Resource Evaluation of the Bigeye Scad, *Selar crumenopthalmus* (Bloch), in the Insular Shelf Waters Around St. Croix, U.S. Virgin Islands

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ABSTRACT

The bigeye scad *Selar crumenopthalmus* is a circumtropical, neritic, schooling carangid species which is seasonally abundant in the shelf waters around St. Croix. Locally called "jackfish" the demand for this species is so great that it is the preferred species when sold next to fresh reef fish at a dealer price of $2.50/pound. Commercial landings catch statistics indicate that it is occasionally harvested by seine net; however, for the most part, it represents an underutilized fishery resource due to the lack of knowledge of the basic biology of the species and appropriate harvesting techniques. Handline fishing techniques, similar to those used for bigeye scad in the Hawaiian Islands but unknown to local fishermen, were employed at two locations off the north and west coasts of St. Croix. Results from a 12-month resource survey show that during 322 hours of fishing, 5028 fish weighing a total of 1997 pounds were caught using homemade jigs on multiple hook leaders (4909 bigeye scad weighing 1851 pounds). Fishing trips averaged 3.7 hours with a mean of 59 fish caught weighing 23.5 pounds. The mean CPUE in pounds/hour/trip, pounds/hour/fisherman and pounds/hour/hook was 5.64, 1.48 and 0.26, respectively. An additional 565 fish weighing 466 pounds were caught with monofilament gill nets. By-catch species caught with handline fishing techniques and gill nets accounted for 6% of the total number of fish caught and 22% of the total catch weight. Based on predicted annual landings of 7.5 to 15.0 tons/year, bigeye scad have the potential to support an alternate nighttime fishery on St. Croix.

INTRODUCTION

The commercial fishery of the U.S. Virgin Islands has increased from early records at the time of United States purchase of the islands from 168 fishermen and 204 boats landing 590,000 pounds of catch (1917 U.S. Virgin Islands census) to its present state of 454 licensed fishermen landing an estimated 2,915,678 pounds (Clavijo, *et al.*, 1984). Fish traps are the most popular fishing method employed (Sylvester and Dammann, 1972), followed by lobster traps and seine fishing in St. Thomas-St. John and line fishing and diving in St. Croix.

Data collected on the gradual expansion of this fishery by Fiedler and Jarvis (1932), Dammann (1969), Swingle *et al.* (1970) and Sylvester *et al.* (1977) have been compiled with mandatory catch and effort information collected annually from commercial fishermen by the Division of Fish and Wildlife (Wood and Olsen 1983). These data indicate the Virgin Islands fishery is approaching the limits of resource potential of the insular shelf platforms (Olsen *et al.*, 1983).

The Virgin Islands commercial fishery has traditionally been a multi-species, multi-method fishery because of limited availability of any one resource for profitable commercial exploitation year-round. An economic analysis of the Virgin Islands commercial fishery shows net returns above variable and total costs for boats less than 22 feet, 22-30 feet, and greater than 30 feet to be $8,185/5,644, $16,017/11,870 and $20,801/5,448, respectively. Profitability decreases with increased boat size (Olsen and Wood, 1983).

Virgin Islanders consume approximately eight-million pounds of seafood annually, five-million pounds in excess of the annual landings. To further compound the problem, the fear of ciguatera fish poisoning forces many consumers to purchase imported species rather than supporting the local fishery. This study was the first in a series of resource evaluation projects designed to increase the current knowledge on and to determine the harvest potential of undeveloped or underutilized fish species.

Carangids are highly esteemed as food fishes throughout the Caribbean (Böhlke and Chaplin, 1968; Randall, 1968). The reported annual catch of carangids in 1975 from the Western Central Atlantic, including the Caribbean, was in excess of 13,100 tons (FAO, 1978). Richards (1984) found that carangid larvae ranked second in occurrence and in the top ten in numbers of collection tows made in the Caribbean Sea. Based on recorded landings (weight), carangids represent one of 13 families of fishes considered important in the Puerto Rico and U.S. Virgin Islands fisheries. The importance of these and related resources are stressed in the Shallow-Water Reef Fish Management Plan for Puerto Rico and the U.S. Virgin Islands (Caribbean Fishery Management Council, 1979).

The bigeye scad, *Selar crumenopthalmus,* is a circumtropical, neritic, schooling carangid species (Jordan and Everman, 1905; Smith, 1949; Herre, 1953) which is seasonally abundant in the insular shelf waters around St. Croix. Personal observations and catch statistics indicate that it is occasionally harvested by seine/surround net, but, for the most part, represents an underutilized fishery resource due to the commercial fishermen's lack of knowledge of the basic biology of the species and appropriate harvesting techniques. Locally called "jackfish" in the Virgin Islands, bigeye scad are imported seasonally to St. Croix from the British Virgin Islands. The demand for this species is so great that it is the preferred species when sold next to fresh, locally-caught reef fish, both at $2.50/pound. Little information is available

about this species in the Caribbean; however, it has been reported that 2,917 tons of bigeye scad were taken from coastal waters around Venezuela (2,617 tons) and Grenada (300 tons) in 1976 (FAO, 1978). Besides considered good eating, bigeye scad are highly rated as baitfish for tuna, dolphin, wahoo and billfish. Richards (1984) noted that *Selar crumenopthalmus* larvae were common among neuston net tows made during the summer months in the Caribbean.

In Hawaii, the bigeye scad or "akule" is the most abundant carangid and has always been one of Hawaii's most important fishery resources. "Akule" ranks third, behind skipjack and yellowfin tuna, in Hawaiian landings and fourth in value of landings (Department of Land and Natural Resources - State of Hawaii, 1979). Commercial landings of 415,337 lbs of "akule" were reported in 1978, valued at $388,713.00. Surround nets, deployed during the day from large vessels with the aid of spotter planes to locate fish schools, and handline techniques, employed by fishermen in small vessels at night, account for 80% and 20% of the commercial landings, respectively. The biology of bigeye scad or "akule" has been detailed by Kawamoto (1973) in relation to developing management plans for this resource in the Hawaiian Islands.

Due to the seasonal abundance of bigeye scad in the inshore waters around St. Croix, low commercial fishing effort for the species and its high local demand and market value, the bigeye scad was selected as a subject for a resource development project for undeveloped and underutilized fish species. The objectives of this project were:

1. To determine the distribution of the bigeye scad on the insular shelf platform.
2. To assess the commercial and recreational significance of this fishery resource as a food fish and baitfish.
3. To research harvest methods for maximum sustainable yield for commercial and recreational fishermen.
4. To train Virgin Islands fishermen in utilizing new fishing techniques to harvest bigeye scad through their participation in the project.
5. To recommend management plans to provide for the continued harvest of this resource, if necessary.

METHODS

Based on the results from exploratory fishing effort for bigeye scad and site accessibility, two sites around St. Croix were selected for concentrated fishing effort. These two sites were off the west coast of Buck Island and the northwest side of Sandy Point (Figure 1). The project generated a significant amount of interest in the commercial fishing community, such that several fishermen generously donated the use of their vessels for the fishing effort. As a result, several monthly fishing survey trips were made possible at each location in the

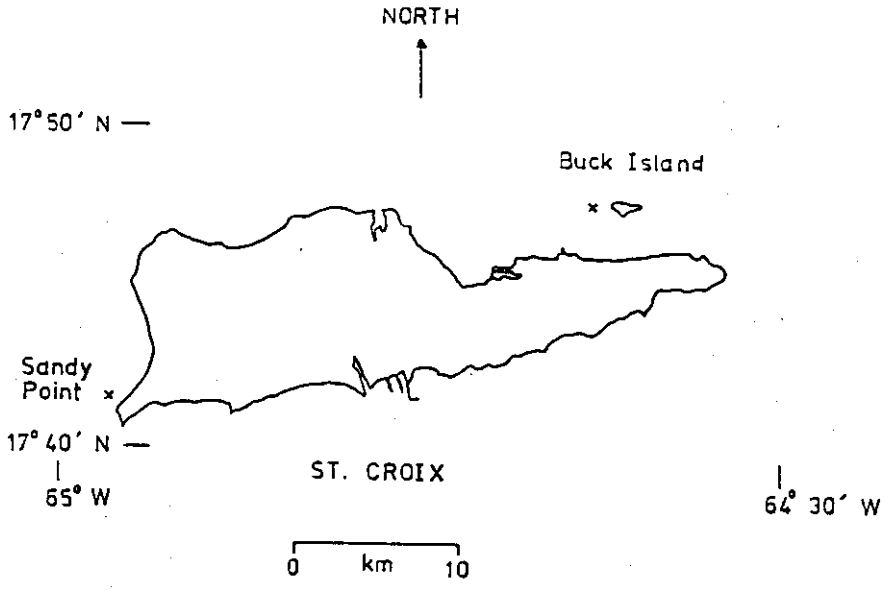

Figure 1. Location of the two bigeye scad study sites in St. Croix, U.S. Virgin Islands: (1) off the west coast of Buck Island and (2) off the northwest side of Sandy Point.

Division of Fish and Wildlife (DFW) vessel and/or privately-owned commercial fishing vessels. Commercial and recreational fishermen participated as crew members on each fishing survey trip. Because of the nocturnal feeding habits of the species, fishing effort was concentrated during the two-week period overlapping the dark phase of the last quarter and new moon.

Two fishing methods, new to Virgin Islands fishermen, were employed to catch bigeye scad at night; Hawaiian (Japanese) handline techniques and gill nets. Hand-made jigs, resembling crustacean zooplankters, were made with white nylon line, red nylon thread or red yarn and Mustad Kirby #12 or #14 hooks. A wrap of the nylon line, approximately 2.5 cm in length, was passed through the eye of the hook and held down along both sides of the hook shaft,

while it was secured by wraps of red thread or yarn. This configuration formed the shrimp-like body of the jig. The jig was then snelled with a 10.0 cm length of 14 kg test monofilament leader and four or five jigs attached one above the other on a main dropper line with a 150 - 300 g weight at the bottom.

Once anchored in 15-50 m of water, a 12-volt light was placed over the side of the vessel to attract zooplankters, which in turn would attract feeding bigeye scad. Handlines with artificial jigs were dropped to the bottom and jigged back to the surface to locate the passing schools of scad. Live scad were also used as bait on heavier handlines and fished simultaneously for large predator fishes. Because of its simplicity, low cost required for materials and effectiveness, handlining for bigeye scad was the primary method employed.

A second fishing method used for bigeye scad involved the deployment of sinking monofilament gill nets, 45.7 m in length and 2.4 m deep. Mesh size was 3.2 cm square and 6.4 cm stretch. To set the net, the fishing vessel was securely anchored and sufficient rope was played out on the anchor line to allow deployment of the net in 15-50 m of water. The vessel moved back up on the anchor line rope until the entire net was set on the bottom. A sufficient distance was allowed between the vessel and the net to allow handline fishing while the net fished. Retrieval of the net was accomplished by reversing the setting procedure. The availability of a second net precluded the need to immediately remove the catch to get the net back in the water to fish and improved overall fishing productivity.

Catch and effort data were obtained from handline and gill net fishing methods and, in combination with port sampling interviews, were used to determine bigeye scad abundance and seasonality. To assess the population structure, a biostatistical sampling program was conducted, consisting of individual length and weight measurements from a subsample of 50 scad per month at the Buck Island and Sandy Point study sites. Sex and gonadal condition of fishes were also recorded. Marketing surveys of bigeye scad caught during the project were conducted through two local fish shops.

ACCOMPLISHMENTS

The monthly catch and effort summary for bigeye scad from January through December 1986 at the Buck Island and Sandy Point, St. Croix, study sites is shown in Table 1. A total of 38 fishing survey trips were made to Buck Island (37 trips by two commercial fishermen and 1 by DFW) and 47 trips to Sandy Point (12 trips by 4 commercial fishermen and 35 by DFW) resulting in 130.5 and 191.5 hours of handline fishing effort, respectively. At Buck Island and Sandy Point, 2,714 and 2,316 fish were caught weighing 1,241 and 756 pounds, respectively (4,909 bigeye and weighing 1,851 pounds). Fishing trips averaged 3.7 hours in length with a mean of 59 fish caught weighing 23.5 pounds.

Table 1a. Monthly catch and effort summary for bigeye scad caught by line fishing January-December 1986, at the Buck Island and Sandy Point, St. Croix study sites. The number of fish caught and pounds of catch includes by-catch species.

LOCATION: BUCK ISLAND/ SANDY POINT
LINE FISHING

	Trips	Fishermen	Hours Fished	Hooks Fished	Fish Caught	Pounds of Catch
Jan.	1/2	4/9	4.0/11.0	20/40	295/493	110/143
Feb.	3/7	13/22	11.5/29.0	50/100	230/765	134/227
March	5/5	23/15	21.0/21.0	100/75	1052/244	470/73
April	5/3	20/16	18.0/13.0	100/60	323/51	136/9
May	3/4	13/14	12.5/16.0	65/70	340/144	156/83
June	7/7	25/26	29.5/26.0	125/130	240/203	113/68
July	1/5	4/12	3.5/22.0	20/60	23/134	23/52
Aug.	4/2	14/6	9.5/7.0	70/30	52/34	23/16
Sept.	2/3	7/8	7.0/11.5	35/40	63/74	23/31
Oct.	3/4	9/16	7.5/16.0	45/80	67/84	43/28
Nov.	1/2	4//6	1.5/8.0	20/30	11/30	8/10
Dec.	3/3	10/9	5.0/11.0	50/45	10/60	2/16
Totals:	38/47	146/159	130.5/191.5	700/770	2714/2316	1241/756

Ordering delays resulted in the late arrival of gill nets at the end of July. Twenty six gill net sets were made from August through December representing 44.5 hours of effort. A total of 565 fish were caught weighing 466 pounds (501 fish weighing 425 pounds at Buck Island and 64 fish weighing 41 pounds at Sandy Point). Of this total, 326 fish were bigeye scad weighing 131 pounds. The mean catch per unit effort (CPUE) in pounds per hour per trip, pounds per hour per fishermen, pounds per hour per hook and pounds per hour per set was 5.64, 1.48, 0.26 and 10.99, respectively.

Table 2 lists the bigeye scad by-catch for the period January through December 1986. A total of 29 species of fish were caught, 360 fish weighing 575.1 pounds. By-catch species represented 6% of the total number of fish caught and 22% of the total catch weight. The most numerous species caught on bigeye scad handlines were horse-eye jacks (*Caranx latus*), longspine squirrelfish (*Holocentrus rufus*) and blue runners (*Caranx crysos*). King mackerel (*Scomberomorus cavalla*) was the most abundant species caught on handlines with live scad as bait. Lane snapper (*Lutjanus synagris*), blackfin snapper (*Lutjanus buccanella*), and bar jacks (*Caranx ruber*) were the most common by-catch species caught in the gill nets.

Table 1b. Monthly catch and effort summary for bigeye scad caught by net fishing January-December 1986, at the Buck Island and Sandy Point, St. Croix study sites. The number of fish caught and pounds of catch includes by-catch species.

LOCATION: BUCK ISLAND/ SANDY POINT
NET FISHING

	Hours Fished	Sets	Fish Caught	Pounds of Catch
Jan.	-	-	-	-
Feb.	-	-	-	-
March	-	-	-	-
April	-	-	-	-
May	-	-	-	-
June	-	-	-	-
July	-	-	-	-
Aug.	6.5/-	5/-	209/-	91/-
Sept.	5.0/-	5/-	114/-	55/-
Oct.	3.0/7.5	2/3	29/3	217/2
Nov.	-/6.5	-/2	-/30	-/16
Dec.	5.5/10.5	4/5	149/31	62/23
Totals:	20.0/24.5	16/10	501/64	425/41

The number of fish caught per month at the two study sites is shown in Figure 2. The number of fishing survey trips per site is indicated above each data set and the total number of bigeye scad caught is in parenthesis. The greatest numbers of fish were caught during the months of January (788), February (995) and March (1296). A second lower peak was present in April, May and June. By June, increased fishing effort did not result in greater catch rates. Fishing effort with gillnets was initiated in August. Net and handline catches of bigeye scad are indicated separately from August to December 1986 in Figure 2.

The fork length, weight and gonadal condition of bigeye scad were sampled monthly from catches at Buck Island and Sandy Point from January through December 1986. These data are presented in Table 3. Subsample size consisted of 50 randomly-selected individuals, when possible. Mean length and weight of scad sampled at Buck Island increased from 199.7 mm and 143.0 g in January to 227.9 mm and 223.8 g in June. September and December data reflect the presence of smaller individuals dominating the catch. The Sandy Point subsample of fish initially had a mean length of 186.7 mm and mean weight of 121.7 g in January and increased slowly to 207.9 mm and 201.7 g in August. The trend in September and December catches was also to smaller individuals.

Table 1c. Monthly catch per unit effort summary for bigeye scad January-December 1986, at the Buck Island and Sandy Point, St. Croix study sites. The number of fish caught and pounds of catch includes by-catch species.

LOCATION: BUCK ISLAND/ SANDY POINT
CATCH PER UNIT EFFORT (LBS./HR.)

	Per Trip	Per Fisherman	Per Hook	Per Set
Jan.	27.50/6.50	6.88/1.44	1.38/0.33	-
Feb.	3.88/1.12	0.90/0.36	23/0.00	-
March	4.48/0.70	0.97/0.23	0.22/0.05	-
April	1.51/0.23	0.38/0.04	0.08/0.01	-
May	4.16/1.30	0.96/0.37	0.19/0.07	-
June	0.55/0.37	0.70/0.30	0.14/0.06	-
July	6.57/0.47	1.64/0.20	0.33/0.04	-
Aug.	1.78/1.14	0.17/0.38	0.03/0.08	2.80/-
Sept.	1.64/0.90	0.47/0.34	0.09/0.07	2.20/-
Oct.	8.25/0.32	2.75/0.08	0.12/0.02	36.17/0.09
Nov.	5.33/0.90	1.33/0.30	0.27/0.04	-/1.23
Dec.	2.03/0.60	0.61/0.20	0.01/0.03	2.82/0.44
Totals:				
Mean	5.64/1.21	1.48/0.35	0.26/0.07	10.99/0.59
s_x	7.26/1.70	1.83/0..36	0.37/0.08	16.78/0.58

Male to female ratio of the Buck Island and Sandy Point fishes sampled were 1:1 and 1:1.5, respectively. Ripe females were more numerous in samples from March through September at both study sites. The length-frequency histogram for the bigeye scad sampled at the two study sites is shown in Figure 3. The Buck Island subsample consisted of larger individuals (21-23 cm) compared to the individuals sampled from catches at Sandy Point (19 -22 cm).

Statistical analysis of length/weight data from bigeye scad caught at Buck Island and Sandy Point indicates a significant difference for both scad lengths and weights at the two study sites. The mean length and weight for scad caught at Buck Island was 212.56 mm (S.D. = 18.54) and 173.56 g (S.D. = 43.72), respectively, while length and weight for scad caught at Sandy Point was 198.98 mm (S.D. = 18.61) and 149.22 g (S.D = 40.26), respectively (t-test 11.91; $p < 0.001$).

Regression analysis demonstrated a significant regression between length and weight at both study sites ($p < 0.001$). The regression equations for Buck Island and Sandy Point scad was wt = -246.69 + 1.98 x length and wt = -163.63 + 157 x length, respectively (Figure 4).

Catch rates from the handline fishing effort for bigeye scad on St. Croix fluctuated widely, varying from only a few fish caught per night to high catches of 398 fish (156 pounds) and 346 fish (105 pounds) per night at the Buck Island and Sandy Point study sites, respectively. A mean catch rate of 59 fish weighing 23.5 pounds per trip was recorded over the 12 month study period. This catch rate is similar to that obtained for bigeye scad, "akule", in the Hawaiian Islands (Kawamoto, 1973; Department of Land and Natural Resources-State of Hawaii, 1979).

Although not adequately shown in this study with high catch rates, the most productive fishing methods for bigeye scad would be a combination of handline and gill net techniques. Handline fishing alone has accounted for as much as 120 pounds of fish in two hours of nighttime fishing effort by five fishermen. Gill net catches at Buck Island on non-productive nights during August, September and December averaged three to four times more fish than handline catches; however, certain problems are apparent with their use. Sinking gill nets can not be deployed in areas of bottom obstructions (*i.e.*, coral reefs) and floating nets are difficult to manage in areas of strong currents or frequent current directional changes. Large predator fishes, such as kingfish or sharks, can destroy large sections of the net within set times of less than one hour by feeding on gilled fishes or becoming entangled in the net themselves. Net repairs or replacement Nightime catch rates can be supplemented by using scad as live bait. Data presented in Table 2 indicate that live jacks are an excellent bait for king mackerel. Inquires have also been made by commercial handline fishermen to obtain bigeye scad as live bait for yellowfin tuna.

Data presented on the numbers of bigeye scad caught per month (Figure 2) indicate that the fish appear to be more abundant during January through March, thus reflecting a seasonal abundance of the resource. Observations made on current speed, current direction and lunar phase indicate that bigeye scad will school and remain in areas where abundant zooplankter food organisms are found. Typically, these areas are on the lee sides of islands or points of land where strong currents sweep past and create eddies in the lee for food organisms to collect. Such is the case of the Buck Island and Sandy Point study sites. Reduced easterly tradewinds, followed by extended periods of calm weather from April through December, resulted in a shift of the westerly current regime to an easterly direction. When these conditions exist, zooplankter food organisms are transported elsewhere, either to other eddies formed in new lee shores along the insular shelf platform or further offshore. This hypothesis has been made as a result of increased fishing effort but low catch rates at the study sites during this period, significantly improved catches at alternate sites and reports that bigeye scad comprise a significant portion of the diet of swordfish caught offshore during the same period. Tagging experiments conducted in Hawaii indicate that very little intermingling or movement of adult schools

Table 2. Bigeye scad by-catch, January—December 1986 (A = fish caught on jigs; B = fish caught on live scad as bait).

Species	Number of Fish			Weight(pounds)	
	Handline		Net	Handline	Net
	A	B			
Caranx latus (horse-eye jack)	40	3	13	57.4	13.3
Caranx crysos (blue runner)	19		12	16.5	11.9
Caranx ruber (bar jack)			23		9.8
Decapterus marcarellus (mackeral scad)			3		0.7
Lutjanus buccanella (blackfin snapper)	1		30	0.3	11.4
Lutjanus synagris (lane snapper)	3		37	2.1	21.4
Lutjanus apodus (schoolmaster snapper)			1		1.0
Lutjanus analis (mutton snapper)	1	2		14.1	
Lutjanus cyanopterus (cubera snapper)			1		0.9
Lutjanus griseus (gray snapper)			1		1.1
Lutjanus mahogoni (mahogany snapper)			3		1.6
Ocyurus chrysurus (yellowtail snapper)	1			0.7	
Epinephelus guttatus (red hind)	3		1	2.5	0.6
Epinephelus cruentatus (graysby)			1		0.5
Haemulon aurolineatum (tomtate)			18		5.2
Haemulon flavolineatum (French grunt)			16		3.8
Haemulon plumieri (white grunt)	3		14	1.0	7.8
Haemulon sciurus (bluestriped grunt)			1		0.5
Priacanthus cruentatus (glasseye snapper)	7		4	3.5	2.8
Holocentrus rufus (longspine squirrelfish)	22		21	7.1	7.7
Myripristis jacobus (blackbar soldierfish)	4		4	1.7	1.0
Harengula humeralis (redear sardine)	1			0.1	
Carcharhinus perezi (reef shark)		1		8.0	
Sphyraena lewini (hammerhead shark)		1	1	35.0	200.0
Scomberomorus cavalla (king mackerel)		12		96.8	
Mulloidichthys martinicus (yellow goatfish)			5		4.0
Chaetodipterus faber (Atlantic spadefish)			1		3.0
Albula vulpes (bonefish)			21		17.4
Gerres cinereus (yellowfin mojarra)			4		0.8
Totals: 29 Species	105	19	236	246.9	328.2

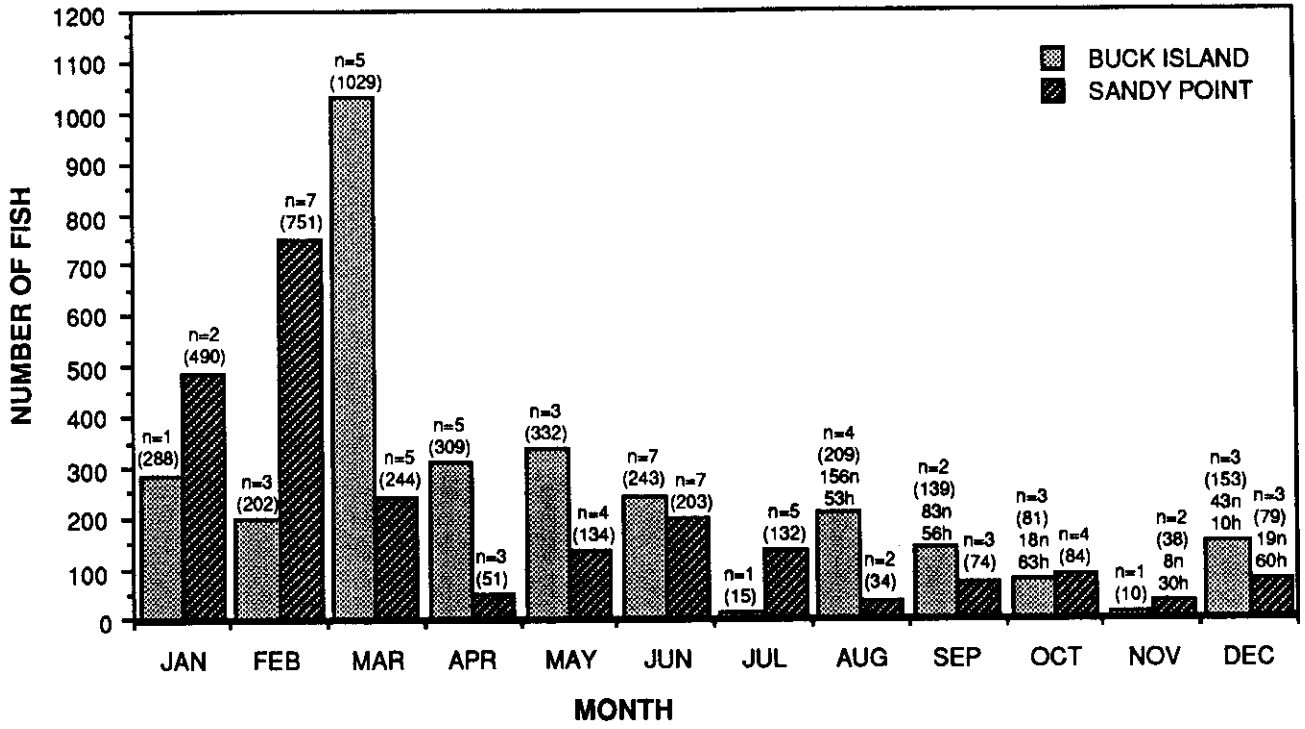

Figure 2. The number of fish caught per month at the Buck Island and Sandy Point, St. Croix, study sites. The number of fishing trips per site is indicated above each data set and the total number of bigeye scad caught is in parentheses. Net (n) and handline (h) catches are indicated separately from August to December 1986.

Table 3. Length, weight and gonadal condition of bigeye scad caught off Buck Island and Sandy Point, St. Croix, January—December 1986 (M/U = male-unripe, M/R = male-ripe, F/U = female-unripe, F/R = female-ripe, I = immature).

Location	Buck Island								Sandy Point							
Month	N	Mean Length (mm)	Mean Weight (g)	Gonadal Condition M/U	M/R	F/U	F/R	I	Mean Length (mm)	Mean Weight (g)	Gonadal Condition M/U	M/R	F/U	F/R	I	N
January	50	199.7	143.0	12	19	7	10	2	186.7	121.7	5	20	6	19	12	62
February	54	213.0	184.3	0	36	10	8	0	196.2	159.5	1	24	5	20	0	50
March	50	217.5	191.5	3	22	4	21	0	196.2	155.5	3	15	6	23	1	50
April	50	220.3	206.5	3	27	7	13	0	188.4	145.0	1	16	5	28	0	50
May	50	223.4	205.5	2	29	6	13	0	188.3	175.5	6	15	14	14	1	50
June	47	227.9	223.8	0	18	2	27	0	198.4	131.1	4	16	3	30	0	53
July	15	223.3	208.3	0	4	0	11	0	199.4	166.0	1	8	7	36	1	53
August	50	220.8	194.5	9	21	3	17	0	207.9	201.7	2	10	4	18	0	34
September	50	208.1	163.0	5	11	1	33	0	202.4	134.9	4	12	6	39	2	63
October	17	220.3	205.9	0	9	1	7	0	210.5	153.9	12	29	1	16	0	58
November	15	222.9	188.5	0	2	1	12	0	201.6	154.6	4	11	2	21	0	38
December	28	209.6	144.7	1	5	1	21	0	198.2	140.5	5	20	6	32	0	63

occurs, even around the same island (Kawamuto, 1973; Department of Land and Natural Resources-State of Hawaii, 1979).

Sakuda (1968) generated a growth curve for bigeye scad in Hawaii, based on tag-recapture data. His growth curve indicates that the Hawaiian commercial "akule" fishery exploits individuals between 7-18 months old (210-265 mm fork length). By plotting the fork length data present in Figure 3 on Sakuda's growth curve for Hawaiian scad, it is estimated that the majority of the biostatistical subsample of fish caught at Buck Island were 7-9 months old (210-230 mm) and those from Sandy Point were 6-8 months old (190-220 mm). It is unknown if this variation in fish size between the two locations represents the actual condition of the fish stocks present or is due to a sampling bias or slight difference in fishing technique employed (*i.e.*, intensity and duration of light source used).

Participation by local commercial fishermen and interest by the fishing community in general was very good. More than 60 commercial and recreational fishermen participated in the bigeye scad project, either by receiving instructions on gear construction and fishing methodology, by providing vessels for fishing trials and demonstrations or by serving as crew members on fishing trips.

The estimated annual catch rate of "akule" in the Hawaiian Islands varies from 0.4 to 0.9 t/nmi of 200 m contour (Polovina *et al.*, 1985). Handline catch represents 10-20% of the estimated annual landings (Department of Land and Natural Resources-State of Hawaii, 1979). Therefore, the maximum estimated annual handline catch rate of Hawaiian "akule" is 0.1 to 0.2 t/nmi. If the handline catch rates for St. Croix (23.5 pounds/trip average for 12 months and 61.2 pounds/trip during peak three-month period) and the Hawaii Islands (20 pounds/trip (Anonymous, 1954) and 40 pounds/trip (Kawamoto, 1973) are considered similar, an estimated annual catch of bigeye scad, based on the length of the 200 m contour for St. Croix as 75 nmi, can be estimated as 7.5 to 15.0 t per year. At $2.50/pound, the value of this resource would be $37,500-$75,000/year.

Clavijo *et al.* (1984) indicated that the estimated total landings of the commercial fishery for St. Croix was 0.5 million pounds. The estimated annual harvest of bigeye scad represents 3-6% of the total annual landings for the island. As an undeveloped and underutilized fisheries resource, bigeye scad have the potential to support an alternate nighttime fishery on St. Croix.

Due to the seasonal abundance of this resource and the effectiveness of seine/surround nets when deployed with diver assistance by knowledgeable commercial fishermen (occasional catches of 1-2 t have been observed), it is recommended that the following management measures be considered:

1. The restriction on the mesh size of seine/surround nets used to harvest bigeye scad to not less than 3.8 cm (1.5 in) stretch measurement.

2. The prohibition of netting bigeye scad measuring less than 17.8 cm (7 in) in total length from August through December.
3. The monitoring of annual harvest trends.

The first management regulation conforms the mesh size on bigeye scad nets with existing U.S. Virgin Islands legislation for the use of seines, gill nets and surround nets for non-baitfish species. The second regulation establishes a

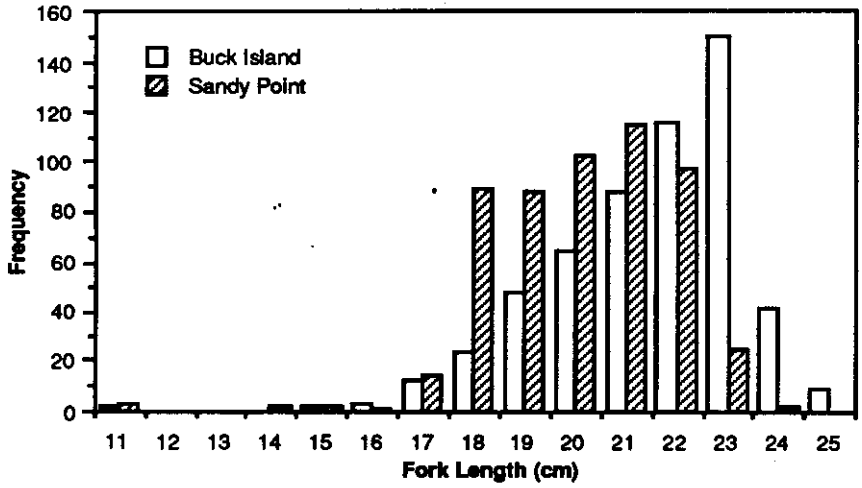

Figure 3. Length-frequency histogram for bigeye scad sampled at the Buck Island and Sandy Point, St. Croix, study sites for January—December 1986.

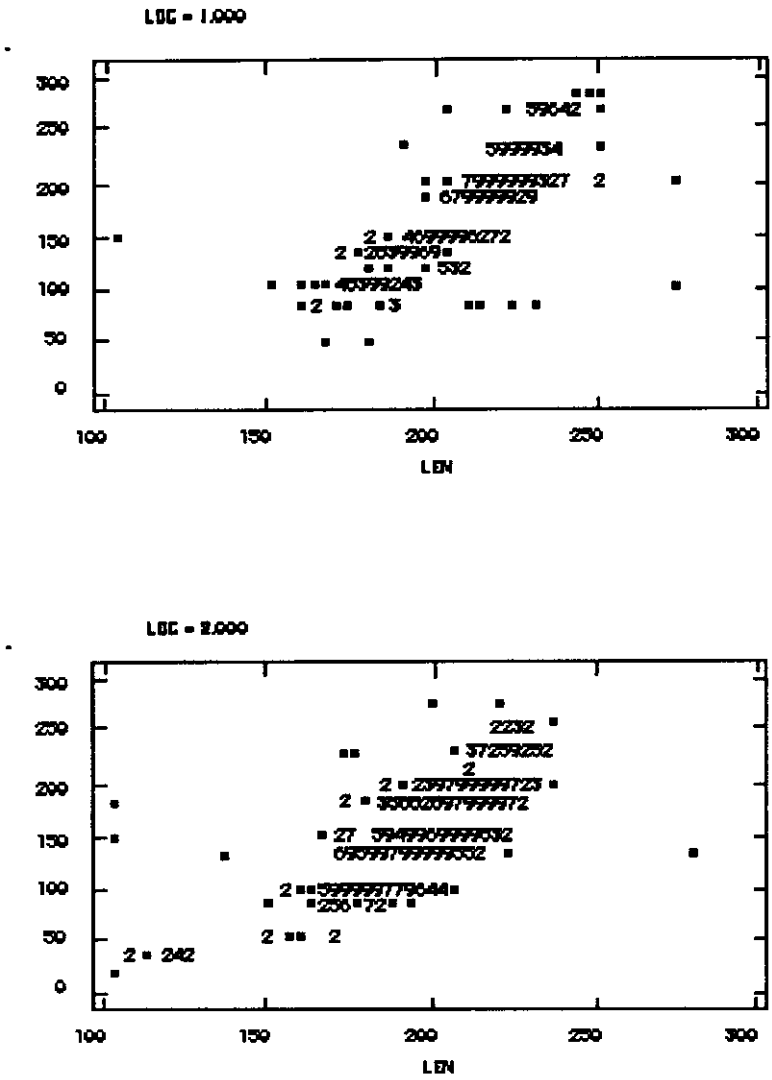

Figure 4. Linear regression plot of bigeye scad length vs. weight from Buck Island (top) and Sandy Point (bottom), St. Croix, populations, January - December 1986.

size limit on bigeye scad to protect them during their peak recruitment into the fishery.

These management measures are similar to those in effect in Hawaiian waters to manage "akule" resources (Kawamoto, 1973). The increase in Hawaiian commercial landings of "akule" in recent years reflects the sound condition of the fish stocks and the apparent effectiveness of the management measures.

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