothidae - Left-eye flounders	0.06	—	—
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Family Monacanthidae - Filefishes

<u>Alutera scripta</u> - Scrawled filefish			0.48
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<u>Cantherhines pullus</u> - Tail-light filefish	1.22	—	—
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<u>Monacanthus ciliatus</u> - Fringed filefish	0.59	0.40	—
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Family Balistidae - Triggerfishes

<u>Balistes vetula</u> - Queen triggerfish	1.16	29.68	20.98
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Family Ostraciontidae - Trunkfishes

<u>Lactophrys bicaudalis</u> - Spotted trunkfish	1.43	0.08	0.79
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<u>L. triqueter</u> - Smooth trunkfish	1.34	0.21	13.21
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<u>Acanthostracion polygonus</u> - Honeycomb cowfish	0.83	0.16	
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<u>A. quadricornis</u> - Scrawled cowfish	1.52	0.27	9.81
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Family Diodontidae - Porcupinefishes

<u>Diodon holacanthus</u> - Spiny puffer	0.50	—	—
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<u>D. hystrix</u> - Porcupinefish	0.06	—	—
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Family Sciaenidae - Drums

<u>Equetus lanceolatus</u> - Jackknife fish	0.01	—	—
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<u>E. punctatus</u> - Spotted drum	0.03	—	—
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Family Ephippidae - Spadefishes

<u>Chaetodipterus faber</u> - Spadefish	0.01	—	—
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TABLE II. CONTINUED

Family Pomacentridae - Damelfishes

Abudefduf saxatilis - Sergeant major

0.01

— —

Crustacea

Panulirus argus - Spiny lobsters

1.36

0.85

1. Artificial Reef: Results are from 503 West Indian Fish Traps which were set on an artificial reef north of St. Thomas (Figure 1) and hauled weekly. Average catch per haul was 5.5 lbs. They caught 3362 individual fish between September 1974 and June 1979. Results are given as percent of total # of fish.
2. Fisherman's Cooperative: These results are from a survey of the St. Thomas-St. John Fishermen's Cooperative. In all, 61 catches (average weight = 125.5 lbs) were sorted by weight. Total poundage was 7654 lbs. The results are given as percent of total weight.
3. Sand Dredging Site: Four traps were set in the area of a proposed sand dredging project (Figure 11) and hauled weekly. They were hauled 78 times and caught 478 lbs. of fish (Average CPUE=5.4 lbs per set). The results are given as percent of the total pounds landed.

The results are listed in Table III. Over 50% of the catch are carangids with tunas (33%), yellowtail snappers (11%), and gar (3%) making up the remainder.

Hook and Line Catch

There are no analyses available of the species composition of the hook and line catch. During the winter months, there is a substantial bottom fishing based on breeding aggregations of red hind (Epinephelus guttatus) and Nassau groupers (E. striatus) (Olsen and LaPlace, 1978). Olsen and LaPlace (1981) demonstrated that there is a potential handline resource with economic potential throughout the shelf. Their catch was primarily serranids, with lutjanids making up 20% to 30% of the landings.

A subjective analysis of the landings would indicate that as much as 60% of the handline catch (excluding the serranid breeding aggregations) may be made up of Ocyurus chrysurus (yellowtail snappers) during the remainder of the year. There is a small but significant kingfish (Scomberomorus cavalla) line fishery during the winter and early spring months.

Table III. Species composition of St. Thomas-St. John catch from net fishing. Data is from V.I. Department of Conservation and Cultural Affairs port sampling of 36,245 lbs. of landed catch.

SPECIES	% OF TOTAL LBS.
Family Carangidae	
<u>Caranx ruber</u> - Carang	42
<u>C. fusus</u> - Hardnose	8
<u>Selar crumenophthalmus</u> - Jackfish	3
Family Scombridae	
<u>Euthynnus alletteratus</u> - Tuna	33
Family Lutjanidae	
<u>Ocyurus chrysurus</u> - Yellowtail	11
Family Belonidae	
<u>Tylosurus</u> sp.	3
TOTAL.....	100

Species Diversity

As an indication of the lack of selectivity by the Virgin Islands commercial fishery, we have compared the diversity of the catch of trap to non-fish components of the biotic assemblages (Table IV).

This analysis of species diversity (H) from the Virgin Islands summarizes species diversity calculations from a variety of studies (Olsen, 1979b) which include both fish and non-fish sampling efforts. The results are listed in Table IV. These data indicate that species diversity (H) on the St. Thomas shelf is very close to 3.000 nats in all cases except when there are obvious perturbations as in the data from Charlotte Amalie, re-poisoning of artificial reefs, and from a mangrove lagoon in St. Croix. (The St. Croix shelf is less than 25% of the size of the St. Thomas shelf and an expected decrease in species diversity may be represented in these data). Both the landed catch from the cooperative and the artificial reef data are very close to this figure. A reduction in the species diversity of the trap catch relative to other biotic components would be expected if fish trapping were to stress the community.

TABLE IV. Species Diversity of selected marine communities from the U.S. Virgin Islands

LOCATION-COMMUNITY TYPE	N	# SPECIES	H ¹	SD
<u>St. Thomas</u>				
Algal Plain ²	23	98	2.890	0.200
Sand and <i>Thalassia</i> ²	4	16	2.330	0.797
Coral Reef ²	19	90	3.111	0.321
Inner Charlotte Amalie ²	4	6	1.169	0.391
Jersey Bay ³	520	58	2.987	0.491
Artificial Reef Fish Traps ⁴	503	72	3.224	
Fishermen's Cooperative Survey ⁴	61	56	2.922	
Sand Dredging Traps ⁴	78	23	2.001	
<u>St. John</u>				
Ramshead Point (Poisoning) ⁵	1	76	3.406	
Beehive Point (Poisoning) ⁵	1	89	3.676	
Artificial Reef (Poisoning) ⁵	1	50	1.917	
Chocolate Hole (First Poisoning) ⁶	1	74	3.076	
Chocolate Hole (Second Poisoning) ⁶	1	19	2.319	
Chocolate Hole (Final Poisoning) ⁶	1	69	2.594	
Fish Traps Around the Shelf ⁶	49	49	3.113	
<u>St. Croix</u>				
Manning Bay ³	306	56	2.025	0.415

1. $H = -\sum p_i \ln(p_i)$ where p_i is the proportion of the i th species in the assemblage. Where a standard deviation is not shown, H was calculated for the entire assemblage, (Pielou, 1966)
2. Coulbourn et al., 1973.
3. Olsen, 1979b
4. Present Study
5. Randall, 1963
6. Danmann, 1969

Landed Catch

Estimates of landed catch are available from the 1917 census at the time that the United States purchased the Virgin Islands from Denmark, from a 1930 survey (Fiedler and Jarvis, 1932), from Dammann's (1969) survey, and from the required catch records submitted by fishermen since 1975 (Olsen, et al., 1975c; Sylvester, 1976; Sylvester, et al., 1977; Coleman, et al., 1979; and Mudre, 1979b, 1980). These latter records are subject to considerable under-reporting as discussed by the various authors.

In an attempt to obtain a more accurate estimate of actual landings from the years 1974 to 1979, we have reanalyzed the results. We have not undertaken a similar analysis for the shellfish landings due to the lack of accurate information on catch and effort from local fishermen or DCCA field data. Some recent survey information is presented to indicate the need for such revision.

The re-analysis of the DCCA catch reports (refer to any of the above listed references for a description of the program) which were submitted by St. Thomas-St. John fishermen is shown in Annex I.

The adjusted finfish landings have several sources of variability, including those previously mentioned, but also based upon the fact that not every fisherman uses fish traps. These sources tend to cancel each other out so that the adjusted figures are certainly a more accurate reflection of finfish landings than was previously available.

Roughly summarized, the fishery was slowly expanding in the period between 1917 and 1975. This expansion is evident from the increased number of fishermen as well as an increase in total fish landings from 350,000 lbs., in 1917 to between 1.24 and 1.84 million lbs. in 1975.

SEASONALITY

Seasonal trends in the St. Thomas fishery are not pronounced but can be seen. The reasons for this relative lack of seasonality lie in shifts within the components of the fishing effort and in the abundances and catchability of the species which make up the fishery.

Seasonality in the catch can be a product of several factors. Weather can restrict effort so that resources cannot be harvested. In the Virgin Islands, perhaps the best known aspect of seasonality pertains to the winter spawning aggregations of the serranids Epinephelus striatus, E. guttatus, and Mycteroperca venenosa, which begin to aggregate in specific areas during the lunar month preceding the winter solstice (Olsen, 1979b). This period normally coincides with a period of bad weather which restricts fishing activity. Since the groupers and hinds aggregate in very localized areas, the fishermen can operate as a fleet and reduce personal risk.

In Figure 2 we have plotted the total finfish catch and its components for the years 1974-1975 and 1977 through 1980. The DCCA Catch Data for the years 1975-1977 were not analyzed in a manner which permitted seasonal estimates by fishing method. In Figure 2d it is apparent that the total landings are lowest during the months between July and November. In December, landings start to rise and continue throughout the spring and early summer. This trend also appears in Figure (2c), where the trap landings are plotted throughout the annual cycle. This is in contrast to the data shown for fish traps which were set on an artificial reef north of St. Thomas (Figure 3). This figure indicates that there are winter and summer seasons in Catch per unit Effort (CPUE) shown here as number of fish caught per trap haul.

The seasonality of the resource can also be seen in Table V. where data is presented on several aspects of the fishery. This table shows the months where these species have been observed with ripe gonads (from Erdman, 1976; Munro, et al., 1973), months where juvenile fish have been observed in Virgin Islands mangrove lagoons (Olsen, 1979b) and the offshore algal plain (work in progress). The months where the catch from the artificial reef was above the average for the year (as tested by T-test with 11 degrees of freedom and $p < 0.2$) is also shown.

The results indicate a wide variety of reproductive and recruitment patterns. It appears that there are reproductive peaks in the period from February to March and that recruitment (to the mangroves and algal plain) occurs throughout the year with more species recruited from September to January.

The period from January to March is the period when most species from the artificial reef were being caught in significantly higher abundance. Every month except August was marked by at least one species being caught in increased abundance.

Table V Summary of seasonal aspects of the life history of fishes from the Virgin Islands Commercial Fishery. Underlined months show the period in which ripe gonads have been observed (Erdman, 1976; Munro et al., 1973) while the months with J are months in which juvenile recruitment has been observed (Olsen, 1979b and C indicates months in which the catch at an artificial reef was significantly above the average for the year.

	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
Order Beryciformes												
Family Holocentridae - Squirrelfishes												
<u>Holocentrus ascensionis</u> - Squirrelfish											C	C
<u>Adiorys coruscus</u> - Reef squirrelfish												
<u>H. rufus</u> - Longspine squirrelfish							C					
Order Perciformes												
Family Serranidae - Sea Basses												
<u>Cephalopholis fulva</u> - Coney												
<u>Epinephelus adscensionis</u> - Rock hind												
<u>E. guttatus</u> - Red Hind								C				
<u>E. striatus</u> - Nassau grouper												
<u>Mycteroperca venenosa</u> - Yellowfin grouper												
<u>Petrometopon orientatum</u> - Graysby												
Family Carangidae - Jacks and pompanos												
<u>Caranx latus</u> - Horse-eye jack				J						J	J	J
<u>C. ruber</u> - Bar jack	C											
Family Lutjanidae - snappers												
<u>Lutjanus analis</u> - Mutton snapper												
<u>L. apodus</u> - Schoolmaster	CJ	J		J				J	J	J	J	J
<u>L. synagris</u> - Lane snapper	J				J	J		J				
<u>Ocyurus chrysurys</u> - Yellowtail snapper							J				CJ	
<u>Pristipomoides aquilonaris</u> - Silk, wenchman												

	M O N T H											
	J	F	M	A	M	J	J	A	S	O	N	D
Family Pomadasysidae - grunts												
<u>Anisotremus surinamensis</u> - Black margate												
<u>A. virginicus</u> - Porkfish												
<u>Haemulon aurolineatum</u> - Tomatate	J								J		J	J
<u>H. flavolineatum</u> - French grunt		C										
<u>H. melanurum</u> - Cottonwick		C										
<u>H. plumieri</u> - White grunt												
<u>H. sciurus</u> - Bluestriped	J							C			J	J
Family Sparidae - porgies												
<u>Calamus calamus</u> Saucereye porgy												
<u>C. penna</u> - Sheepshead porgy												
<u>C. pennatula</u> - Pluma												
Family Mulligidae - Goatfishes												
<u>Mulloidichthys martinicus</u> - Yellow goatfish												
<u>Pseudupeneus maculatus</u> - Spotted goatfish	J							J			C	
Family Chaetodontidae - Butterflyfishes												
<u>Chaetodon capistratus</u> - Foureye butterflyfish												
<u>Colacanthus bermudensis</u> - Blue angelfish												
<u>H. ciliaris</u> - Queen angelfish												
<u>H. tricolor</u> - Rock beauty												
<u>Pomacanthus arcuatus</u> - Gray angelfish												
Family Scaridae - parrotfishes												
<u>Scarus coelestinus</u> - Midnight parrot												
<u>S. coicensis</u> - Striped parrotfish												
<u>S. taeniopterus</u> - Princess parrotfish												
<u>Sparisoma surofrenatum</u> - Redband parrotfish												
<u>S. chrysotermum</u> - Redtail parrotfish	J	J		J	J	J	J				J	J
<u>S. radians</u> - Bucktooth parrotfish	J								J			J
<u>S. rubripinne</u> - Redfin parrotfish												J
<u>S. viride</u> - Spotlight parrotfish									J	J		J

J F M A M J J A S O N D

Family Sphyraenidae - barracudas

Sphyraena barracuda - Great barracuda

Family Acanthuridae - Surgeonfishes

Acanthurus bahianus - Ocean surgeon

A. chirurgus - Doctorfish

A. coeruleus - Blue tang

_____ J
C _____ J CJ J

Order Teraodontiformes

Family Balistidae - Triggerfishes and filefish

Balistes vetula - Queen triggerfish

Family Ostraciidae - Boxfishes

Lactophrys bicaudalis - Spotted trunkfish

L. triqueter - Smooth trunkfish

Acanthostracion polygonia - Honeycomb cowfish

A. quadricornis - Scrawled cowfish

C C C C
C C C

-25-

Total No. of Species with Ripe Gonads (37)	14	32	30	31	30	19	16	14	11	11	11	11
Total No. of Species with Catch Peaks (C)	4	6	4	2	1	1	2	0	3	1	3	1
Total No. of Species with Juvenile Recruitment (J) 7	3	3	3	4	3	3	3	1	6	3	6	8

FIGURE 2. Seasonal trends in total finfish catch (D) trap (C) hook and line catch (B) and net catch (A). The results are shown for the reporting years 1974-75, 1977-78 and 1978-79 and are given as the percent of total finfish poundage landed by that method in that month.

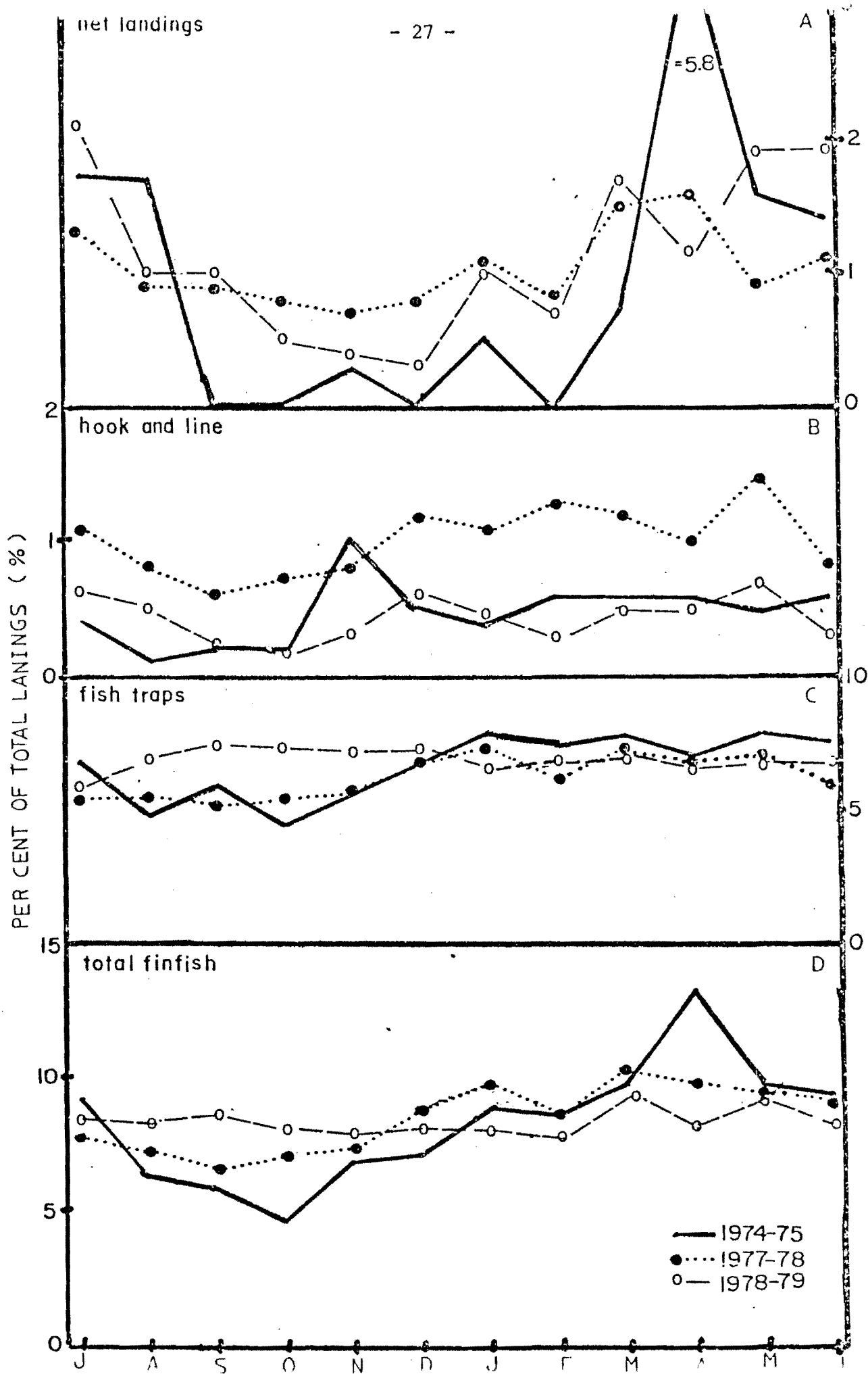
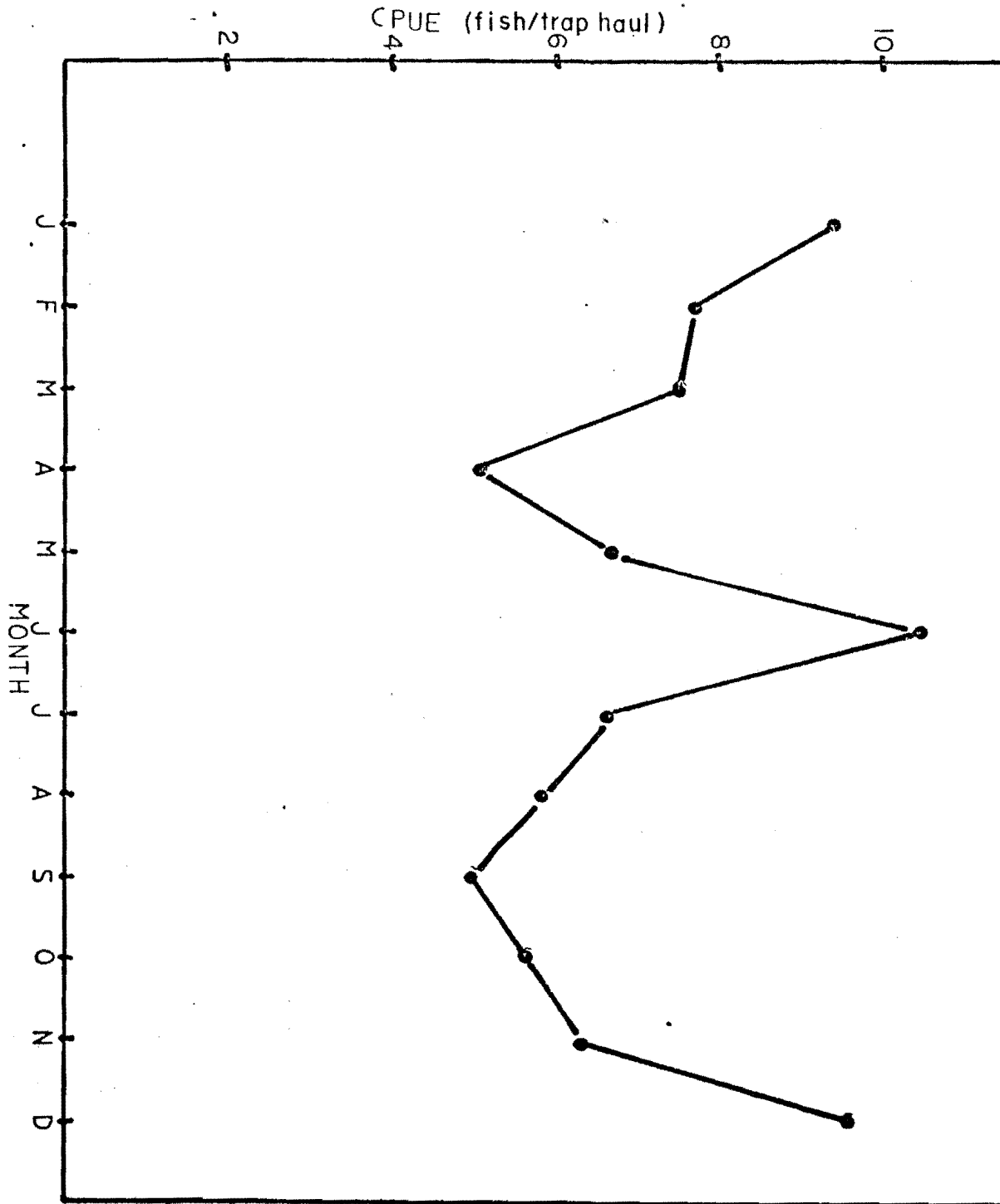


FIGURE 3. Catch per unit effort (fish per trap haul) from 503 trap hauls on an artificial reef north of St. Thomas (Figure 1).



These results, taken together, indicate a complex fishery resource with seasonal phenomena which differ from species to species. As a result, annual catch trends are not pronounced.

AREAL DISTRIBUTION OF THE CATCH

Information on the areal distribution of the catch comes from the DCCA catch reports. These results are summarized in Tables VI and VII.

In Table VI we have presented the distribution of the fish and lobster landings by catch reporting area. These areas are shown in Figure 4. The results of the analysis of the mandatory reporting program indicate that area T-1 is an extremely important area for the fishery as nearly half of the finfish landings and over one third of the lobster landings come from this area. The remaining areas of the St. Thomas-St. John shelf are relatively uniform in terms of production of fish and lobster.

In Table VII we have shown the distribution of landings by method and by catch reporting area. The results indicate that the different areas are the foci for different fishing activities. The trap fishery takes place predominantly in area T-1 and to a lesser extent in T-2. The hook and line fishery is most active in area T-2 and to a lesser extent in Areas T-1, T-4, and B-3 (in British Virgin Islands waters). Nearly three quarters of the net fish landings come from the north side of St. Thomas in area T-4. Lobster trapping takes place predominantly on the offshore shelf area of T-4 and to a lesser extent in T-1, T-2, and T-5. Diving for lobster is a fishery which takes place primarily in areas T-1, T-2, and T-3.

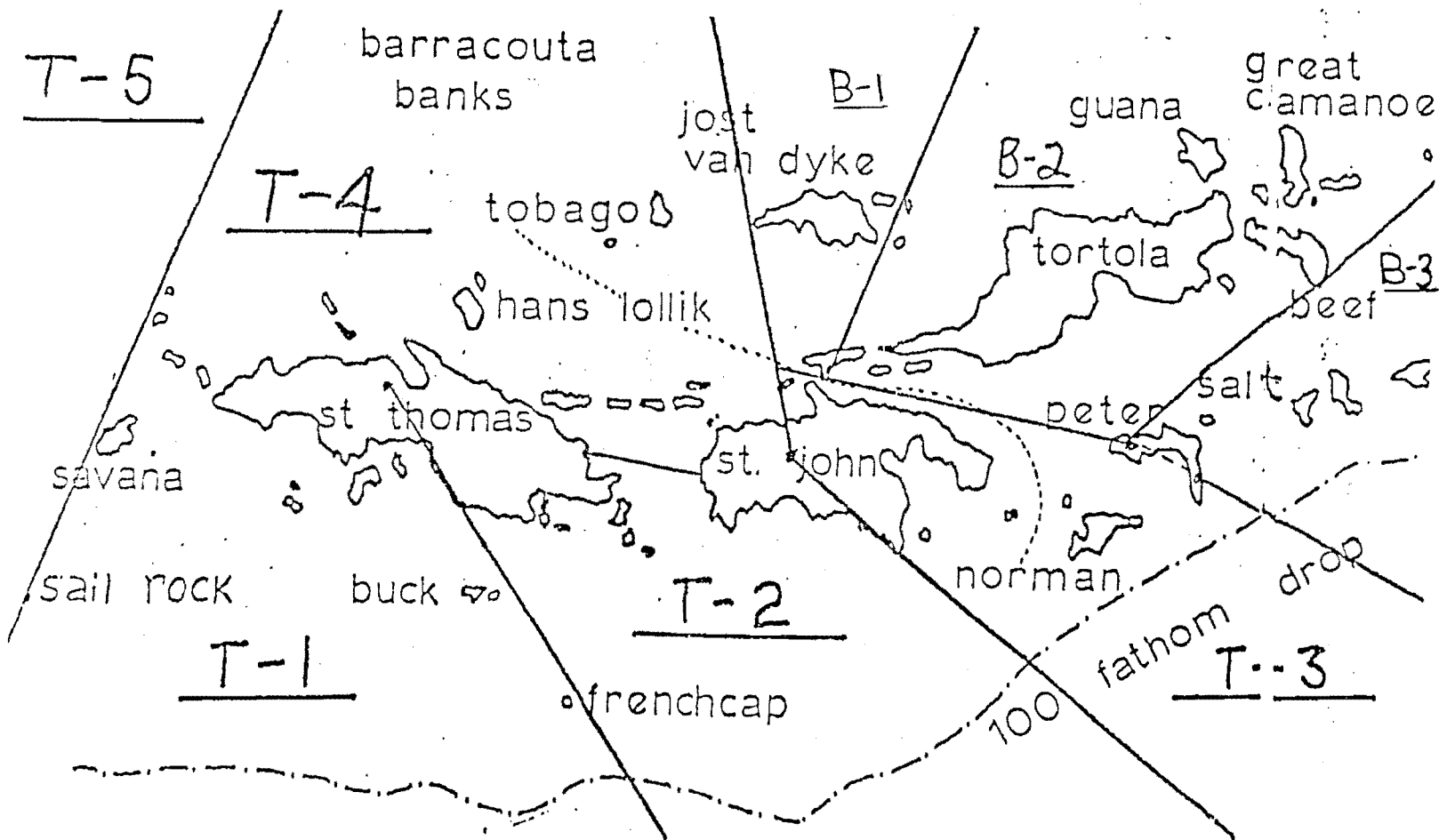
TABLE VI. Total Reported St. Thomas-St. John Commercial Fish and Lobster Landings from 1974 to 1979.
 Figures are given in percent (Standard Deviation)

<u>AREA</u>	<u>% of FISHERMEN</u>	<u>% of FISH</u>	<u>% of LOBSTER</u>
T-1	30.4	49.6 (5.1)	36.4 (10.3)
T-2	20.8	19.6 (2.5)	14.7 (10.1)
T-3	11.1	4.3 (2.8)	15.5 (10.6)
T-4	24.0	16.6 (6.9)	24.2 (9.1)
T-5	2.6	4.7 (3.3)	7.1 (7.1)
B-1	3.7	1.4 (2.4)	0 (0)
B-2	5.8	1.7 (2.3)	0.9 (.7)
B-3	1.6	2.1 (2.1)	1.2 (2.8)
TOTAL	100.0	100.0	100.0

TABLE VII. Distribution of St. Thomas and St. John reported fishing effort by fishing method and catch reporting area. Figures are given as the percent of the total for that method and are the average for reporting years 1977-78 and 1978-79.

Area	Traps	Hook Line	Net	Lobster Traps	Lobster Diving
T-1	59.0	14.8	14.5	10.2	39.3
T-2	17.2	37.3	5.8	11.9	23.1
T-3	5.3	7.4	0	3.4	31.0
T-4	9.5	14.1	78.6	54.3	1.6
T-5	3.7	1.3	0.7	17.2	1.4
B-1	0.1	0.3	0.4	0	0
B-2	2.8	9.4	0	0	3.0
B-3	2.4	15.4	0	3.0	0.6
	100.0	100.0	100.0	100.0	100.0

FIGURE 4. Catch Reporting areas for Virgin Islands mandatory catch Reporting System.



Some of the fishing methods like diving and trapping lobsters and reef fish require specific types of bottom habitat for the target species. Net fishing is primarily practiced by fishermen of French extraction who live on the northside of St. Thomas surrounded by Area T-4. The south shelf is known to produce a greater frequency of ciguateric fish poisoning, a fact which results in some reduction in effort in those areas. Much of the recreational fishery is practiced in those areas which are convenient to the major facilities for boat storage and where the waters are somewhat sheltered by nearby islands.

The results of this analysis provide a picture of a fishery which is determined by the shelf geology, weather related environmental features, and by the cultural characteristics of the fishing communities exploiting the resource.

Recreational Fishery

The recreational fishery in the Virgin Islands has been developed as an offshoot of the commercial fishery until recent times. The only published information on this subject is a report by Olsen (1979a). Much of the activity reported by respondents in this survey was more oriented to boating and sailing than actual fishing. The recreational resource users employ a variety of techniques which are shown in Table VIII. Use of the fishery resources is summarized in Table IX. The results of Olsen's survey have been used to estimate recreational landings in reporting area T-1 (Figure 4) which includes the Southwest Roads area.

The recreational fishery exhibits little seasonality. Olsen (1979a) reports that St. Thomas recreational fishermen spent 6.5 days per month during the summer months and 7.0 days during the winter months. The general trend for the Virgin Islands was 7.0 days per month in summer and 7.1 days during winter months. One would expect that recreational fish landings also do not exhibit much seasonality.

TABLE VIII. Types of Virgin Islands Recreational Boating and Fishing activity. Table values indicate percent of the total number of days reported in a survey by Olsen (1979a).

	<u>St. Thomas</u>	<u>All V.I.</u>
Business related recreation	9.3	4.8
Water surface contact sports	8.7	8.7
Cruising	22.1	14.6
Snorkeling/skindiving	13.5	11.7
SCUBA diving	9.9	9.2
Chartering (Captained)	4.5	6.0
Bare-boating Chartering	1.9	5.1
Commuting	5.1	5.7
Linefishing (Recreational)	9.3	10.0
Spear fishing	4.5	6.5
Commercial fishing	3.2	5.7
Other	8.0	12.0
Total Days Reported	312	98.4

RECREATIONAL ACTIVITIES AND LANDINGS IN THE VIRGIN ISLANDS

TABLE IX. Estimated Recreational Use of Southwest Roads, St. Thomas, U.S.V.I.
(from Olsen, 1979a).

Method	% of Respondent	CPUE (lbs.) /Day	Days /Month	Effort Person Days/Yr	Total Catch (lbs.)
Trolling	18.3	9.3	3	969	9011
Bottom Fishig	4.9	11.3	4.9	478	5402
Spear Fishing	12.7	10.5	4.4	992	10,434
Lobster Diving	17.3	7.6	2.6	799	6,068
Conch	7.3	5.6	1.4	181	1,013
Whelks	7.3	6.9	1.4	181	1,251
Snorkeling	23.6		8.0	3352	
UW Photos	6.4		9.3	1057	
Other	2.3			380	
TOTAL				8389	33,179

The species which constitute the recreational catch are shown in Table X. The results indicate greater utilization of pelagic species resulting from the emphasis on trolling by recreational fishermen. Virgin Islands spear fishermen also emphasize pelagic species to a greater extent than anticipated. This table also provides an estimate of the harvest by recreational fishermen in the Southwest Roads area.

The Fishery Within Southwest Roads

The exact economic role of the Southwest Roads area cannot be provided. Most of the available data are from the DCCA catch reports or Olsen's (1979a) survey in which the unit of summary is for DCCA catch reporting areas. As can be seen in Figure 4, the Southwest Roads is a relatively small portion of this larger area.

In order to provide more precise information on the Southwest Roads area, a direct survey of 36 out of the 48 fishermen who fish in area T-1 was undertaken. The survey form is shown in Annex IV.

The survey was originally designed to provide information on the area of probable immediate impact and an area of secondary impact from the proposed sand dredging. Analysis of the data indicated that the fishermen failed to make that distinction, so the results were merged.

The results shown in Table XI indicate the levels of catch and effort in the Southwest Roads area. The respondents indicated that they have an average of 12.8 (SD=9.7) fish traps in the area and catch 66.3 lbs. of fish and 6.7 lbs. of lobster per day. Average CPUE is 5.2 lbs. of fish and 0.5 lbs. of lobster per trap set. These results suggest that there are approximately 18 fishermen who utilize Southwest Roads for trap fishing with an estimated 233 total traps.

Lobster diving around the cays and offshore reefs were employed by 12 fishermen who caught 39 lbs. per day. Hook and line fishing was the next major method employed (11 fishermen caught 59 lbs/day).

Table: X Species Composition of Virgin Islands Recreational Catch.
Values are listed as % of respondent's efforts (from Olsen, 1979a) which were used to estimate catch in Area T-1.

Estimated landings for AREA T-1 were calculated for Olsen (1979) by assuming that the fishery in the area harvested the same species as surveyed and that 7.4% of the effort was employed in SW Roads & the surrounding water of T-1.

Species	% of Effort	Area T-1 Estimated Landings (lbs.)
<u>FAMILY</u>		
Coryphaenidae		
<u>Coryphaena hippurus</u>		
Dolphin	6.9	2289
Belonidae		
<u>Tylosurus crocodilus</u>		
Houndfish	.3	100
Holocentridae		
<u>Holocentrus sp.</u>		
Squirrelfish	1.0	332
Sphyraenidae		
<u>Sphyraena barracuda</u>		
Great Barracuda	8.6	2853
Serranidae		
<u>Epinephelus sp., Mycteroperca sp.</u>		
Grouper	8.6	2853
<u>Epinephelus guttatus</u>		
Red hind	3.3	1094
<u>Cephalopholis fulva</u>		
Butterfish	0.6	179
Priacanthidae		
<u>Priacanthus sp.</u>		
Bigeye	0.3	100
Carangide		
<u>Caranx ruber</u>		
Carang	0.3	100
<u>Caranx sp.</u>		
Jacks	1.0	332
<u>C. fuscus</u>		
Blue runner	0.3	100
<u>Trachinotus goodei</u>		
Palcmeto	0.6	199
<u>T. falcatus</u>		
Permit	0.3	100

Scombridae

<u>Scomberomorus sp.</u>		
Mackerels	9.4	3118
<u>S. cavalla</u>		
Kingfish	8.2	2720
<u>Acanthocybium solandri</u>		
Wahoo	3.0	995
<u>Euthynnus alletteratus</u>		
Bonito	4.9	1625
<u>Euthynnus sp., Thynnus sp.</u>		
Tuna	1.5	500

Lutjanidae

<u>Lutjanus sp.</u>		
Snapper	12.2	4048
<u>Ocyurus chrysurus</u>		
Yellowtail	4.9	1626
<u>Rhomboplites aurorubens</u>		
Silk	0.3	100

Pomadasydae

<u>Haemulon sp.</u>		
Grunts	2.3	763
<u>H. album</u>		
Margate	0.3	100

Sparidae

<u>Calamus sp.</u>		
Porgy	0.6	199

Bothidae

<u>Bothus sp.</u>		
Flounder	0.3	100

Chaetodontidae

<u>Pomacanthus sp., Holacanthus sp.</u>		
Flatfish	0.6	199

Balistidae

<u>Balistes vetula</u>		
Oldwife	4.9	1626

Crustacea

<u>Panulirus argus</u>		
Lobster	2.0	663

Mollusca

<u>Cittarium pica</u>		
Whelks	1.3	431
<u>Strombus gigas</u>		
Conch	1.3	431

Other Finfish

6.6 2189

Unrecognizable response

3.3 1094

TOTAL

100.0 33,158

TABLE XI. Commercial Catch and Effort from the waters of Southwest Roads, St. Thomas. Data were derived from a survey of the fishermen who use the area. A number of the respondents reported utilizing more than one fishing method, therefore, the total % in sample is more than 100%.

Fishing Method	% in Sample*	Predicted # of Fishermen*	Days/yr.	Catch/Day (lbs.)	Total (lbs.)
Fish Traps	38.7	18.7	113.4	66.3	140,594
Lobster Traps	12.9	6.2	113.4	6.7	4,711
Lobster Diving	22.5	10.9	183.6	38.8	77,648
Conch Diving	12.9	6.2	12.8	67.5	5,357
Hook and Line	19.3	9.3	121.0	59.4	66,843
Net fishing	3.2	1.5	30.0	264.0	11,880
TOTAL Finfish	219,317				
TOTAL Lobster	82,359				
TOTAL Conch	5,357				

*Predicted number and percent of fishermen add to more than 100% and 48 fishermen because some fishermen utilize more than one fishing method.

The results of this survey, when compared to the DCCA catch reports, indicate that 27.6% of the finfish landed from area T-1 come from the Southwest Roads. The lobster landings (Table XI) derived from the survey are approximately 185% of that reported in the DCCA catch reports for the entire area of T-1.

The subarea of Southwest Roads that has been proposed as a potential site for sand dredging is apparently not as productive as other areas of Southwest Roads for fish trapping. The 78 traps hauled by the project fisherman caught only 5.49 lbs. per set ($SD=3.97$) while his traps hauled in the control area southwest of the dredging site caught 9.20 lbs/set ($SD=5.90$). This difference was significant at the 0.001 level when tested by Student's t ($t_s=5.43$, $df=711$). The traps from both areas were identical in design, baiting and length of set.

Recreational Use Of Southwest Roads

Use of the Southwest Roads area by recreational boaters and fishermen is difficult to assess because the major portion of recreational boating takes place to the east of Charlotte Amalie (Olsen, 1979a). Another factor contributing to this difficulty is that many Virgin Islands "recreational" fishermen sell their "surplus" catch and utilize methods similar to commercial fishing.

The only extant data based comes from a survey undertaken by Olsen (1979a) for the National Marine Fishery Service. This survey reported that 7.4% of all recreational boating is spent in reporting area T-1 which includes the Southwest Roads area. This would indicate that approximately 30 boats utilize this area, with an average of 31 trips per year.

Olsen (1979a) estimated that each boat owner spends approximately \$3,072 annually to keep and maintain a boat. He also spends nearly \$53 for daily trip expenses. These figures indicate that a total of \$92,000 is spent annually to maintain the boats which utilize reporting area T-1, and nearly \$129,000 is spent on daily expenses associated with the activities of these boats. Total expenditure for recreational boating in area T-1 is approximately \$220,000.

Olsen (1979a) estimated that the economic impact multiplier for the recreational fishery sector was between 1.43 and 1.52. This would increase the total value of recreational expenditures in reporting area T-1 to be between \$312,000 and \$334,000 annually, exclusive of the value of the fish landings by recreational fishermen.

The recreational landings estimated by Olsen (1979a) for area T-1 are approximately 33,000 lbs. (Table IX). Much of the recreational fishing activities in this area take place around the cays adjacent to the Southwest Roads, but it is not possible to quantify this at present.

SUMMARY AND CONCLUSIONS

Due to the diverse nature of Virgin Islands fisheries, local fishermen have always had to exhibit flexibility in fishing techniques. The more primitive small boat fishery is rapidly beginning to be replaced by larger and faster vessels capable of harvesting greater quantities of fish and lobster to meet the ever-increasing demand for seafood. Adaptation has become a necessary reality.

The West Indian fish trap is still the most common method used to harvest finfish and lobster and accounts for more than 80% of the total landings. Handline techniques are used to exploit both benthic and pelagic fishery resources and account for approximately 5% of the total finfish catch. Other traditional fishery methods include net fishing, trolling and diving for lobster.

Seasonality is not as important in tropical fisheries as in temperate waters. The trap fishery exhibits very little seasonality, although an analysis of abundances of the component species indicates that there are seasonal peaks in catch. Both the handline and net fisheries, which depend on fewer species and on local weather conditions, exhibit greater seasonality. Generally, low catch periods are from September through March for these fisheries.

Fishery landings from St. Thomas-St. John are estimated to be over 1.5 million pounds annually--critically close to the maximum sustainable yield for the shelf area. Catch reporting area T-1 (the southwestern portion of the St. Thomas shelf) is the major area of production, accounting for 50% of the finfish and 36% of the total lobster landings.

Data from the 1980 survey suggest that the Southwest Roads area may make a significant contribution to the lobster catch since the 82,359 pounds reported is greatly in excess of the 44,000 pounds of lobster reported in the DCCA catch reports for the entire area T-1.

Our survey data indicate that approximately 233 traps/day are set in Southwest Roads.

The commercial and recreational fisheries contribute directly and indirectly (through recycling of expenditure) to the Virgin Islands economy. The direct contribution of the commercial and recreational fishery originating from the waters of Southwest Roads is substantial, possibly amounting to more than \$1 million. The recreational catch from this area is relatively small, but the indirect contribution from the multiplier effect of recreational expenditures may be substantial.

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ANNEX I

ANNEX I

REANALYSIS OF DCCA CATCH RECORDS

Estimates of landed catch are available from the 1917 census at the time that the United States purchased the Virgin Islands from Denmark; from a 1930 survey (Fiedler and Jarvis, 1932); from Dammann's (1969) survey; and from the required catch records submitted by fishermen since 1975 (Olsen, et al., 1975c; Sylvester, 1976; Sylvester, et al., 1977; Coleman, et al., 1979; and Mudre, 1979 a and b, 1980). These latter records are subject to considerable under-reporting as discussed by the various authors.

In an attempt to obtain a more accurate estimate of actual landings from the years 1974 to 1979, we have undertaken the following analysis to obtain a range of adjusted landings for the finfish landings. We have not undertaken a similar analysis for the shellfish landings due to the lack of precise information on catch and effort from local fishermen or DCCA field data.

The re-analysis of the DCCA catch reports (refer to any of the above listed references for a description of the program) which were submitted by St. Thomas-St. John fishermen is as follows:

1. Number of Fishermen. We reviewed the receipts for fishing licenses for each fishing year and compiled a list of all fishermen. Substantial discrepancies were found for the fishing years 1975-1976 and 1976-77. The actual numbers are recorded in Table I.
2. Numbers of Traps per Fisherman. Port sampling and information provided on the DCCA forms indicated that the number of traps per fisherman increased from 16.7 to 25.3 over the course of the reporting period. This was supported by the trap compensation claims submitted after Hurricanes David and Frederick in 1979.
3. Numbers of Days fished. Due to the large number of part-time fishermen, the average number of days per fisherman was reported at 5 per month. Williams (1974) reported that full time fishermen fish around 8.4 days per month so that current estimates may represent as much as a 40% under-estimate of landings by using 5 days per month.

4. Catch per Trap per Day. Using the information summarized in (1) through (3) we calculated the number of trap days of effort. This figure was then divided into trap fish landings from the reporting period to get the catch (in lbs. per day) figure shown in footnote 3 of Table 1.
5. Conversion of Landings. The catch per trap figure was then used to convert the landings by dividing it into 5 lbs. per haul and 7 lbs. per haul to obtain the conversion constants shown in Table I as Low and High Multipliers. These figures were chosen because there is abundant evidence (DCCA, 1975) to indicate that actual catch per trap is in this range. Records from a fisherman contracted for this study indicated that his CPUE was over 9 lbs. per haul. (See Table II of this annex).
6. Conversion of Hook and Line and Net Landings. Conversion coefficients were calculated which ranged between low estimates equal to actually reported to DCCA and high estimates based on Mudre (1979a) port sampling figures for average catch per day using these techniques.

The results of this analysis are shown in Table I. The adjusted finfish landings have several sources of variability including those previously mentioned but also based upon the fact that not every fisherman uses fish traps. These sources tend to cancel each other out so that the adjusted figures are certainly a more accurate reflection of finfish landings than was previously available.

ANNEX

TABLE: I. Adjustment of St. Thomas-St. John DCCA Catch Report Data for 1974 to 1979 for under reporting and for documented number of fishermen.

Trap Fishing Landings (lbs.)

Year	# Fishermen	Projected Landings	Low Mult. (3)	High Mult. (3)	Low Estimate	High Estimate
74-75	211	704,800	1.52	2.12	1,071,296	1,494,176
75-76	165	365,508	2.27	3.18	829,703	1,162,315
76-77	172	548,836	1.61	2.26	883,625	1,240,369
77-78	162	468,836	2.59	3.63	1,214,526	1,702,212
78-79	161	628,611	1.92	2.69	1,206,933	1,690,963

Hook & Line Landings (lbs.)

74-75	51,098	1.0	1.69	51,098	86,355
75-76	34,722	1.0	1.69	34,723	58,681
76-77	52,139	1.0	1.69	52,139	88,114
77-78	76,783	1.0	1.69	76,783	129,763
78-79	37,529	1.0	1.69	37,529	63,424

Net Fish Landings (lbs.)

74-75	120,697	1.0	2.13	120,697	257,084
75-76	59,851	1.0	2.13	59,851	127,482
76-77	89,871	1.0	2.13	89,871	191,425
77-78	78,687	1.0	2.13	78,687	167,603
78-79	103,204	1.0	2.13	103,204	219,824

Cont'd.....

Combined Finfish Landings (lbs.)

74-75	1,243,091	1,837,612
75-76	924,277	1,384,478
76-77	1,025,635	1,519,908
77-78	1,369,996	1,999,570
78-79	1,347,666	1,974,214

FOOTNOTES

Method for Calculation of adjusted figures.....

1. Reported catch for TRAPS ÷ # Fishermen ÷ # Days/yr^a ÷
Traps/fisherman^b = Catch/Trap/Day
a = 5 days/month
b = 16.7 traps/fisherman (1974-1977), 25.3 TRAPS (1977-1979)

2. Conversion Constant = Known catch/trap^a/(1)
a = 5 to 7 lbs./Day from catch
records of DCCA and records from commercial fishermen

3. Year	Reported Catch/Trap	Low Multiplier (5 lbs./Trap)	High Multiplier (7 lbs./Trap)
74-75	3.3	1.5	2.1
75-76	2.2	2.3	3.2
76-77	3.1	1.6	2.3
77-78	1.9	2.6	3.6
78-79	2.6	1.9	2.7

4. Fishermen who received compensation for lost traps following Hurricanes David & Frederick. These were the "bigger" offshore fishermen. The Median claimed, however, before the storm was 28 traps and Modal number was 25.

An additional indication that the DCCA catch records contain substantial under reporting can be found in the actual field data on trap CPUE from the present survey of Southwest Roads, a nearby fishing area, the artificial reef fish traps, and a figure from Mudre (1979a) shown in Table II.

ANNEX

Table II. Catch per Unit of Effort (lbs./trap haul) for fish traps from St. Thomas, U.S.V.I.

AREA	N	CPUE (lbs./set)	SD
North Shelf ¹	--	7.39	---
Artificial Reef ²	107	5.43	4.50
Sand Dredging Site ²	78	5.49	3.97
South Shelf ²	635	9.20	5.90

1. Mudre (1979a)
2. Present Study

The artificial reef and sand dredging sites did not differ significantly ($t_s=0.09$, $df=183$, $p=n.s.$) while the South Shelf and Sand Dredging traps did ($t_s=5.43$, $df=711$, $p 0.001$). There is some indication that some of these difference may be attributable to differences in trap baiting but the point remains that the CPUE reported in the DCCA catch reporting system is certainly less than the actual figure.

ANNEX II. Summary of catch surveys from St. Thomas/St. John fishermen's Cooperative December, 1979 to June 1980. Figures are given as percent of total poundage for the month.

	D	J	F	M	A	M	AVERAGE
Class Osteichthyes							
<u>Tylosurus crocodilus</u> - Gar		0.27	5.83	0.24	0	0.45	1.13
Family Holocentridae - Squirrelfishes	11.69	4.71	3.79	1.51	5.09	2.24	4.84
Family Serranidae - Sea Basses							
<u>Epinephelus morio</u> - grouper	0	0	0	0	0	5.01	0.84
<u>Cophalopolis fulva</u> - Coney	6.40	1.25	0.91	1.90	2.01	1.72	2.37
<u>Epeniphelus adensionis</u> - Rock Hind	0	0.29	1.94	4.49	2.15	5.01	2.31
<u>E. guttatus</u> - Red Hind	18.54	14.55	6.69	4.16	6.50	1.79	8.71
<u>E. striatus</u> - Nassau grouper	5.08	6.05	0.42	0.24	0.42	1.31	2.25
<u>Mycteroperca venenosa</u> - Yellowfin grouper	0	0.21	0.49	1.86	0	0.89	0.58
<u>Grouper sp.</u>	0	0	0	3.62	0	0	0.60
Family Carangidae - Jacks and Ramponos							
<u>Caranx fusus</u> - Blue runner or hardnose	0	0	0	1.57	0	0.64	0.37
<u>C. ruber</u> - Bar Jack	0	0	0	4.52	0	0	0.75
Family Scombridae - Tunas and mackerals							
<u>Scomberomorus cavalla</u> - Kingfish	0	0	0	1.78	0	12.26	2.34
<u>Euthynnus alletteratus</u> - Bonito	0	0	0	20.55	0	12.26	3.43
Family Lutjanidae - Snappers	0.44	0	0	0	0	0	0.07
<u>Apsilus dentatus</u> - Black silk snapper	0	0	0	0		0.75	0.13
<u>Lutjanus analis</u> - Mutton snapper	0	0	0.69	0	0	1.01	0.28
<u>L. apodus</u> - Schoolmaster	0	0	0.08	0	0	0.09	0.03
<u>L. synagris</u> - Lane snapper	3.97	10.45	0.64	0.06	0.59	1.63	2.89
<u>Ocyurus chrysurus</u> - Yellowtail snapper	1.32	0.78	1.47	2.24	1.26	4.45	1.92
<u>Pristipamoides aquilonaris</u> - Silk	0	0	0	0	0	0.97	0.16
<u>Lutjanus griseus</u> - Grey snapper	3.09	0	0.32	0	0	1.12	0.76
<u>L. jocu</u> - Dog Snapper	0	0	0	2.23	0.04	0.45	0.45
<u>L. buccanella</u> - Blackfin snapper	0	1.77	2.84	0.03	0.21	0	0.81

	D	J	F	M	A	M	AVERAGE
Family Pomadasyidae - Grunts	2.32	2.53	10.40	3.71	10.70	0	6.61
<u>Haemulon album</u> - Margate	0	4.81	0.27	0	0.63	0.64	1.06
<u>H. flavolineatum</u> - French grunt	0	0	0	0	0	0.41	.07
<u>H. melanurum</u> - Cottonwick	0	0	0	0	0	0.24	.04
<u>H. plumieri</u> - White grunt	0	0	0	0	0	2.07	0.35
<u>H. sciurus</u> - Bluestriped	0	0	0	0	0	0.30	.05
<u>H. macrostoma</u> - Spanish grunt	0	0	0	0	0	0.97	0.16
Family Sparidae -porgies	3.42	2.65	5.07	2.71	4.72	2.32	3.48
<u>Calanus calanus</u> - Saucereye porgy	0	0	0	0	0	0.89	0.15
Family Mullidae - Goatfishes	0	1.23	0.67	0.54	2.34	0	0.80
<u>Mulloidichthys martinicus</u> - Yellow goatfish	0	0	0	0	0	0.30	0.05
<u>Pseudupeneus maculatus</u> - Spotted goatfish	0	0	0	0	0	0.82	0.14
Family Chaetodontidae - Butterflyfishes							
<u>Chaetodon capistratus</u> - Foureye butterflyfish							
<u>Holacanthus bermudensis</u> - Blue angelfish	0	0	0	0.42	0	0	0.07
<u>H. ciliaris</u> - Queen angelfish		0.3	0.46	0.32	0.11	0	0.20
<u>H. tricolor</u> - Rock beauty	0	0	0.08	0.33	0.45	0.34	0.20
<u>Pomacanthus arcuatus</u> - Gray angelfish	0.66	0.14	0.29	0	0.47	1.59	0.53
Family Labridae - Wrasses							
<u>Bodianus rufus</u> - Spanish hogfish	0	0	0	0	0.19	0.52	0.12
<u>Lachnolaimus maculatus</u> - Hogfish	1.54	0.66	0.53	0.27	0	3.36	1.06
Family Scaridae - Parrotfishes							
<u>Scarus coeruleus</u> - Striped parrotfish	0	4.40	4.79	0.60	1.19	0.07	1.84
<u>Scarus soelestinus</u> - Midnight parrot	0	0	0.48	0	0.24	0	0.12
<u>S. taeniopterus</u> - Princess parrotfish	0	0	0.22	0	0.34	0	0.09
<u>Sparisoma aurofrenatum</u> - Redband parrotfish	0	0	0	0	0.07	1.05	0.19
<u>S. chrysoternum</u> - Redtail parrotfish	1.32	2.59	1.35	0.12	3.08	0.36	1.47
<u>S. viride</u> - Stoplight parrotfish	6.62	1.28	5.13	3.62	5.17	2.09	3.99
<u>Scarus vetula</u> - Queen parrotfish	0	0.41	0.19	0	0	0	0.19

	D	J	F	M	A	M	Average
Family Acanthuridae - Surgeonfishes							
<u>Acanthurus bahianus</u> - Ocean surgeon	0	0	0	0.72	0	0	0.12
<u>A. chirurgus</u> - Doctorfish	4.19	4.07	4.02	0.56	4.89	4.67	3.73
<u>A. coeruleus</u> - Blue tang	0	0	0.09	0	0	0	0.02
Family Balistidae - Triggerfishes							
<u>Balistes vetula</u> - Queen triggerfish	25.83	22.90	32.58	22.09	40.94	26.76	29.68
Family Ostraciidae - Boxfishes							
<u>Lactophrys bicaudalis</u> - Spotted trunkfish	0	0	0.45	0	0	0	0.08
<u>L. triqueter</u> - Smooth trunkfish	0	0	0.29	0	0	0.95	0.21
<u>Acanthostracion polygonia</u> - Honeycomb cowfish	0	0	0	0	0	0.97	0.16
<u>A. quadricornis</u> - Scrawled cowfish	0	0.16	0.38	0	0.42	0.64	0.27
Crustacea							
<u>Panulirus argus</u> - Spiny lobster	1.32	0.66	1.12	1.45	3.36	0.22	1.36
TOTAL (lbs.)	453	1215	1559	1659	1430	1338	7654
Catches	4	8	10	9	9	16	56
Average weight/catch (lbs.)	113	152	156	118	159	85	126

Annex III. Summary of fish catch from West Indian fish traps set in an area of proposed sand dredging from December 1979 to June 1980. Data are given as the percent of the total for the species.

SPECIES	MONTH						AVERAGE
	D	J	F	M	A	M	
Family Dasyatidae - Stingrays							
<u>Dasyatis americana</u> - Southern stingray	0	0	2.0	0	0	1.7	0.63
Family Holocentridae - Squirrelfishes	1.5	0	0	0	0	0	0.25
Family Serranidae - Groupers							
<u>Cephalopholis fulva</u> - Coney	1.3	0	0	0	0	0	0.22
<u>Epinephelus guttatus</u> - Red hind	0.6	0	0	0	0	1.4	0.34
<u>E. striatus</u> - Nassau grouper	0	0	0	0	0	2.1	0.35
<u>E. morio</u> - Red grouper	2.3	0	0	0	0	2.1	0.74
Family Carangidae - Jacks							
<u>Caranx latus</u> - Horseys jack	3.2	0	0	0	0	0	0.53
<u>C. ruber</u> - Carangue	3.8	0	8.8	27.6	4.9	4.2	7.58
<u>C. fusus</u> - Hardnose	0	0	1.8	0	3.9	2.1	1.29
Family Lutjanidae - Snappers							
<u>Apsilus dentatus</u> - Black silk snapper							.35
<u>Lutjanus analis</u> - Mutton snapper	0	0	4.0	0	7.8	0	1.96
<u>L. synagris</u> - Lane snapper	3.6	15.8	39.3	30.2	35.6	8.0	22.95
<u>Pristipomoides aquilonaris</u> - Silk	0	5.4	3.1	1.7	2.9	0	2.19
Family Sparidae - Porgies	3.4	16.4	23.2	13.8	7.8	6.6	11.83
Family Chaetodontidae - Angelfishes							
<u>Pomacanthus arcuatus</u> - Gray angelfish	6.4	0	0	0	0	1.4	0.24
<u>P. para</u> - French angelfish							1.83

SPECIES	MONTH						AVERAGE
	D	J	F	M	A	M	
Family Scaridae - Parrotfishes							
<u>Sparisoma chrysopteron</u> - Redtail parrot	0	0.8	0	0	0	0	0.11
Family Monacanthidae - Filefishes							
<u>Alutera scripta</u> - Scrawled filefish	0.4	0	0	0	0	1.8	0.48
Family Balistidae - Triggerfishes							
<u>Balistes vetula</u> - Queen triggerfish	63.8	21.4	0	0	2.9	27.3	20.98
Family Ostraciontidae - Boxfishes							
<u>Lactophrys bicaudalis</u> - Spotted trunkfish	0.4	1.9	0	0	0	2.4	0.79
<u>L. triqueter</u> - Smooth trunkfish	5.5	20.3	11.5	13.8	25.9	10.8	13.21
<u>Acanthostracion polygonia</u> - Honeycomb trunkfish	5.5	22.2	6.4	11.2	1.0	12.5	9.81
Crustacea							
<u>Panulirus argus</u> - Spiny lobster	1.7	0	0	0	3.4	0	0.85
Total (lbs.)	117.8	95.3	113.3	29.0	51.3	72.0	79.75
Total # Catches	16	12	20	4	16	10	13
Average Catch (lb.)	7.4	7.9	5.7	7.3	3.2	7.2	5.5

ANNEX V. Summary of fish landings at the St. Thomas/St. John Fisherman's Cooperative as recorded in fisherman landing tickets. Species groups are given with probable method of capture, listed in order of probable importance. Data are given as percent of total weight for the month.

SPECIES GROUP	FISHING ¹ METHOD	MONTH							AVERAGE
		N	D	J	F	M	A	M	
Family Holocentridae - Squirrelfishes	T	2.1	2.0	0	0	1.1	0	0	0.77
Family Serranidae - Groupers									
<u>Epinephelus striatus</u> - Nassau grouper	T,H								
<u>E. guttatus</u> - Red hind	H,T	0	2.7	24.4	5.2	0	0	0	4.62
other groupers	T,H	28.5	29.0	11.14	20.0	1.2	1.1	4.0	13.62
Family Carangidae - Jacks									
<u>Caranx ruber</u> - Caranque	N,H,T	0	1.2	0	0	4.2	0	2.9	1.19
<u>C. fusus</u> - Hardnose	N,H,T	0	0	0.5	0	1.1	0	0	0.22
Family Scombridae - Tunas									
<u>Scomberomorus cavalla</u> - Kingfish	N,H	0	0	0.2	0.4	0	0.6	5.5	0.96
<u>S. maculatus</u> - Spanish Mackerel	N,H	0	0.6	0	0.3	3.8	0	0	0.65
<u>Euthynnus alletteratus</u> - Tuna	N,H	0	1.0	0	0	0	0	0.7	0.24
Family Lutianidae - Snappers	N,H,T	2.6	2.6	0.4	0.6	0.7	0.7	1.9	1.36
<u>Ocyurus chrysurus</u> - Yellowtail snapper	H,N,T	0	3.2	1.5	1.7	3.5	7.7	12.5	4.29
Family Belonidae - Gar									
<u>Tylosurus crocodilus</u> - Gar	N	1.4	0.9	2.5	0.7	0	0.4	0.6	0.92
Family Ostraciontidae - Box fishes	T	2.4	4.0	0	0.2	0.5	0	2.0	1.30

¹Fishing Methods:

T = Fish Trap

H = Hand Line Fishing

N = Fishing By Haul Seine

SPECIES GROUP	FISHING ¹ METHOD	MONTH							AVERAGE
		N	D	J	F	M	A	N	
Crustacea									
<u>Panulirus argus</u>	T,D	2.8	3.5	2.2	0.6	1.4	1.7	0.3	1.77
Pot Fish	T	60.2	47.1	49.4	68.9	81.6	86.6	65.4	61.27
Total Landings (lbs. x 1000)									
		9.6	10.8	12.5	12.4	9.5	12.8	12.1	80.00
Total # Catches									
		38	54	81	91	74	97	98	533
Average Catch (lbs.)									
		253	198	154	136	132	132	124	150

¹
Fishing Methods:

T = Fish Trap

H = Hand Line Fishing

N = Fishing By Haul Seine