

# **The Status of Red Hind and Coney in the U.S. Virgin Islands between 1974 and 1992**

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## **ABSTRACT**

Reported finfish landed in the United States Virgin Islands increased from 110,024 pounds to 1,116,282 pounds between 1974 and 1992. The increase in landings occurred mainly between 1974 and 1978. The total number of licensed fishermen in the U.S.V.I. ranged from 281 to 578 between 1974 and 1992. The percentage of reporting fishermen steadily increased varying from 16 % in 1976 to 87% in 1992. Total reefish effort increased by 43% from 1987 through 1991 with larger increases being observed for St. Croix. The total number of reefish trips ranged from 8,241 to 15,969 trips between 1987 and 1991 with a decline occurring in only one year, 1989, the year when an intense summer storm swept the island of St. Croix. Fishing effort increases on St. Thomas/St. John were most apparent for the trap fishery.

Biostatistical samples collected between 1983 and 1991 showed a decline in mean individual length for red hind and corroborates earlier reports in declining length of red hind stocks. Coney mean size was more variable and did not indicate strong trends in size. Declining trends in red hind sample average weight were observed after 1990 for both trap and hook and line gears.

Coney were rarely observed in any of the years in the aggregate catch samples. Red hind contributed on average from 67% to 99% of the total catch landed and from 88% to 99% of the total weight landed. The fishery sampling rate ranged on average from one to six percent, as measured in terms of fishing trips.

Red hind catch per effort (CPUE) per trip increased steadily between 1984 and 1990 in both catch and weight while coney CPUE consistently declined. CPUE trends in weight were more stable than were CPUE trends in catch. Over the period, 1984 through 1990, declines in coney abundance were thought to have been at least 20 % by number and 29 % by weight; coney abundance declines are more dramatic if the CPUE data from 1991 and 1992 are also used. Total landed weight and catch were dominated by the trap fishery for both species. Total fishery landings of red hind by trap gear ranged from 82% to 96% by weight and 79% to 96% by number between 1987 and 1991 while trap gear accounted for over 95% of total landings between 1987 and 1990 for coney.

Red hind current resource status off St. Croix was investigated using a maximum likelihood estimation model that incorporated fishing effort, sample average weight, and fishery yield into abundance estimation. Red hind fishing mortality increased between 1987 and 1991, from 0.5 to 0.9, providing further support for concern for this resource. Total abundance of red hind was variable without strong trend over the period.

**KEY WORDS:** Coney, *Cephalopholis fulva*, *Epinephelus guttatus*, red hind, stock assessment

### INTRODUCTION

Traps and hook and lines are the dominant gears used in the Caribbean Island fisheries (Fiedler and Jarvis, 1932; Idyll and Randall, 1959; Hess, 1961, Swingle *et al.*, 1970, Brownell, 1971; Brownell and Rainey, 1971; Sylvester and Dammann, 1972. Olsen *et al.*, 1978; and Jennings, 1990). The most important species landed historically include Nassau grouper (*Epinephelus striatus*), mutton snapper (*Lutjanus analis*), yellowfin grouper (*Mycteroperca venenosa*), yellowtail snapper (*Ocyurus chrysurus*), queen triggerfish (*Balistes vetula*), and silk snapper (*Lutjanus vivanus*). The condition of nassau grouper, red hind (*Epinephelus guttatus*), and coney (*Cephalopholis fulva*) resources was studied by Beets and Friedlander, (1989), Beets *et al.* (1992) Sadovy and Figuerola (1992), and Sadovy (1993 a,b), and Sylvester *et al.* (1978) documented the decline of the Nassau grouper spawning stocks off St. Thomas in the U.S. Virgin Islands (U.S.V.I.)

After the collapse of Nassau grouper stocks in the late 1970s, other smaller and less frequently marketed groupers (red hind, coney, and graysby (*E. cruentatus*) became the dominant commercial species (Clavijo *et al.*, 1986; Matos and Sadovy, 1989; Beets *et al.*, 1990; Beets and Friedlander, 1992; and Sadovy, 1993a,b).

This study 1) summarizes total reefish landings and effort statistics of for 1974 - 1991 in the U.S.V.I., 2) develops estimates of directed reefish fishing effort from 1987 - 1992, 3) summarizes red hind and coney biostatistical samples for 1983 - 1991, 4) estimates red hind and coney trap and hook and line yield and catch from 1987 - 1991 off St. Croix, 5) evaluates the stock status of red hind and coney off St. Croix during 1987 - 1991 using a weight (yield) based population abundance estimator and considers these results in terms of future management of the resource, and 6) identifies important research needed to further quantify the status of these species.

### **MATERIALS AND METHODS**

Prior to 1972 total finfish landings and effort for the U.S.V.I. fisheries were estimated by interviewing fishermen, from aerial counts of fishing craft and fish trap buoys, from questionnaires completed by cooperating fishermen, and by census (see Dammann (1969) and Fiedler and Jarvis (1932). These surveys were sporadic and non-random in nature.

The U.S.V.I. fishery statistics data collection system, begun by Legislative Act 3330, began in 1972 (Sylvester *et al.*, 1978) required fishermen to submit written reports once a year on the amount and composition of their catch for the preceding twelve months. Fishermen were requested their name and the date and license number, the island and area of primary fishing activity, the number of helpers, and the daily catches from one of several fishing method categories that included: potfish, netfish, hook fish, speargun, lobster, and several kinds of invertebrates. Fishermen were also required to record monthly information on the number of boats in use, number units of fishing gear, number of days fished, number of gear losses, areas fished, number of pounds caught by species category, and price information. Fishermen were not required to record the species of their catch. In 1989 fishermen were asked to separate the finfish landings into snapper/grouper and other fish categories, but this practice was terminated in 1991 and the original categories of net fish, pot fish, spearfish, etc., were replaced on the catch reporting form.

Initially many fishermen did not report at all, many forms were incompletely filled out, many fishermen submitted only annual summaries rather than monthly, and many submitted blank forms). Beginning in 1977, catch reporting rates were improved by making interviews (Coleman *et al.*, 1979b). From these interviews the landings estimates were compared with daily records kept by the fishermen to determine the level of under-reporting. Hurricane Hugo of 1989 destroyed much of the statistical data for the month of September, and a design study was conducted afterwards to review sampling strategies afterwards. Reporting requirements were changed from annual to monthly in July 1989 (CSFR Annual Report for 1990, Barshinger 1993). During the first years of the statistics program under-reporting was a significant problem. Sylvester reported that during 1975 - 1977 catch reporting was a low percentage of the total population of fishermen with many of the reports sent in blank or marked "no catch". In addition, non-reporting was very evident from port sampling. In 1990, the geographical reporting areas were changed from the previous alpha-numeric letter coding system (e.g., T1-T5) to a quadrant system (e.g., TSE) as a way of better indicating the approximate fishing area. Apparently even with the simplified system, 82 % of the reports received did not have the fishing location specified (Barshinger, 1992). Computerization of the fishermen's license file began in 1982 for St. Thomas/St. John and in 1983 on St. Croix.

### **Total Catch and Weight**

Total weight and numbers caught of red hind and coney landed were not recorded in the formal fishery statistics however, total finfish and reefish landings were reported by commercial fishermen. Annual total reefish landings were calculated by the U.S.V.I. Division of Fish and Wildlife (DFW) from reported landings and non-reporting ratios. Non-reporting ratios were not stratified by time, fishing location, or type of fishery. The number of licensed fishermen was known although effort directed at a single species was not recorded. The approximate total number of gear units used each year was recorded on catch reporting forms submitted by fishermen.

### **Fishing Effort**

About ten different types of gear have been used in the U.S.V.I. with the west Indian fish trap, often referred to as "pots" in this report, being the most frequently used (Olsen *et al.*, 1975, 1978). The earliest fish traps were made from woven hoop vine and split bamboo (Sylvester and Dammann, 1972) with poultry wire being used in the mid-1970s. Traps were mandated to have mesh size openings of 1.25 inches or larger in the early years. Sylvester *et al.*, (1978) stated that fishermen preferred to use 1.5 inch hexagonal mesh over the 1.25 sized mesh. The present day fishery uses traps made of vinyl clad mesh wire with steel reinforcement and zinc anodes (U.S.V.I. DFW State Federal (SF) 1989 - 1990 Fiscal Year Annual Report). Mesh sizes were mandated to be three inches beginning in 1993. Traps remain the preferred fishing gear because they are inexpensive, easily constructed, and do not require tending, leaving fishermen free for other jobs. Swingle *et al.* (1970) reported that 83% of 187 fishermen interviewed used traps in the U.S.V.I.. Most fishermen do not use mechanical trap haulers. Usually the traps are hauled after four to six days of set. Gear losses are believed to be significant in the trap fishery with Olsen *et al.* (1975) estimating that over 9,000 traps were lost each year. Trap mortality is both direct and indirect. Mortality caused by gear losses is considered indirect source but thought to be significant. Other kinds of fishing gear used in these fisheries includes: hook and line, net, seine, lobster trap, and spear. Clavijo *et al.* (1984) reported that differences in gear exist between islands with seine fishing being the next most popular fishing method after traps in St. Thomas/St. John and line fishing and diving in St. Croix.

Historical information on total fishing effort has included the number of licensed fishermen, number of fishermen reporting, number of helpers, number of traps per boat, number of traps lost, number of days fished per month, and summary information on the number of units of gear reported by fishermen used throughout the year (U.S.V.I., DFW Annual Reports). In this study fishing effort was measured in terms of fishing trips as opposed to number of fishermen.

Directed effort was enumerated from reports of daily fishing records submitted by fishermen. The individual fishermen reports of daily landings provides a measure of the amount of fishing effort expended in the reefish fishery at least in current years where the data are computerized and available. Each landing was considered as one separate fishing trip or one unit of effort in this study.

### **Fishery Biostatistics**

Prior to 1978, biological sampling of the U.S.V.I. fisheries focused on 1) quantifying spawning aggregation activity and 2) assessing the overall spawning condition (state) of fish from two known areas on the north and south coasts of St. Thomas and St. John and from an area south of St. Croix. Fisheries were known to be conducted year round on these aggregations however, for these very early sampling activities the majority of the fish size data is for the spawning aggregations. Sometimes in these studies observations were made on predators of the spawning aggregation. In a few incidental cases, reports document the sizes of fish caught in non-spawning aggregations but in general, randomly collected samples of the year round fisheries are not available for the fisheries until the mid 1980s.

In 1978, a Cooperative Statistics Program (CSP) between the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC) of the United States and the U.S.V.I. DFW was initiated (Clavijo *et al.*, 1984). The program focused initially on verification of fishermen's reported catches through port sampling. Biological sampling was very limited even in the early years of the cooperative program and was directed towards specific projects, as in studies carried out during the mid 1970s mentioned above. The job statements of many of the final project reports of the DFW list the focus of the projects towards assessment of the population dynamics of snapper/grouper spawning aggregations. Also, corroboration of the decline in certain spawning aggregations was a major aim during the earliest sampling years. Apparently, from 1978 - 1984 trigger fish and yellowtail snapper were sometimes measured during regular port sampling activities. A yellowtail snapper age and growth study was also conducted between 1978 and 1984 (Clavijo *et al.*, 1984). Beginning in the middle 1980s more routine monitoring of the overall reefish fishery was begun.

### **Estimated Total Catch and Weight Landed of Red Hind and Coney**

A pseudo-random based estimator was used to develop estimates of total red hind and coney catch and yield. Information on two attributes of the fishery, total catch and total weight, existed from randomly collected samples for a number of catches within a stratum. Samples were collected during the regular CSP port sampling by the NMFS, Trip Interview Program (TIP). A stratum

was posteriorly defined as a fiscal year, quarter, and gear catch partition for this study. Only samples that were identified as being complete landings interviews in the TIP database were used in the calculation of the mean to obtain as accurate as possible estimate of catch rate per trip. The procedure was as follows. First, using the set of reefish catch interviews available from the CSP TIP database, the weighted average numbers (catch) and pounds (yield) caught per trip and the variance of catch and yield were computed for each fiscal year and quarter for each gear type strata in the data separately for each species and for species combined. Then values of directed reefish fishing effort expended for reefish by St. Croix fishermen, developed from the individual fishermen reported landings records were grouped by fiscal year and quarter of the year strata for the two major gears, traps and hook and lines. Next, for each fiscal year, quarter, and gear strata in the data, the estimator of total yield or total catch of red hind and coney was simply computed from the stratum mean catch (or yield) per trip times the total amount of fishing effort for that stratum. The variance of the estimated total yield (or catch) was computed in the usual manner for that of a population total as the variance of mean catch per trip (or yield) times the square of the estimated total catch (or yield). The strata means and their variance estimates were calculated in the usual manner for a random sample (Scheaffer *et al.*, 1979). Finite population correction (fpc) factors were not applied to the variance estimates. The effect of not including population correction factors into the estimate of the sample mean variance was probably small in this study, since the number of trips sampled ( $n$ ) was a very low percentage of the total number of trips ( $N$ ) thought to be directing effort and, thus the correction factor, calculated as  $(N-n)/N$ , was probably near unity for most strata. As an example, the calculated fpc for 1987/1988 fiscal year (all gears and all quarters stratum) would be (3311 total fishing trips minus 206 catch samples) divided by 3311 total fishing trips = 0.94. This indicates a slight overestimate in the variance estimate of the stratum means of catch per trip (or weight) would result from not applying the population correction factor, as was the case here.

### **Population Abundance Model**

An extended time series of species specific landings and catches, fishing effort, biological length, age composition statistics for use in catch curve analyses and virtual population analyses were unavailable for red hind and coney. A critical need of this study first, available statistics for red hind and coney were assembled including: landings, catches, fishing effort expended, and biological samples. These results were used in conjunction with a population abundance estimation model that contains relatively few data requirements, to obtain baseline information on red hind and coney abundance. The maximum likelihood estimation (MLE) abundance estimation model, SLM (Simple

Likelihood Method) was used.

### **Data Requirements, Model Description, and Assumptions**

Detailed background regarding development of the model, the theoretical basis for the estimator, and the results of applying the SLM model to the U.S. Atlantic coastal shark fishery data is given in Parrack (1990a, 1990b, 1992). The method was used recently to investigate the U.S. Atlantic amberjack fishery (Parrack (1993a, 1993b). A recent treatment of the method including simulation analyses of the model performance is given in Parrack (1994).

In this case method, the following statistics were required:

- i) an index of the time fished for all gear type - year data strata
- ii) for several gear type - year strata, one or both of the following:
  - ii-a) the sample average weight, and its estimated variance, and an enumeration of the landed yield.
  - ii-b) a normally distributed estimate of the numbers landed and an estimate of the variance of numbers landed.

Ideally, both 2(a) and 2(b) will exist for all strata. The method will work however, if just one of the two exist on some strata and some strata may not be recorded at all (except for an index of fishing time). Note, that an index of fishing effort is always required. In this study both 2(a) and 2(b) were available on all cells; the observations were sample average weight and it's variance, yield (assumed known), enumerated fishing effort, and a catch estimate. In actuality yield was estimated in this study. The significance of violation to model results are unknown. The method assumes:

- i) catch estimates are distributed normally;
- ii) equal time intervals;
- iii) unreported catch and natural exit (predation) from the stock are Poisson events and
- iv) catch (C) equals the coefficient of catchability (q), times the amount of fishing time (f), times the initial stocksize (N), or the familiar equation,

$$C = q * f * N.$$

The assumption of normally distributed sample average weights was evaluated from visual inspection of plots of sample average weight for each year gear partition and the Shapiro-Wilk statistic, W, computed for each cell and found to hold for most strata. If the aggregate weight samples were from a

normally distributed population then according to the Central Limit Theorem their means should distribute normally. Fishing effort was enumerated in this study. Catches were estimated from prorated sample means and thus probably distribute normally although, this assumption was not rigorously checked. The likelihood model is:

$$L = \prod_{t=1, T} \prod_{k=1, G} e^{-\frac{1}{2} \left[ \frac{[\hat{C}(t,k) - C(t,k)]^2}{\sigma^2[\hat{C}(t,k)]} \right]} \cdot e^{-\frac{1}{2} \left[ \frac{[\bar{w}(t,k) - \frac{Y(t,k)}{\hat{C}(t,k)}]^2}{\bar{\sigma}^2[\bar{w}(t,k)]} \right]}$$

$$2^2 \cdot \pi^2 \cdot \sigma[\hat{C}(t,k)] \quad 2^2 \cdot \pi^2 \cdot \sigma[\bar{w}(t,k)]$$

where G referred to j fisheries and T referred to t time periods.

Maximization was carried out by minimizing the negative logarithm of the likelihood with the constant terms dropped and sample estimates of variances substituted for variances and using the Needler-Reed simplex method, i.e., by minimizing the likelihood equation (Parrack, 1994):

$$\log[L] = \sum_t \sum_j \frac{[\hat{C}(t,j) - C(t,j)]^2}{s^2[\hat{C}(t,j)]} + \frac{[\bar{w}(t,j) - Y(t,j) \div \hat{C}(t,j)]^2}{s^2[\bar{w}(t,j)]}$$

Estimates include parameters for natural change rate of new entrants and post entrants (m,M), gear efficiency coefficients for each fishery (q), the number of new entrants into the population each year from all sources (R or total Recruitment), and the total abundance during the year (N).

The requirements of the estimator in order to apply the model as summarized by Parrack (1994) are: an enumeration of fishing time ("fishing effort"), or an index of it, for each time period t and each fishery j and a model of catch. The sample observation for a time period can be either an estimate of catch (numbers) and its variance estimate, or a sample average weight and its variance estimate, or both. If sample average weight is used, then it must be accompanied by an enumeration of the landed yield for that cell.



## **RESULTS**

All of the licensed fishermen in the U.S.V.I. do not report their daily landings consistently. An index of compliance was obtained from the number of fishermen making monthly fishermen reports (Table 1). The percentage of licensed fishermen making reports in St. Croix ranged from 6 % (1976) to 88 % (1984) and on St. Thomas/St. John from 20 % (1976) to 88 % (1992). The rate of reporting increased during 1974 - 1978 and fluctuated without trend afterwards. Table 1 indicates the total number of licensed fishermen remained stable since 1977 on St. Thomas/St. John and since 1974 on St. Croix. Wood (1983b) reported non-reporting ranged from 22 % to 42 % during 1978 - 1981. The number of full time commercial fishermen is believed to be about 50 % of the total number of licensed fishermen and the percentage of "part-timers" varies inversely with economic conditions.

### **Total Reported Fishery Landings**

Computerized files of the daily fishing records reported by fishermen were available by fiscal years, July 1 - June 30 for 1886/1987 - 1991/1992 from the U.S.V.I. DFW. The convention of fiscal year was kept for this study throughout. Recorded for each record in the daily fishing activity files were the year, month, day, and pounds landed for each marine species category. The category varied depending upon the fiscal year of the data file. Total finfish landings statistics are given since the early 1970s in unpublished reports from the U.S.V.I. DFW. For several years, finfish landings are available in reports stratified by gear (i.e., traps, hook and lines, dive, nets) and for 1989 - 1992 reported finfish landings are available stratified by category of fish (i.e., snapper and grouper combined, reefish, all other fish).

Landings values presented in Table 1 represent reported catches of all finfish in the U.S.V.I. and are unadjusted for non-compliance or landings by un-licensed fishermen ("part-timers"). Fiscal year refers to July 1 - June 30. Total reported commercial finfish landings ranged from 110,024 pounds (1976/77) to 1,116,282 pounds (1991/1992) (Table 1). Reported landings of all finfish by island ranged from 4,481 pounds (1975/1976) to 469,729 (1991/1992) pounds on St. Croix and from 102,177 pounds (1976/1977) to 693,599 pounds (1988/1989) on St. Thomas/St. John. Significant increases in reported landings occurred, especially in the early years of the time series, 1974/1975 - 1978/1979. These increases could be reflective of improved reporting rates and not necessarily increased catch rates (Barshinger, 1993). Since the late 1970s reported total landings have varied without trend. Large reductions in total landings occurred during 1980 and again in 1986 and 1987 and all years showed reduced reporting rates. In 1989, a reduction in reported landings was observed for St. Croix and was in part at least related to the occurrence of a major storm,

Table 1. Reported landings (pounds) from U.S. Virgin Islands finfish fisheries, 1974-1992.

Fiscal Year	St. Croix			St. Thomas - St. John			St. Croix & St. Thomas & St. John		
	Reported Landings All Finfish	Number of Licensed Fishermen	% of Fishermen Reporting	Reported Landings All Finfish	Number of Licensed Fishermen	% of Fishermen Reporting	Reported Landings All Finfish	Number of Licensed Fishermen	% of Fishermen Reporting
74/75	-	220	25	-	230	32	-	450	29
75/76	4,481	197	13	230,836	312	44	235,317	509	29
76/77	7,947	225	6	102,177	621	20	110,024	846	16
77/78	73,451	103	25	263,349	162	45	381,331	281	36
78/79	119,697	120	48	413,142	161	52	532,839	281	50
79/80	223,346	143	50	423,358	212	53	646,704	355	51
80/81	94,470	163	32	380,590	258	43	475,060	421	37
81/82	253,838	322	29	458,974	256	48	712,812	578	38
82/83	180,276	195	47	452,928	259	51	633,204	454	49
83/84	357,168	182	76	524,644	255	58	881,812	437	67
84/85	355,834	182	88	501,723	255	62	857,557	437	75
85/86	376,938	206	68	553,744	330	42	930,682	536	55
86/87	268,658	200	44	515,528	329	41	784,186	529	43
87/88	171,110	217	52	451,122	306	43	622,232	523	47
88/89	384,279	188	65	693,599	237	70	1,077,878	425	68
89/90	231,213	206	41	402,148	198	54	633,361	404	47
90/91	447,575	188	50	574,159	182	72	1,021,734	370	61
91/92	469,729	197	59	646,553	231	69	1,116,282	428	65
92/93	322,642	197	86	777,386	212	88	1,100,028	409	87

Sources: U.S. Virgin Islands Department of Fish and Wildlife Annual Report

Hurricane Hugo, that occurred during the month of September. Landings increased significantly during 1990 on St. Croix and have varied without trend since that year. Barshinger (1993) also noted that during 1991 - 1992, U.S.V.I. DFW data entry technicians noted that on average, individual fishermen were completing a full twelve months of catch reports.

### **Fishing Effort**

*Historical Trends* — Based on information obtained from annual reports, from 1974/1975 to 1991/1992, the number of licensed fishermen ranged from 103 to 322 for St. Croix and from 161 to 621 for St. Thomas/St. John. The number of reporting fishermen varied during the nineteen year period from 6% to 88% (St. Croix) and 20% to 88% (St. Thomas/St. John) (Table 1). The records indicate a more stable pattern of reporting began about 1982 with consistently more than 50% of the licensees reporting annually. Current reporting rates for 1992 were 88% and 86% for the islands of St. Thomas/St. John and St. Croix, respectively. The increase in reporting with the observed increase in reported landings further suggests that exact levels of landings cannot possibly be known and that confidence should be placed only in recent years landings records as reporting rates have increased.

Bolden (1994) enumerated the count of individual fishermen making landings reports for trap and hook and line gear between 1989 and 1991 by season (Table 2). These counts were used to follow overall trends in total usage of gear and best reflect changes in gear usage between fishermen. Those counts indicate that the number of fishermen that reported using hook and line gear was much lower than traps (pots) over the three year period as was also observed with trends in annual landings. The counts provided by Bolden (1994) represent the number of fishermen using these gear and not the number of trips or total directed fishing effort.

Table 2. Number of fishers by gear and season - St. Croix only.

Gear	1989/1990										
	July, Aug, Sept	Oct, Nov, Dec	Jan, Feb, Mar	Apr, May, June	All						
Pot	121	40	93	100	354						
Hook	59	50	69	74	252						
1990/1991											
Pot	120	131	131	139	521						
Hook	84	73	96	88	341						
1991/1992											
Pot	151	148	150	130	579						
Hook	93	84	95	91	363						

Source: S. Bolden (1994)

*Current Trends in Effort* — Five years of daily fishermen's fishing were available for this study beginning July 1, 1987 (1987/1988 fiscal year) continuing through June 30, 1992 (1991/1992 fiscal year). During the five year period, fishermen recorded on their forms that they operated in five fisheries including reefish, finfish, lobster, whelk, conch, and baitfish. Reports indicating that the trip activities emphasized lobster, whelk, conch, or baitfish were excluded from calculations. Records from the 1986/1987 fiscal year were not used because the attribute "fishery" not coded and fishermen reports after 1992/1993 were unavailable.

Reported reefish fishery effort ranged from 8,241 trips (1989/1990) to 15,969 trips (1988/1989) over the five year time series for all islands. A major drop in total reported trips occurred during the 1989 fiscal year when a major storm occurred during the fall on the island of St. Croix. In 1990/1991, effort returned to very near pre - 1989/1990 levels on St. Croix. The total number of reported trips also increased on St. Thomas/St. John the year following the big storm. The high value observed in 1988/1989 was not observed again in the reports examined through at least the 1991/92 fishing year. These values show a significant increase (43%) in total fishing effort from 10,019 trips to 14,305 trips between 1987/1988 and 1991/1992 for all islands and all gear types combined (Figure 1a).

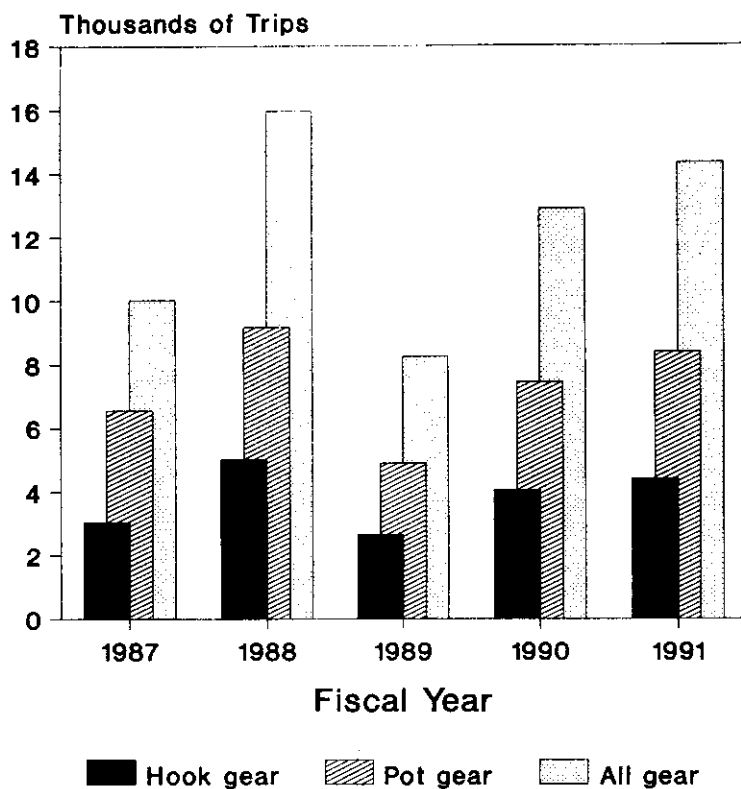
*Gear Changes* — The daily fishing reports also provide additional information on the distribution of effort over the five year time period by island and gear. The total number of fishing trips using trap gear varied from 4,893 (1989/1990) to 9,175 (1988/1989) for the three islands. Even though the 1988/1989 value is aberrantly high as observed for all gears combined, the trend is one of increasing effort from 6,459 trips in 1987/1989 to 8,380 trips in 1991/1992 for all islands (Figure 1a). The decline during 1989/1990 was probably an artifact of a major summer storm that swept the island of St. Croix. These data indicate the use of hook and line gear varied from 2,657 trips (1989/1990) to 5,003 trips (1988/1989) across all islands. An increasing trend in effort is also observed for hook and line gear from 3,042 trips in 1987/1988 to 4,403 trips in 1991/1992 (Figure 1a). Again a decline in 1989/1990 for use of hook and line gear was most probably the result of the hurricane. Throughout the five year series, the use of trap gear averaged 59% of the total reports while hook and line gear averaged 31% of the total reported effort.

*Island Differences* — The number of fishing trips are more variable between years when considered by island and the observed increases in effort are less steep particularly for trap gear on St. Thomas/St. John (Figure 1b,1c). Increasing trends in effort are quite evident since 1989/1990 for hook and line gear of St.

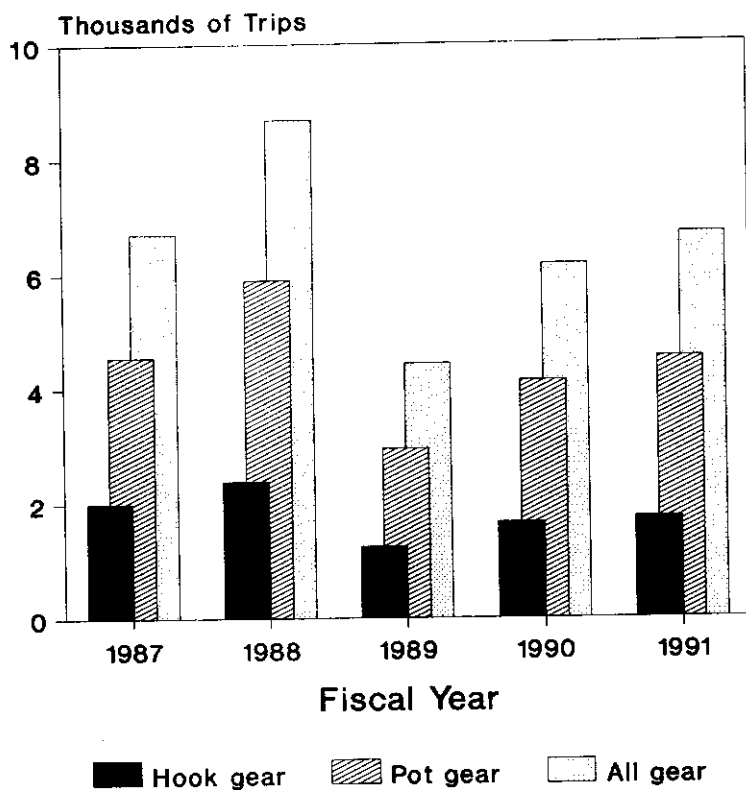
Thomas/St. John and for both traps and hook and line gear in St. Croix. The aberrantly high values observed in 1988/1989 are still evident.

The greatest proportion of the fishing reports came from fishermen landing on St. Thomas/St. John during the first three years of the time series (1987/1988 - 1989/1990). This is not totally unexpected since the greater percentage of license holders were also indicated from St. Thomas/St. John in early years (see Table 1). A shift occurred in 1990/1991 with a greater percentage of reports coming from St. Croix fishermen. The number of licensed fishermen indicates a decline in licenses also occurred in 1990 and that the percentage of reporting fishermen increased. This shift in reporting may be more indicative of an overall increase in the number of non-licensed fishermen for St. Thomas/St. John than a real shift in the frequency of reporting between islands. Future fishing records will help to evaluate this observed change.

Barshinger (1993) suggested a change in gear usage occurred between 1989 and 1990 in the proportional landings by gear type on St. Croix. According to Barshinger, during 1989/1990, 24% of the finfish landings were caught by hook and line while during 1990/1991 this rate changed to 30%. Barshinger evaluated change in effort between gears through change in landings proportions. Direct comparisons are not possible since changes in gear usage was measured differently between studies (i.e., fishing trips in this study vs proportion of total pounds landed by gear in Barshinger's study). The results do not indicate a major change occurred in gear usage in terms the distribution of total fishing trips by gear over time. A suspected increase in hook and line landings could also be due to an increase in the real reporting rate of fishermen using a particular gear (i.e., hook and line gear) as opposed to an actual change in the number of fishermen making trips and using a different gear. The overall reporting rates among fishermen has increased each year since 1989/1990 on St. Croix. However, license files are not available to examine if reporting by gear type changed. Additionally, although the overall reporting rate has increased the number of licenses has declined so the true reporting rate is confounded with those fishermen who not only do not report but not licensed (non-licensees) and by part time fishermen. Any observed increase in the percentage of catch of the total landings by hook and line gear could also be due to a change in catching success of a particular type of gear and a change in catch per unit of effort for a particular gear. If landings proportions by gear changed between years as suggested by Barshinger (1993) and effort remained stable then catching success by gear may have changed indicating an overall change in catchability.



**Figure 1a.** Number of fishing trips in the U.S. Virgin Islands, 1987 - 1991 — Reeffish fishing effort.

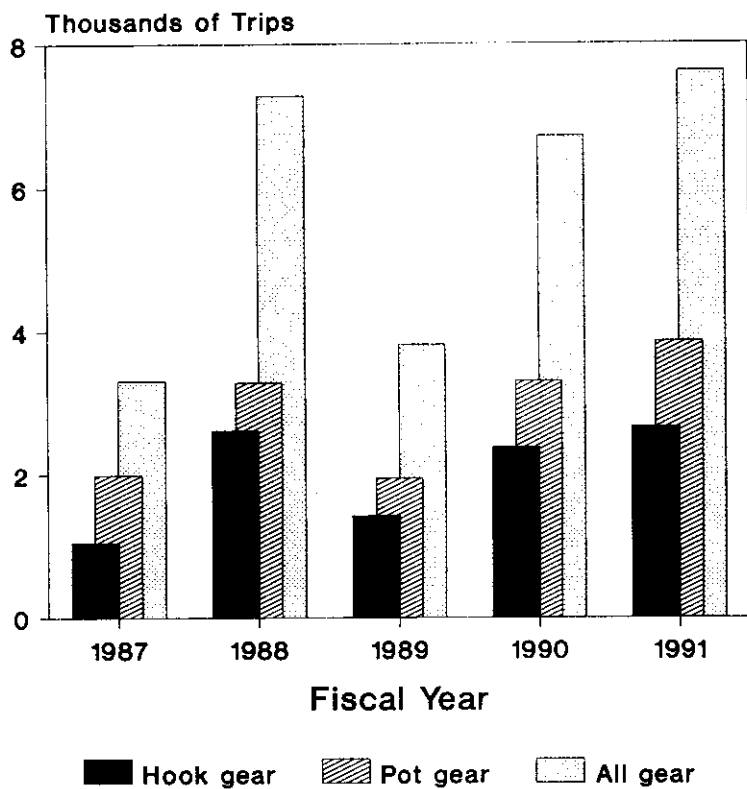


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**Figure 1b.** Number of fishing trips in St. Thomas - St. John, 1987 - 1991 — Reeffish fishing effort.

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**Figure 1c.** Number of fishing trips in St. Croix, 1987 - 1991 — Reeffish fishing effort.

The results are not conclusive as to the exact magnitude of effort because of problems in under-reporting however, the trends are useful. These results indicate that the total number of fishing trips increased in recent years for both trap and hook and line fishing in St. Croix and at least for hook and line gear on St. Thomas/St. John. These results also indicate that trap fishing effort varied without trend on St. Thomas/St. John.

*Observed Sizes* — The NMFS, CSP TIP database was the only source of biostatistical data available for this study. These samples were of two major types: 1) those from individual fish and 2) those from composite samples taken of the entire catch. Individual length and weight measurements were taken from 571 red hind and 556 coney. Composite samples included those in which the weight and number of all individuals of a species caught were recorded. Between 1983 and 1991 some 12,459 total fish of both species (8,188 red hind, 4,271 coney) were sampled from composite samples (Figure 2a and 2b). Visual inspection of the raw data sheets indicated these samples were from St. Croix landings. Thus, all discussion pertaining to size data refers to St. Croix. Samples of individual fish sizes were not available from the CSP TIP database for the years before 1983 or for 1986 - 1989 although, such samples likely exist based on a review of the literature (Bohnsack *et al.*, 1985; Beets and Friedlander, 1989; Beets *et al.*, 1990, and Appledorn *et al.*, 1993).

*Individual Length and Weight* — Red hind mean length sampled from trap gear ranged from 28 cm TL in 1983/1984 to 33 cm in 1985/1986 (Table 3a). Mean length of trap caught red hind was lower in 1990/1991 and 1991/1992 than observed in 1984/1985 (29 cm vs 33 cm TL). Mean individual weight of red hind showed the same pattern. Both observed length and weight show a declining trend since 1984. Observed mean length of red hind from hook and line gear also declined between 1984 and 1991 (37 cm vs 33 cm TL) although this observation is not strong as sample sizes are very low. Although the sample sizes are low, these data indicate that hook and line caught red hind were slightly larger than those caught by traps).

Coney observed size did not show strong trends with either time or gear. Observed mean length of coney from trap gear varied from 22 cm TL (1990) and 26 cm TL (1984/1985). Coney mean individual weight ranged from 0.4 to 0.7 pounds (Table 3b). The lack of samples from several years of the time period makes it more difficult to discuss observed changes and excepting the initial year, 1983/1984, sample sizes were not sufficient to adjust upwards to the total catch. Definitive statements regarding trends in red hind and coney mean length and weight are further complicated mainly because of the large gap in temporal coverage and extremely low size frequency sample sizes for many years.

**Table 3a.** Observed mean individual length (mm) and weight (lbs) of red hind caught with fish pots and hook and line for this study.

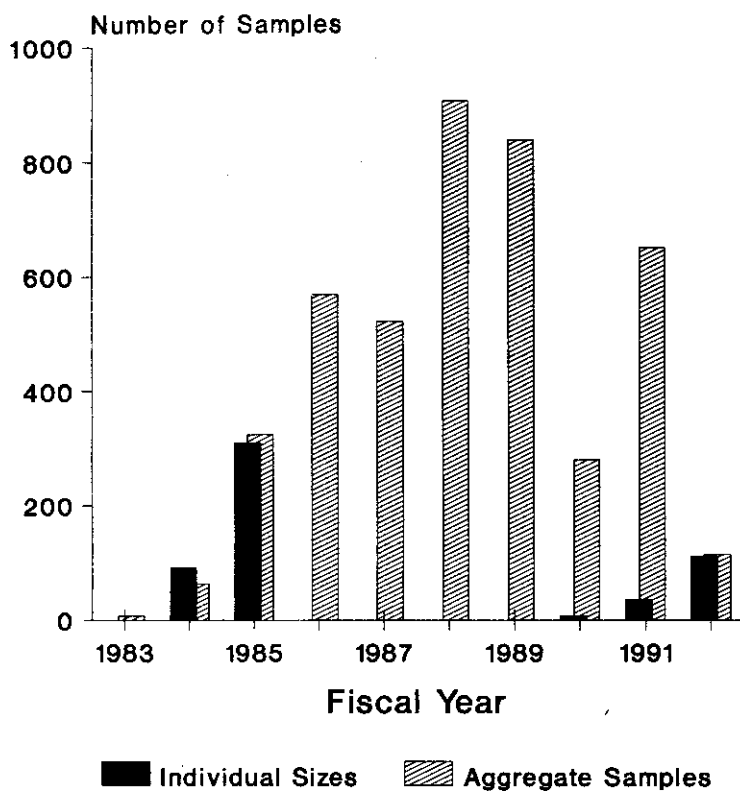
Fiscal Year	POT				HOOK AND LINE				ALL GEARS			
	Mean Length (TL)	Mean Weight (lbs)	N		Mean Length (TL)	Mean Weight (lbs)	N		Mean Length (TL)	Mean Weight (lbs)	N	
1983	278	0.8	92		281	0.8	19		279	0.8	11	
1984	339	1.5	35		365	1.5	1		340	1.5	36	
1985	326	1.5	7		-	-	0		326	1.5	7	
1986	-	-	0		-	-	0		-	-	0	
1987	-	-	0		-	-	0		-	-	0	
1988	-	-	0		-	-	0		-	-	0	
1989	-	-	0		-	-	0		-	-	0	
1990	289	1.0	40		352	1.7	270		344	-	31	
1991	298	1.0	20		332	1.5	72		325	1.4	92	

- denotes no information available

**Table 3b.** Observed mean individual length (mm) and weight (lbs) of coney caught with fish pots and hook and line for this study.

Fiscal Year <sup>2</sup>	POT			HOOK AND LINE			ALL GEARS		
	Mean Length (TL)	Mean Weight (lbs)	N	Mean Length (TL)	Mean Weight (lbs)	N	Mean Length (TL)	Mean Weight (lbs)	N
1983	231	0.5	375	251	0.6	110	236	0.5	485
1984	257	0.7	38	-	-	0	257	0.7	38
1985	-	-	0	-	-	0	-	-	0
1986	-	-	0	-	-	0	-	-	0
1987	227	0.4	9	-	-	0	227	0.4	9
1988	-	-	0	-	-	0	-	-	0
1989	-	-	0	-	-	0	-	-	0
1990	216	0.4	10	298	0.5	8	252	0.5	18
1991	256	0.6	4	239	0.5	17	242	0.6	21

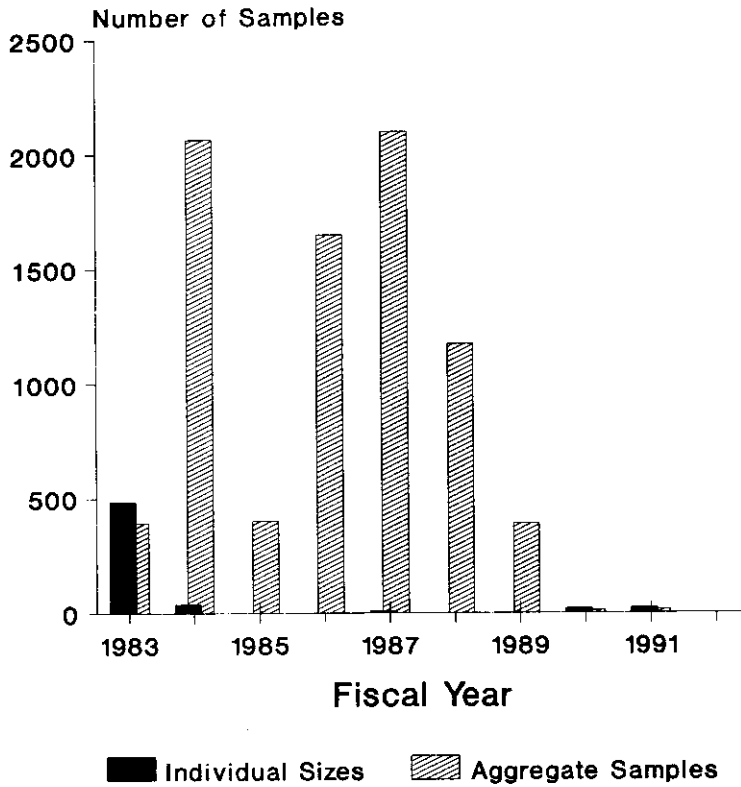
- denotes no information available



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**Figure 2a.** TIP samples for red hind, based on individual sizes and aggregate samples, for 1983 - 1991.

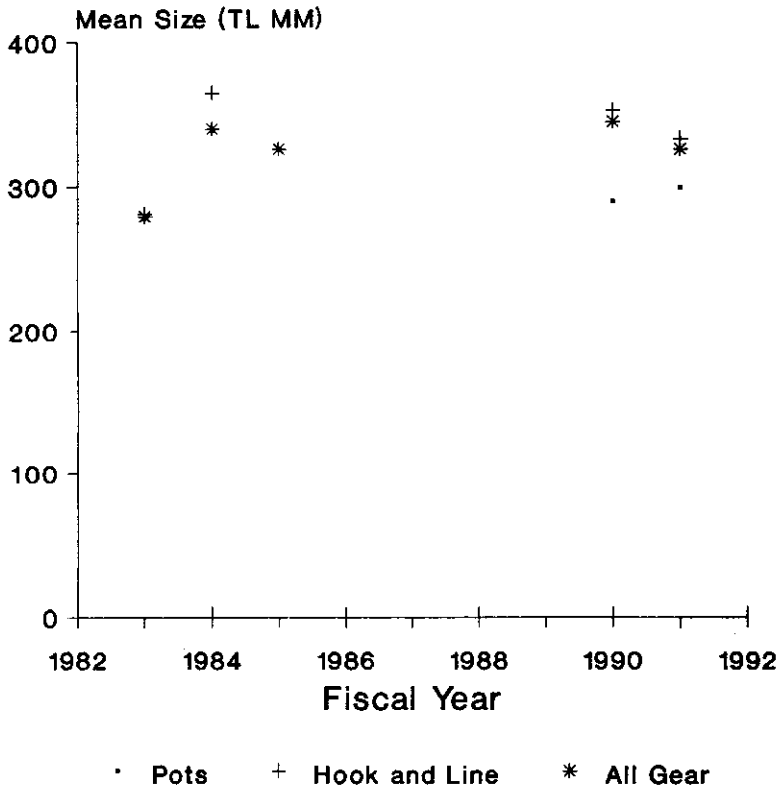
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**Figure 2b.** TIP samples for coney, based on individual sizes and aggregate samples, for 1983 - 1991.

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**Figure 3.** Mean Length of red hind captured by pots, hook and line and all gear from St.Croix, 1982 - 1992. (Observed mean length)

*Sample Average Weight* — The total weight and the number of the fish from a sample of the catch (trip) were also collected by the NMFS, CSP TIP. These data covered ten years, 1983/1984 - 1992/1993 and included 903 catch samples in which red hind and/or coney were encountered (Figure 2a and 2b). For many of these catches (trips) the entire catch of all species was enumerated separately and the total yield (weight) of each catch was recorded by the sampler; these were labeled complete catch samples because all of the species caught were identified, counted, and weighed. Meyers (1994) reported that the DFW placed emphasis on obtaining biostatistical data on complete catches when possible and this pattern is strongly supported from the observed frequency of catches that were sampled in their entirety. These composite samples were considered complete catch samples that provided the total catch numbers and the total weight landed of that catch (trip) across all species landed and were used in later calculations of total landed catch and yield and species composition.

The majority of the complete catch samples were taken from trips using traps (89.4% trap vs 11.6% hook and line). The trap fishery sampling rate ranged from 45% to 60% annually from 1987/1988 - 1991/1992 of the total reported fishermen trips for the island St. Croix, averaging 50% across all years. The level of sampling declined significantly after 1989. The aggregate catch samples can also be used to evaluate abundance of all species within the U.S.V.I reef fishery. If the aggregate catch samples that were available for this study to the NMFS are representative of the true fishery sampling rates made between 1983/1984 and 1991/1992 for the island of St. Croix, then the reef fish trap fishery received more sampling effort than the hook and line fishing assuming the a fishing trip was the sampling unit. Based on these data, the trap fishery was over-sampled for purposes of obtaining basic primary information on species composition and catch or weight per trip. Circumstances that could impact the observed sampling rate would be the existence of samples that were taken but were not available for inclusion into calculations for this study. Such a case is thought to have existed, a set of samples, mostly hook and line, taken from pelagic fishing trips received at the NMFS, SEFSC but not yet computerized. However, the number of these samples and the degree of "completeness" of sampling was not known at the time of this study.

The complete (aggregate) catch samples examined indicate that sample average weights of landed red hind from the St. Croix trap fishery ranged from 0.77 pounds to 1.24 pounds and from 1.00 pounds to 1.58 pounds from the St. Croix hook and line fishery from 1983/1984 - 1991/1992. From 1983/1984 - 1989/1990, sample average weights of red hind varied without clear evidence of strong trends for either gear, trap or hook and line. However, slight declines are noticeable for both gears since about 1990/1991. The number of samples from which to compute sample average weight declined significantly after 1989/1990,



aberrantly so, and highlights the need for continued effort to determine if all data collected through the NMFS, CSP have been computerized and submitted to the TIP database. Sample average individual weights and the variance of sample average weight for red hind are presented in Table 4a.

Sample average weights of coney varied from 0.43 pounds to 0.66 pounds for coney from trap gear and 0.34 pounds to 0.61 pounds from the hook and line gear between 1983/1984 and 1991/1992 (Table 4b). Sample average weights for coney increased slightly over the time series, 1983/1984 - 1991/1992, for both gears. It is difficult to be conclusive regarding trends in coney sample average weight for years after 1989/1990 for trap gear and for all hook and line catches because coney was apparently not frequently encountered in interviewed samples. This is also supported by the observed mean catch and weight per trip of coney given in Table 6 and Figures 5 and 6. Sample average weights and the variance of sample average weight are presented in Table 4b for coney.

*Mean Catch and Mean Weight Landed Per Trip (CPUE)* — From 1984/1985 through 1990/1991, the number of reef fish trips sampled each year in which complete catch samples were taken ranged from 51 to 206. Over all seven years of the time series, a total of 835 samples from either trap or hook trips were taken in which all species in the catch were identified, enumerated, and weighed. From these samples stratum mean catch per trip and the variance of the mean were calculated. A few samples from trips made during the later part of the 1992 calendar year existed providing a few data for the 1992 fiscal year however, only biological measures and total landing weight statistics were recorded from these samples so they were not usable as complete catch samples.

The total number of reef fish pounds sampled yearly from the set of complete catch samples was quite variable over the seven year period, ranging from 6,689 pounds (1990/1991) to 33,931 pounds (1986/1987). This sampling level may be considered relative to the total reported reef fish landings for St. Croix for the same period to get an idea of the relative coverage rate for the entire fishery for species composition sampling (U.S.V.I. DFW Annual Report for 1993) in terms of landings rate. The total catch numbers sampled over the period ranged from 6,573 (1990/1991) to 33,083 fish (1988/1989). Estimated mean weight and catch per trip of red hind and coney for 1987/1988 - 1990/1991 are included with variance estimates in Tables 5 and 6 by year and gear. Fishery total catch and yield estimates were not made for years before 1987/1988 or for years after 1990/1991 as discussed above.

Based upon the complete catch trip interviews, red hind were landed (caught) much more frequently than were coney in both trap and hook and line gear on St. Croix, where these interviews are believed to be from. Mean weight per trip of red hind varied from 27 pounds to 120 pounds between 1984 for the trap fishery

and from 1 pound to 32 pounds per trip for the hook and line trips (Figure 3). The 1986 mean value is considered suspect and review of the actual data indicated a large number of very small catches during the second quarter of that fiscal year. This would correspond to the months of April - June and this may suggest fishing on new recruits. In addition, the low estimated mean catch per trip may be an artifact of the overall low sampling rate. These data indicate that trap red hind CPUE has significantly increased since 1984/1985. Mean weight per trip of red hind from hook and line landings varied without trend from 1984/1985 to 1987/1988 and showed slight increases thereafter. Mean weight landed per trip of red hind from trap landings showed a steadily increasing trend over the entire time series.

Observed mean catch per trip of red hind from 1984/1985 - 1990/1992 ranged from 23 fish to 107 fish for the trap fishery again steadily increasing over the period as observed with mean weight per trip (Figure 4). This increase was very pronounced in recent years and over the entire period represents a significant increase in catch per trip. Estimated mean catch per trip of red hind per trip from the hook and line fishery fluctuated from five fish per trip to 50 fish per trip again varying without any evidence of strong trend as with average weight per trip of red hind from hook and line landings.

Coney landings from trap gear averaged from about five pounds to near ten pounds between 1984/1985 and 1989/1990 generally showing a strong declining trend in mean weight per trip. Coney caught by hook and line gear ranged from less than one half pound to five pounds. The 1990/1991 observations for both gears and the 1988/1989 hook and line observations were excluded from this discussion as they indicated exceptionally small, and questionably so, fish were being landed. Although, the data for hook and line gear are more variable the trend is still a declining one. Coney mean catch per trip from trap trips varied from nine fish to 24 fish over the period showing a slight decline between 1986/1987 and 1989/1990 (Figure 5). Mean catch per trip of coney from hook and line trips averaged 1 fish to 25 fish again varying without trend.

In summary, both coney and red hind were more frequently caught with trap gear. Coney were caught (landed) at a much lower rate than red hind from both trap and hook and line fishing gear on the island of St. Croix. Also, coney mean catch (i.e., numbers caught per trip) rates were much more variable than were red hind. Mean weight and catch per trip of coney showed declines over the period and mean catch per trip was much more variable. This suggests that coney may not be targeted at the same level as red hind on the island of St. Croix or are not as available to this fishery as are red hind. Support for the latter hypothesis comes from the observation that mean weight landed per trip of coney showed a decline over the time series. The reef fish fisheries of the

Table 4a. Sample mean weight and the variance of sample mean weight for red hind.

Fiscal Year <sup>1</sup>	Pot Gear				Hook and Line			
	N <sub>1</sub>	N <sub>2</sub>	Sample Average Weight (lbs)	Variance Average Weight (lbs)	N <sub>1</sub>	N <sub>2</sub>	Sample Average Weight (lbs)	Variance Average Weight (lbs)
1983	114	14	0.90	0.29	0	0	-	-
1984	240	68	0.77	0.20	407	12	1.03	0.10
1985	132	32	1.13	0.40	140	4	1.19	0.08
1986	559	77	1.24	0.37	278	10	1.14	0.38
1987	347	90	1.02	0.51	557	33	1.37	0.20
1988	342	65	1.00	0.13	180	17	1.34	0.16
1989	138	27	1.12	0.19	431	12	1.58	0.11
1990	27	12	0.97	0.02	296	9	1.57	0.12
1991	16	5	1.05	0.02	48	4	1.00	0.09
1992	0	0	-	-	7	1	1.22	-

- denotes no information available

Table 4b. Sample mean weight and the variance of sample mean weight for coney.

Fiscal Year <sup>1</sup>	Pot Gear				Hook and Line			
	N <sub>1</sub>	N <sub>2</sub>	Sample Average Weight (lbs)	Variance Average Weight (lbs)	N <sub>1</sub>	N <sub>2</sub>	Sample Average Weight (lbs)	Variance Average Weight (lbs)
1983	394	15	0.50	0.01	0	0	-	-
1984	1872	81	0.47	0.02	187	12	0.34	0.01
1985	381	29	0.56	0.03	13	1	0.48	-
1986	1444	83	0.51	0.01	203	3	0.47	0.01
1987	1712	109	0.51	0.08	380	16	0.47	0.01
1988	1168	75	0.43	0.01	4	1	0.52	-
1989	349	21	0.51	0.03	40	5	0.50	0.02
1990	1	1	0.66	-	9	3	0.61	0.04
1991	3	3	0.62	0.00	10	1	0.40	-
1992	0	0	-	-	0	0	-	-

- denotes no information available

Table 5. Observed mean weight (pounds) of red hind and coney landed per trip for the island of St. Croix.

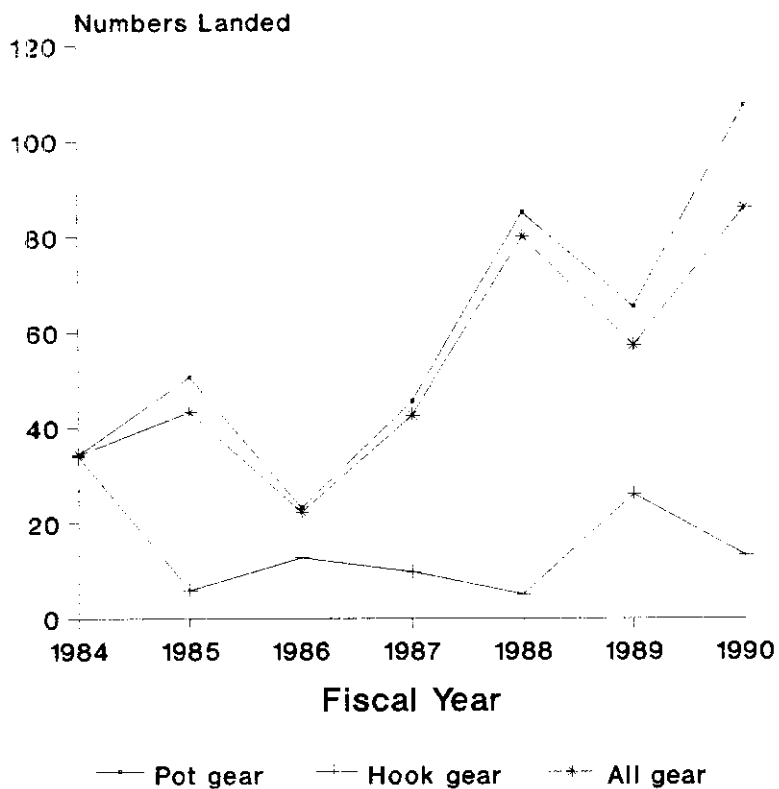
Species	Fiscal Year	Pot	(N)	Hook	(N)	All	(N)
Red hind	1984	39.49	(83)	31.60	(22)	38.22	(107)
	1985	59.31	(48)	17.43	(25)	53.99	(73)
	1986	26.99	(90)	1.29	(48)	9.42	(138)
	1987	54.50	(99)	8.74	(100)	43.28	(206)
	1988	95.75	(74)	4.98	(106)	79.93	(180)
	1989	68.36	(31)	20.62	(58)	48.03	(89)
	1990	119.89	(71)	22.62	(34)	81.98	(51)
Coney	1984	10.09	(83)	4.76	(22)	9.40	(107)
	1985	4.81	(48)	0.80	(25)	4.30	(73)
	1986	8.59	(90)	0.30	(48)	2.92	(138)
	1987	7.25	(99)	1.24	(100)	5.78	(206)
	1988	6.41	(74)	0.01	(106)	5.30	(180)
	1989	6.19	(31)	0.48	(58)	3.76	(89)
	1990	0.04	(71)	0.18	(34)	0.10	(51)

N = Number interviews available.

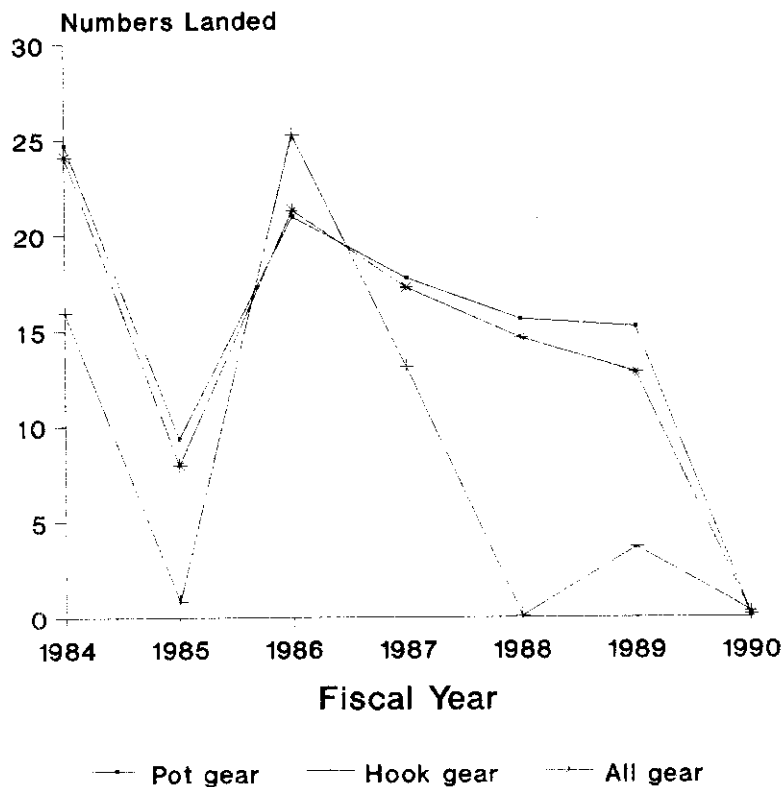
Table 6. Observed mean catch (number of fish) of red hind and coney caught per trip for the island of St. Croix.

Species	Fiscal Year	Pot	(N)	Hook	(N)	All	(N)
Red hind	1984	34.37	(83)	33.99	(22)	7.19	(107)
	1985	34.27	(48)	50.54	(25)	43.26	(73)
	1986	23.18	(90)	12.79	(48)	22.35	(138)
	1987	45.44	(99)	9.70	(100)	42.48	(206)
	1988	84.84	(74)	4.93	(106)	79.80	(180)
	1989	65.11	(31)	26.06	(58)	57.02	(89)
Coney	1990	106.83	(17)	13.22	(34)	85.62	(51)
	1984	24.09	(83)	15.94	(22)	24.08	(107)
	1985	9.33	(48)	0.81	(25)	7.94	(73)
	1986	20.94	(90)	25.22	(48)	21.28	(138)
	1987	17.73	(99)	13.08	(100)	17.24	(206)
	1988	15.57	(74)	0.06	(106)	14.59	(180)
	1989	15.14	(31)	3.66	(58)	12.76	(89)
	1990	0.09	(71)	0.28	(34)	0.13	(51)

N = Number interviews available.



**Figure 4.** Mean catch per trip of red hind for St Croix landings, 1983 - 1990.



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**Figure 5.** Mean catch per trip of coney for St Croix landings, 1984 - 1990.

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U.S.V.I. are not directed at a single species and therefore the absence or declining catch of coney seems to be more suggestive of declining availability. In addition, the information presented on mean individual weight, mean individual length and sample average weight indicate that although, coney have shown large variation in size, that significant and dramatic declines in mean sizes have not occurred in the last ten years or at least not supported from the available data suggesting a change in availability rather than a shift in target species.

*Total Catch and Total Yield In the Fishery* — Estimated mean catch and mean weight per trip of red hind and of coney from interviewed complete catch samples and enumerated fishing effort data from the trap and hook and line fisheries were used to develop estimates of total catch and total weight landed of these species by trap and hook and line gear on St. Croix. Interviewed catch per trip was recorded for 1983/1984 through 1991/1992 from by CSP TIP and daily fishermen's fishing reports that were coded for fishery and gear existed for 1987/1988 - 1992/1993 fiscal year. Thus, total catch of red hind and coney in St. Croix could be estimated from the 1987/1988 fiscal year through the 1990/1991 fiscal year.

The rate of trip sampling for mean catch and weight was very low. During the four year period, 1987/1988 - 1990/1991 between 51 and 206 complete catch interviews (fishing trips) were taken annually (Table 3a,b). For the same period, the total number of reported fishermen's trips ranged from 3,311 to 7,281 for St. Croix, indicating a sample rate ranging from 0.8 % (1990) to 6 % (1987). Variance estimates and calculated confidence intervals around the point estimates of total catch and weight landed were large indicating sampling levels for the total fishery were un-reasonably low and added uncertainty to the overall estimates. Although, fpc adjustments were not made to variance estimates of the strata means this is not thought to have drastically impacted the width of estimated confidence intervals.

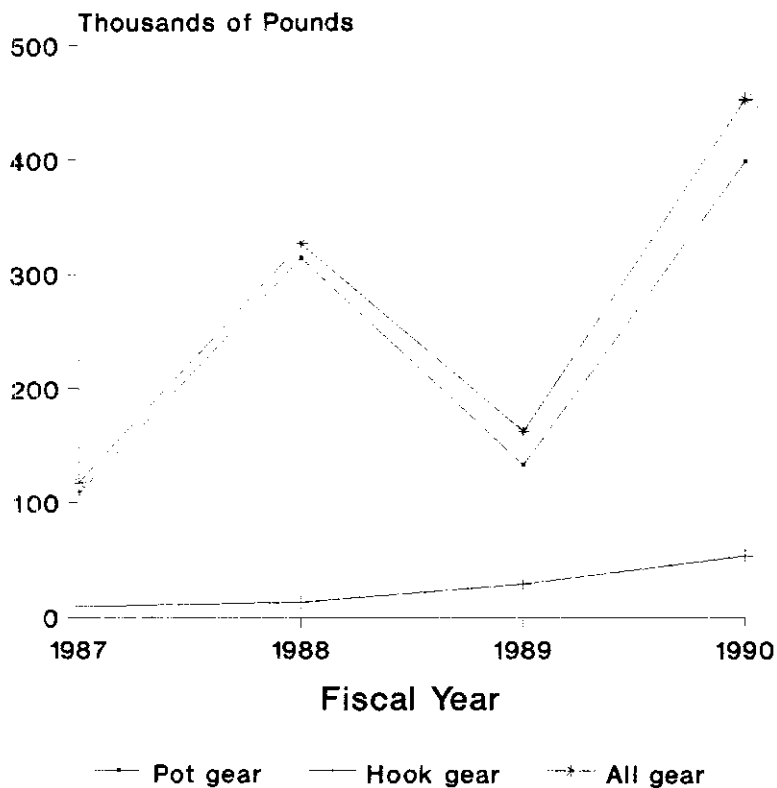
For the four year period, 1987/1988 - 1990/1991, for which mean catch and weight and effort statistics were made, total fishery yield of red hind and coney (combined) on the island of St. Croix by trap and hook and line gear (combined) ranged from 133,444 pounds (1987/1988) to 450,512 pounds (1990/1991). Total catch landed of red hind and coney varied from 149,616 fish (1987/1988) to 383,393 fish (1990/1991). The four year trend in both total catch and weight shows a steady increasing trend excepting in 1989 the year of the major fall storm that swept the island of St. Croix. The most significant portion of the total landings in weight and in catch came from trap gear, ranging from 79 % to 96 % by number and from 82% to 96% by weight over the period.

The proportion of the landings by gear for red hind and coney may be compared with previous estimates of percentage landings by gear made by

Coleman *et al.* (1979) and Barshinger (1993) described earlier in this report. These comparisons can also be used to judge to whether the data and the estimation procedure used to estimate total catch and weight in this study were reasonable in terms of patterns in overall landings by gear. In addition, the change in landings between gears suggested by Barshinger (1993) can be further evaluated. The range of values, partitioned by gear, for red hind and coney over these four years does not provide any support for a large increase in landings by hook and line gear as suggested by Barshinger. These data, albeit for a very limited time series and for only two of all reefish species landed in the U.S.V.I., suggest that trap gear still dominate the landings and shifts in percentage landings by gear varied without trend.

As indicated from overall trends in mean catch per trip, red hind was the dominant component of the total catch (and weight) landed from both trap and hook and line landings of St. Croix for the four year period (Figure 4). For both gears, red hind ranked from 67% to 99% of the total catch landed and from 88 to 99% of the total weight landed. A very small number of catch trip samples were available for the most recent years to calculate observed catch and weight per trip ( $n = 89$  in 1989/1990, 51 in 1990/1991) and the resulting variance estimates of the means are quite large. Because the overall fishery trip sampling rate is very low, extreme caution should be used when using the results for other than detecting major trend changes. Estimated red hind landings by trap gear ranged from 108,564 pounds to 396,116 pounds between 1987/1988 and 1990/1991 (Figure 6). Over the same period, estimated red hind landings from hook and line gear showed an increasing trend from 9,124 pounds to 53,835 pounds. The trend in red hind landings is an increasing one for both gears since 1987/1988.

Red hind are mainly caught by trap and hook and line gear in the U.S.V.I.. The quantity of landings from other gears are believed to be a very minor part of the current total landings for these species. This is supported by the proportional distribution of daily reported fishing trips using nets, spearguns, and seines, that made up on average from four to eleven percent annually, of the total number of fishing reports (Table 1). Over the five year period for which daily fishing records were available fishing trips using nets showed a slight upward trend. These primary gears, traps and hook and lines, are then thought to exploit the majority of red hind and coney in the U.S. Virgin Islands fisheries. The fishermen interviews available through the NMFS, CSP were assumed to all have been taken from the islands of St. Croix based on visual inspection of the raw data forms as was the case of individual size and sample average weight data. Estimated total landings and catch were calculated for only St. Croix at this time since the data required by the procedure used to estimate total catch and yield was not available for the other islands.



**Figure 6.** Estimated total yield of red hind for St. Croix, 1987 - 1990.

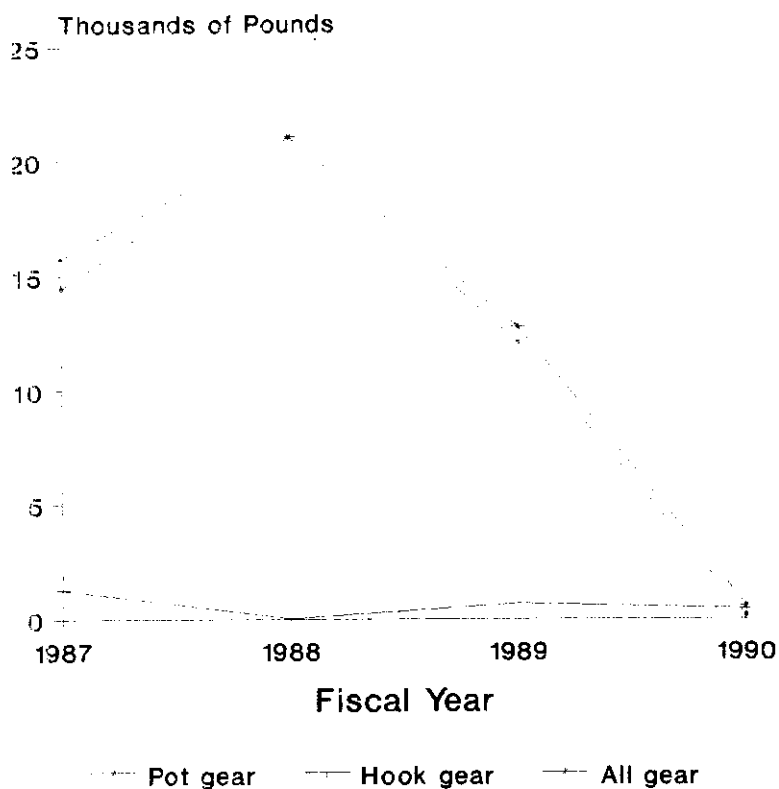
Coney landings showed more variability over the four year period with the majority of catch and weight being taken by trap gear. Total weight landed of coney from trap gear varied from 12,051 pounds to 14,442 pounds and for hook and line gear from less than 50 pounds to 1,294 pounds. A cursory examination of the stratum mean catch and weight statistics for coney from Appendices 3 and 4 indicated aberrant points for hook and line catches in 1988 and for 1990 both gears so these years are excluded from this discussion regarding trends. Trends in coney yield is shown in Figure 7.

### **Red Hind Stock Status**

Calculated CV's for the MLE estimates that are of most interest (abundance levels and gear efficiency factors) are reasonably low, less than ten percent, in spite of very low sampling rates and large variation (wide confidence intervals) in total catch estimates. The overall results indicate trap fishing is clearly the major source of fishing mortality for red hind, and accounted for over 95% of the total death rate annually from 1987/1988 - 1990/1991. These findings suggest that the efficiency (catchability) of fish traps was one order greater than that of hook and line gear. This finding is also supported by catch and fishing effort and observed mean catch and weight per trip (Table 3a). The SLM model assumed constant catchability so changes in gear efficiency over time the four year period would not be surfaced through this analysis, however, there is no evidence of a change in fishery practices during this period, 1987 - 1990.

The annual fishing mortality significantly increased between 1987/1988 and 1988/1989, declined in 1989, and increased in 1990/1991. A large increase in fishing effort occurred between 1987/1988 and 1988/1989. The decline in estimated fishing mortality in 1989/1990 occurred during the year in which a major fall storm swept the island of St. Croix.

The initial abundance (N) estimates shows an increasing trend during the four year period (Figure 6). Results indicate that abundance for 1990/1991 was about 47% higher than for 1988/1989, the year before the major hurricane. The model does not contain size structure information so recruitment estimates includes fish that immigrate into the fishery area (immigrants) plus those that grow from a size too small to be caught to a catchable size during the year (Recruits). These results indicated that recruitment was variable without trend over the four year period and suggests that production of the fishery may be very dependent upon total Recruitment. This component, R, would also include individuals that move into the nearshore fishing grounds from offshore areas not traditionally fished because of the vast distances and need for bigger vessels.



**Figure 7.** Estimated total yield of coney for St. Croix, 1987 - 1990.

These findings (increasing fishing mortality, variable recruitment, stable abundance) are supported by: 1) a clear trend of increasing effort in both trap and hook and line fisheries as reported by fishermen (Figure 1); 2) increasing mean catch and weight by fish traps observed from port samples increasing mean weight landed by hook and lines (Table 3a,b) stable catch (numbers) of red hind caught by hook and line gear as evidenced from samples; and 5) slight trends of declining sample average weight in recent years from both trap and hook and lines, with the trend being clear for traps since 1990 and for hook and line gear since 1986).

### **Coney Stock Status**

The weight based abundance estimation model was also applied to the coney data without success. Initial trials to locate reasonable estimates for the stocksize and recruitment parameters failed to converge. The data were not sufficient to estimate coney population and fishery statistics (abundance, recruitment, fishing mortality rates, catchability coefficients).

### **SUMMARY**

The number of licensed fishermen from the islands of the U.S.V.I. ranged from 281 to 846 between 1974 and 1982 varying without trend. The percentage fishermen reporting increased from 6% to 88% between 1974 and 1978 and remained stable after 1979. Total reported finfish landings increased from 235,317 lbs in 1974/1975 to 1,100,028 lbs in 1992/1993 with the largest increase observed between 1974 and 1978 and a stable trend observed after 1979. Nearly 90 % of the fishermen reported using traps and an estimated 59% of the total reefish fishing trips used trap gear between 1987 and 1991. Estimated total reefish effort increased by about 43% from 1987 through 1991 with an 86 % increased in total effort for the island of St. Croix. The increasing effort trend observed for St. Croix and the stable landings trend may indicate the fishery is at the maximum production.

Biostatistical sampling data were available from 1983-1991 for St. Croix. These samples showed that U.S.V.I. fishing trips using traps were sampled more frequently than hook and lines. Red hind were encountered more frequently than were coney in the catch sampling. Coney were rarely observed in the catches. Red hind made up from 67% to 99% of the total number landed and from 88 % to 99% of the total weight landed per trip. Red hind mean length declined slightly between 1984 and 1991 on St. Croix. Sample average weight of red hind declined after 1990 for both trap and hook and line catches. Confidence in

average size trends is reduced because of low sample sizes and missing years. Data were insufficient to detect trends in coney average length and weight

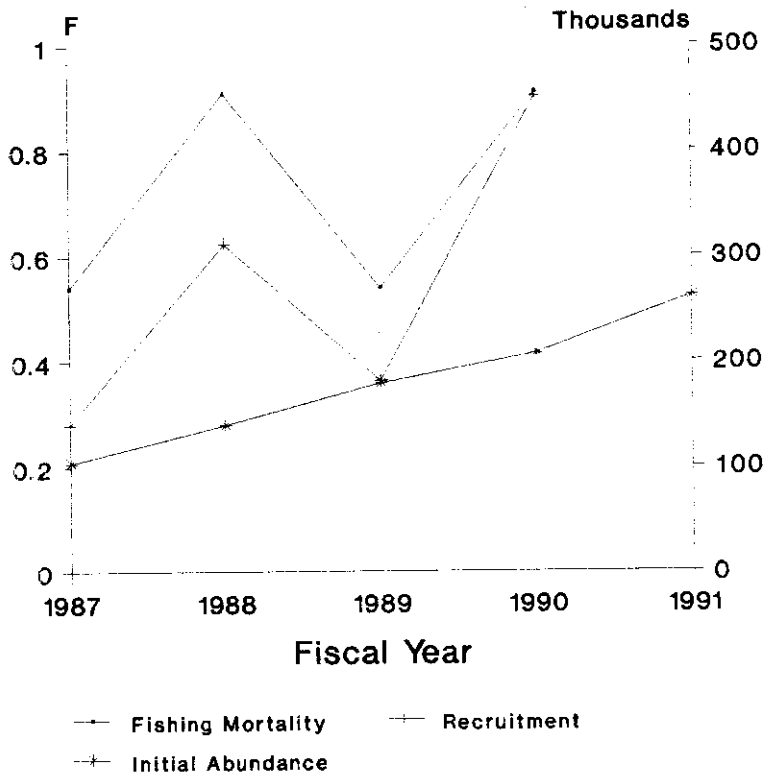
statistics.

Red hind CPUE showed increasing trends in weight and catch over the study period, 1984-1990, with hook and line CPUE more variable. The largest CPUE increases were with trap gear. Coney CPUE showed a continual declining trend over the entire study period.

Red hind estimated total catch increased more than two fold from 1987-1990 from 100,642 fish to 384,429 fish, with the trap fishery dominating comprising from 82% to 96% by weight of the landings and from 79% to 96% of the catch. Coney estimated total catch declined by 98% and yield declined by 96% over the same period.

Estimated fishing mortality on red hind showed an upward trend between 1987 and 1990. Fish traps were the dominant component of total exploitation on red hind. Estimated total abundance of red hind was very variable over the same period. The basic data were inadequate to obtain information on fishing mortality and abundance.

This study documented an increase in fishing effort of the U.S.V.I. trap and hook line fisheries. The results of this study corroborate previous reports of declining average size of red hind off St. Croix. In addition, the abundance model results from this study suggests that fishing mortality on red hind increased between 1987 and 1991 off St. Croix. When taken in total the results of this study argue for action to be taken in the short-term on reductions in total fishing effort across all trap fisheries in the U.S.V.I.. In addition, the results of this study support the long-term need for improved biostatistical monitoring of the U.S.V.I. reefish fisheries.



**Figure 8.** Population statistics for red hind from St. Croix, 1987 - 1991.



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