SURVEY OF THE SHARK
RESOURCE IN SHELF WATERS
OFF SOUTH CAROLINA

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Acknowledgements

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Abstract

The availability, species, and size composition of sharks off South Carolina was evaluated from July 1983 through April 1984. Six surface longline sets made during July-September 1983 in 12-34 m of water produced an average of 4.7 sharks per 100 hooks, with the tiger shark (*Galeocerdo cuvieri*) being the dominant species. During July 1983 through April 1984, 74 bottom sets produced an average of 8.0 sharks per 100 hooks, with 59% of the catch by number consisting of sandbar sharks (*Carcharhinus plumbeus*). In February 1984, 9 trawl tows made in 7-15 m of water with paired 60/40 4-seam shrimp nets produced 7 spiny dogfish (*Squalus acanthias*) and 44 smooth dogfish (*Mustelus canis*).

In fishing with the bottom longline gear, no difference in catch rate by bottom type was observed, nor did depth appear to be a major factor when all species were considered. Catch rates were highest for overnight sets (9.9 sharks per 100 hooks), with morning daytime sets producing the smallest catches (4.4 sharks per 100 hooks). For all species combined, the average catch rate was highest during January-April (12.0 sharks per 100 hooks), although small species (dogfishes and Atlantic sharpnose, *Rhizoprionodon terraenovae*) contributed substantially to the catch. For sandbar sharks, no difference in size by depth, season, or sex was noted and the female:male ratio was 1.3:1.

Introduction

It has been over 30 years since a commercial shark fishery of significant magnitude operated in the South Atlantic Bight. The fishery during 1936-1950 was based on livers and was most active off southeast Florida (Springer 1951). The catch in the Carolinas peaked during the late 1930's at an annual level of 225,000-340,000 kg (500,000-750,000 lb) (Chestnut and Davis 1975). Synthetic production of vitamin A brought an end to the directed commercial fishery. Regional landings since 1950, consisting primarily of incidental catches landed for food, remained very low until the 1980's. In 1981, commercial landings in the Carolinas more than tripled those of the previous year and reached 97,629 kg (215,235 lb) in 1982. The ex-vessel value (based on the price for the meat only) was approximately $55,000. This pronounced increase in the commercial harvest of sharks reflected a number of factors, including a growing recognition of the export market for fins, increased acceptance of the meat as an economical substitute for high-priced seafoods in a time of wide-spread recession, and to a lesser extent, a rapidly expanding swordfishery (which caught pelagic sharks in large numbers).

The regional commercial fishery is very small compared to the recreational fishery for sharks. The estimated 1979 sport catch (in numbers of sharks) is shown below (NMFS 1980):

	NC	SC	GA	FLA. EAST COAST
All species (except dogfish)	137,000	60,000	<30,000	234,000
Dogfish	50,000	-	-	<30,000

While most of the small, dogfish-type sharks were reportedly retained, anglers released about 70% of the large individuals. If the regional retention percentage is applied to the South Carolina catch and a dressed weight of 9.1 kg (20 lb) per shark is assumed, then the 1979 carcass weight accounted for by South Carolina anglers could have been around 166,000 kg (366,000 lb), far in excess of the 8,172 kg (18,016 lb) reported as commercial landings. Even the estimated 1983 commercial catch of 47,223 kg (104,109 lb) round weight is small in comparison.

Viewed from another perspective, it is possible that regional anglers released more than 2,767,000 kg (6,100,000 lb) of edible shark meat (excluding dogfish) during 1979 and that South Carolina fishermen alone contributed about 378,300 kg (834,000 lb). If rational exploitation strategy dictated that only a portion of this could be utilized by the commercial sector, the resulting increase in harvest value would still be considerable. This assumes greater significance when valuable products such as fins and hides are included in the evaluation of the potential for increased commercial utilization of regional shark resources.

Practically all of the 1983 South Carolina commercial shark catch was landed incidentally, most of it from the shrimp trawl fishery. Although shark landings are unclassified as to species, this implies that the bulk of the catch consisted of small inshore species (e.g., the Atlantic sharpnose, Rhizoprionodon terraenovae, and the bonnethead, Sphyrna tiburo). The deep-water bottom longline fishery accounted for an estimated 7,785 kg (17,163 lb) round weight, about 16% of the total commercial catch. Although they catch large numbers of sharks, swordfishermen landed only small amounts, primarily mako (Isurus spp). Landings by other commercial fishermen were insignificant.

The magnitude of the shark catch presently released by recreational fishermen and commercial swordfishermen suggests that the regional resource could withstand a higher rate of utilization. Although there certainly will be a continued expansion of the important recreational fishery, the fact that an estimated 70% of the catch of larger sharks is released will be a mitigating factor. The market potential for increased utilization also appears to be present, given the strong demand for fins for export and increasing domestic utilization of the meat.

Evaluations of the feasibility of increased commercial utilization of sharks in other areas have shown the need for several types of information. In addition to an appraisal of the absolute abundance of sharks, their seasonal availability is a critical factor in the establishment of stable demand. The size of the dressed carcasses is an important market factor, as is the species composition, since some varieties have poor edibility characteristics and the fins of others are unsuitable. Catchability in terms of time of day and habitat is obviously important to the fishermen, as well as the economic attractiveness of shark fishing relative to alternative opportunities in other fisheries. Our objectives in this study were to address these information needs from the standpoint of developing a commercial directed fishery for sharks off the Carolinas and Georgia.

Methods

Although sharks can be caught using a wide variety of gears and techniques, we chose three methods that are the most appropriate for this region, based on the experience of the fishermen and the characteristics of their boats. These were: (1) double-rig trawling, (2) surface longlining, and (3) bottom longlining.

Trawling is a proven method for harvesting small sharks. Double-rigged shrimpers work coastal waters (< 10 m or 30 ft deep) during May-December and catch large numbers of small individuals, particularly bonnethead sharks (Castro 1983). Viable fishing opportunities during January-April are rather limited for most of the operators of such vessels and a cold-weather coastal trawl fishery (with larger meshed nets) would be the most acceptable alternative to them. Both spiny (Squalus acanthias) and smooth dogfish (Mustelus canis) are known to be present in coastal waters off the Carolinas during winter (Bearden 1965, Castro 1983). We made one trip in February to investigate the potential contribution of these species to a winter inshore trawl fishery. Our gear was limited to paired 60/40 4-seam shrimp trawls with 1.22 x 0.76 m (4 ft x 30 in.) wooden doors (with tickler chains). We made nine daylight tows near Charleston, South Carolina in depths of 6-15 m (18-45 ft). With one exception, tow duration was one hour at 900 rpm. Catches from both nets were combined in calculating catch rates (number of sharks per hour trawled).

The surface longline consisted of a 9.5 mm (3/8 in.) polypropylene mainline with 50 hooks per set. Hooks were 13 m (40 ft) apart and 178 x 381 mm (7 x 15 in.) bullet floats were spaced after every third hook. The hooks were 12/0 Superior Mustad O'Shaughnessy (#3407) shark hooks and were attached to swiveled (4/0) 3 mm (0.12 in.) wire snaps with 4 m (12 ft) of 2.4 mm (3/32 in.) stainless steel 7/7 strand cable. Nicopress type sleeves were used for all connections. The mainline was buoyed and anchored at each end. The hooks were baited with approximately 0.22 kg (0.5 lb) chunks of cut fresh-frozen Atlantic mackerel (Scomber scombrus) . Six sets of variable timing and duration were made in the locations indicated in Fig. 1 and Appendix 1.

The bottom longline gear consisted of a groundline of 4.0 mm (5/32 in.) galvanized steel (Portland) cable with hooks, gangions, and bait as described above. Hooks were spaced at 13 m (40 ft) intervals between aluminum crimps. Each set contained 50 hooks and was anchored and buoyed at each end. During the second half of the project, the two sections (skates) were connected and shot as a single unit, although data were recorded for each skate separately. Hooks and gangions were stored on a leader cart (small hand winch). They were removed and baited as the gear was shot and wound on the winch as the gear was retrieved to minimize handling problems. The gear was shot in a straight line without regard to current or bottom topography, the main determinant being the anticipated wind direction at haul-back. Gear was retrieved heading into the wind; in our fishing areas, currents were seldom a factor. Stations were made in the general locations shown in Fig. 1. Specific data are provided in Appendix 1.

Because our trips were of a multipurpose nature (i.e., to obtain scientific specimens, maximize production for marketing demonstrations, test different times, locations, etc.), we made no attempt to adhere to a pre-determined, rigid sampling design but rather matched our sampling efforts to current conditions and requirements. The deployment of effort (50-hook sets) that resulted is summarized below (the diel figures do not add up correctly because sets that extended over more than one interval are not listed):

Substrate	SAND			HARD			
Time	AM	PM	NIGHT	AM	PM	NIGHT	TOTAL
Depth (m)							
10-19	2	9	5	0	7	2	
		16			9		25
20-29	1	3	6	3	4	4	
		12			13		25
30-39	2	6	2	2	3	4	
		13			11		24
TOTAL	5	18	13	5	14	10	
		41			33		74

Large sharks were occasionally tagged and released with data entered on species, approximate length, and sex. The others were snared with a cable loop passed down the gangion and around the body just behind the gill slits, then lifted aboard. At the completion of haul-back, the sharks were measured (total length and fork length to nearest cm), sexed, and their tails were cut off. After bleeding, they were butchered (fins, head, viscera, and belly flap removed), washed thoroughly with sea water, and placed either in a sea water-ice slush tank or directly in crushed ice. Very large carcasses were sectioned to facilitate handling and rapid cooling. Carcasses were placed belly down to permit draining. At dockside, carcasses were weighed on a platform scale. The meat was distributed among project personnel, the NMFS Charleston Lab (for food technology studies), the Division's marketing program, and the state corrections system. Various biological samples, primarily blood, liver and reproductive tissues, were collected for university personnel, several of whom participated in the field work.

Results and Discussion

Trawl. Seven of the nine tows produced sharks, all of which were dogfish (7 spiny, 44 smooth). Bottom water temperatures were 12.8°C (55.0°F) at 7 m (22 ft) and 14.0°C (58.2°F) at 17 m (50 ft). Catch rates were 5.4 sharks per hour in depths < 10 m (30 ft) and 6.9 sharks per hour in > 10 m. All of the spiny dogfish were females, with a size range of 73-100 cm TL (64-89 cm FL) and a mean of 87 cm TL (76 cm FL). Mean carcass weight was 1.06 kg (2.33 lb). Male smooth dogfish (N = 25) ranged from 31 to 104 cm TL (27-89 cm FL), with a mean of 77 cm TL (67 cm FL). Females (N = 18) varied in total length from 61 to 121 cm (53-105 cm FL) and averaged 99 cm TL (86 cm FL). Females contained pups. Mean carcass weight of the smooth dogfish was 1.42 kg (3.13 lb). Incidental catches were small and consisted primarily of small spots (Leiostomus xanthurus) and butterfish (Peprilus triacanthus), whelks (Busycon spp.), and crabs (Callinectes sapidus).

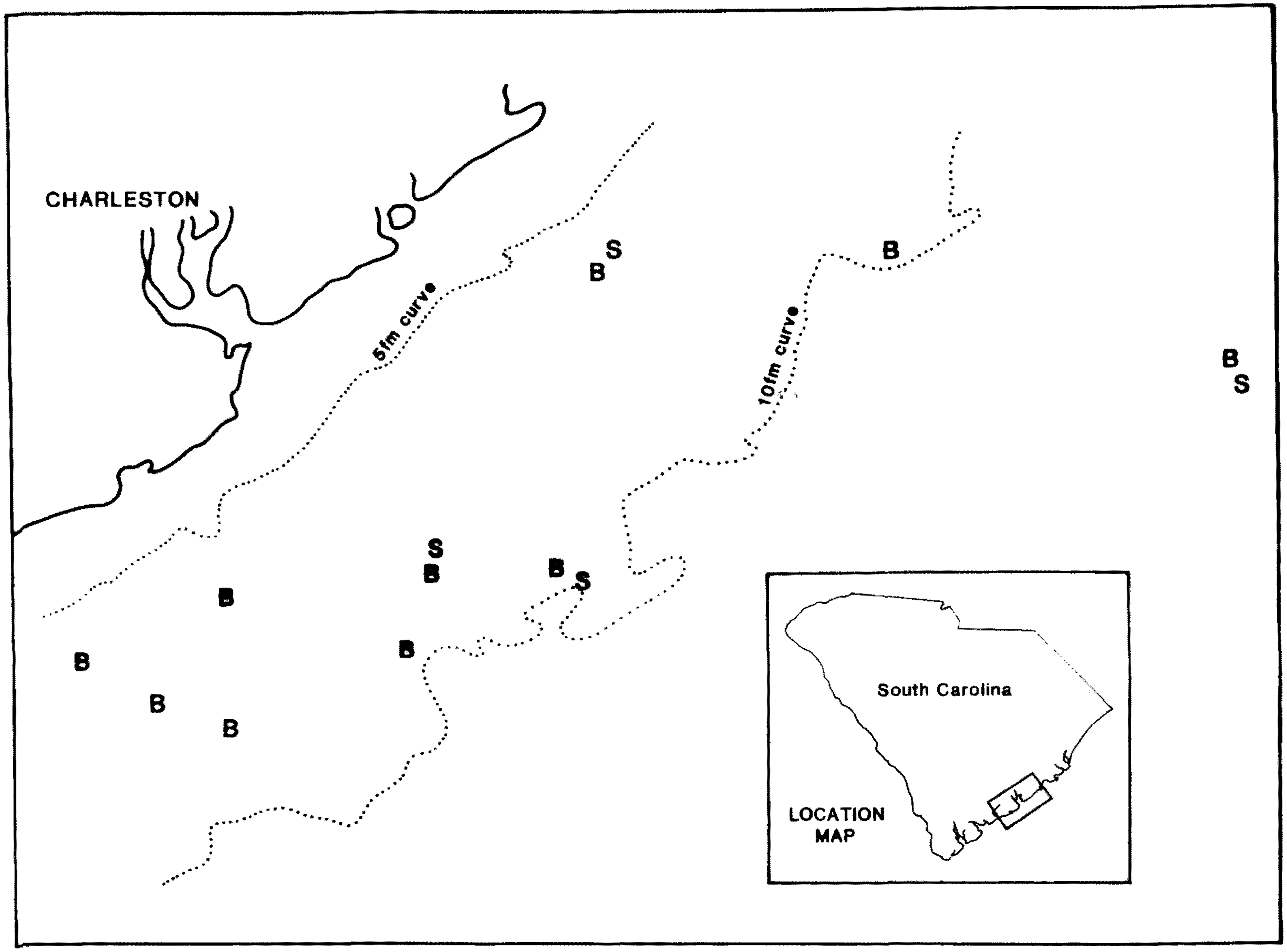

Fig. 1. Areas of surface (S) and bottom (B) longline stations.

Surface Longline. The catch consisted of eight tiger (Galeocerdo cuvieri), three sandbar (Carcharhinus plumbeus), two sharpnose, and one lemon shark (Negaprion brevirostris), taken during July-September. Five of the sets were in < 30 m of water and the small number (N = 6) of total observations does not permit meaningful comparisons of catch rates by time of day. The overall catch rate was 2.33 sharks per set (4.66 per 100 hooks).

Any large shark resulted in a tangled mess. This, combined with the low catch rate, caused us to discontinue use of this gear early in the project. Its extensive use in congested coastal waters, particularly at night, would pose obvious problems and it appears to be most efficient on the offshore, pelagic species, e.g. blue (Prionace glauca), silky (Carcharhinus falciformis), and night (Hypoprion signatus) sharks.

Bottom Longline. The total catch (N = 297) from 74 sets included the following sharks: 175 sandbar, 40 tiger, 36 smooth dogfish, 31 Atlantic sharpnose, 9 scalloped hammerhead (Sphyrna lewini), two dusky (Carcharhinus obscurus), two sand tiger (Odontaspis taurus), one silky, and one lemon.

The major variables identifiable in our study that could affect availability of sharks are season (summer, fall, and winter-spring), depth (10-19, 20-29, and 30-39 m strata), and bottom type (sand or hard). Catchability could have been influenced by bottom type, time of day, and soak time. The quantitative impact of the latter factors is extremely difficult to measure and warrants brief discussion relative to the further presentation of our results.

In Murphy's (1960) longline catch equation, it can be seen that bottom type can influence catchability through its effect on the instantaneous rate of bait loss. This is a function of the density of predators competing for the bait, which is higher on hard bottom than over sand. The extent of bait predation is probably more significant at night, due to increased activity of predators. The potential influence of soak time is complex, involving the activity level of both predators on bait and the sharks as well as their respective densities. Durability and attractiveness of the bait are partly functions of soak time, as is the escape rate of hooked fish (another of the critical parameters in Murphy's equation). Because of the limited number of observations available to fill in the complex sampling design required to complete a rigorous statistical analysis of the interactions of these variables, we had to make several simplifying assumptions before proceeding further in our interpretation of the data.

Skud (1978) noted that bait loss is not constant with time and is very rapid during the first hour of soak. After that, the rate appears to be more or less constant at a relatively low level. Grimes et al. (1982) noted that a minimum useful soak time for bottom longlines in the tilefish fishery is perhaps 1.5-2.0 hours and that bait predation becomes significant after 3.0 hours. Even after short soak times, we seldom recovered hooks with bait, particularly on hard bottom. The average soak times in the AM (0800-1200), PM (1200-1800), and night (1800-0800) were 2.73, 3.25, and 13.22 hours, respectively. Skud (1978) stated that, while CPUE for halibut increases with soak time in a curvilinear relationship, the rate of increase with other species differs in accordance with timing of the set relative to time changes in feeding behavior. Catch rates we observed were extremely variable and showed no apparent relationship with soak time (Fig. 2), although the mean CPUE (3.3 sharks per set) for sets of < 6 hours duration was substantially lower than that (5.5) for longer soaks. Theoretically, Murphy's (1960) model implies that, given a high rate of bait loss early in the soak period, the time required for the maximum catch is substantially less than that corresponding to our night sets, but somewhat longer than that for our average daytime sets. In practice, we believe that most sharks were hooked fairly soon after the gear was set and that relatively few of the hooked ones escaped after a brief initial attempt; most were rather docile when brought to the boat. We also think most of the unoccupied hooks were stripped of bait by the third hour of soak. Since most of the sets were longer than two hours, we treated soak time as a random variable and assumed that any trends we observed in catch rate were independent of it.

Sandbar and tiger sharks, the two most abundant species in our catch, are nocturnal (Springer 1960, Tricas et al. 1981, Castro 1983) and commercial bottom longline fisheries in other areas have concentrated on the nighttime hours (Springer 1951, Linsin 1984). Inspection of the raw data shown below indicated that CPUE (sharks per set) was highest at night. We assumed that the

		CPUE		
TIME	SETS	SANDBAR	OTHER SPP.	ALL
AM	9	1.33	0.89	2.22
PM	31	1.87	1.90	3.77
NIGHT	23	3.65	1.30	4.95

diel effect on CPUE was probably independent of season, depth, and type of bottom because it reflected the behavioral pattern of the sharks rather than changes in gear efficiency. Before examining CPUE for possible influences of these other factors, we adjusted the data for presumed differences in catchability due to the time of the set. Catchability at night was assigned a coefficient of 1.00. Then coefficients for the other times of day were calculated as

$$AM_j = CPUE_{am} \times \frac{1}{CPUE_{night}}$$

$$PM_j = CPUE_{pm} \times \frac{1}{CPUE_{night}}$$

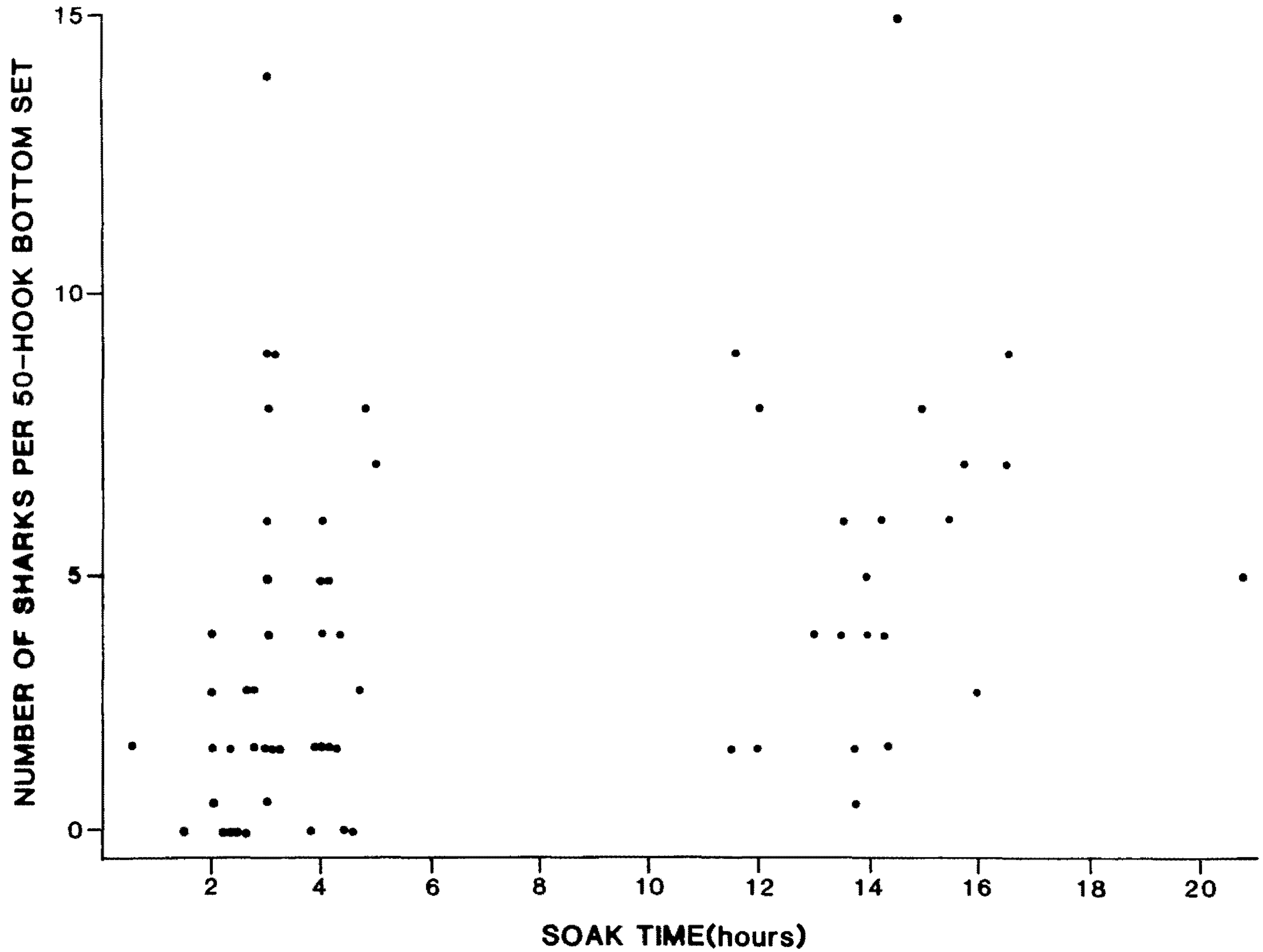

Fig. 2. CPUE (sharks/set) as a function of bottom longline soak time.

The resulting coefficients for sandbars were 0.36 (AM) and 0.51 (PM), while for all species combined they were 0.45 (AM) and 0.76 (PM). CPUE observations in the various time intervals were divided by the appropriate coefficient. If a set extended over more than one time interval, the coefficient for the first interval was used. Results are summarized below, where CPUE is the number of sharks per 50-hook set:

Sandbar Sharks

Depth (m)	Sand	Hard	All
10–19	4.32	3.72	4.11
20–29	4.68	3.22	3.92
30–39	2.17	3.22	2.65
All	3.75	3.36	3.57

All Species Combined

Depth (m)	Sand	Hard	All
10–19	4.16	6.45	4.98
20–29	5.08	4.81	4.94
30–39	5.88	4.48	5.24
All	4.97	5.15	5.05

The anomalously low value shown for all species in the sand bottom shallow cell is due to the fact that most of the sets were in the afternoon and the all-species coefficient for that period was considerably higher than that used for sandbars only.

The distribution of unadjusted CPUE on a monthly basis is listed in Table 1 with information from Springer's (1951, Table 2) analysis of the bottom longline shark fishery at Salerno for comparison. The variability in monthly availability for both all species and sandbars for South Carolina is much higher than that reported off Florida, although it must be noted that the effort for South Carolina during July, August, and September was only three sets in each month. If the low September value is deleted, the variances in CPUE for the two areas are much more comparable. Time of day of the sets was also much more variable in our data than was apparently the case in Springer's. When our data are adjusted for the diel influence,

Season	Sandbars	All Species
Summer (July-Sept)	6.2	7.2
Fall (Oct-Dec)	8.5	9.6
Winter-Spring (Jan.-April)	5.3	12.0

the winter-spring peak in the all species fishery is apparent for both areas. It should be noted that this seasonal peak in the South Carolina data is largely attributable to the increased availability of smooth dogfish and sharpnose sharks. The low catch rate for sandbars in September is probably a sampling artifact, because Springer (1960) reported high catch rates off the Carolinas in September for this species.

We experienced very few problems with the bottom longline gear, other than occasional minor hangs over hard bottom. With the exception of scalloped hammerheads, nearly all of the sharks were alive when brought to the boat, even after long soaks. Shark damage to hooked individuals was confined to the small individuals (sharpnoses, dogfish, and small tigers) and the attacker was usually hooked. Large tigers caused most of the problem, as has been noted in other areas (Springer 1960).

The incidental fish catch was small and consisted of large roughtail stingrays (*Dasyatis centroura*, 13), greater amberjacks (*Seriola dumerili*, 5), barracuda (*Sphyraena barracuda*, 3), bluefish (*Pomatomus saltatrix*, 4), gag grouper (*Mycteroperca microlepis*, 3), and red drum (*Sciaenops ocellata*, 5). The amberjacks, barracuda, bluefish, and groupers were taken either on or very close to hard, live-bottom, with all of the bluefish being taken from one station in April, when this species is seasonally abundant offshore. The red drum were taken on two adjacent shallow water (12 m or 36 ft) sets off an inlet in October, when these fish school in such locations. Cobia, *Rachycentron canadum*, often accompanied hooked sharks to the boat, although they were never caught on the longline gear.

Sex and Size Composition of Sharks Caught on Bottom Longline.

The length composition of sandbar sharks is shown in Fig. 3. The mean carcass weight was 16.2 kg (35.8 lb). Both the sex and size composition of our sample differ from reports in the literature. In the Florida (Salerno) fishery, adult females far outnumbered the males and Springer (1960) reported an overall ratio (females:males) of 5:1. Our ratio was about 1.3:1 (females:males), with a substantial seasonal difference:

Season	Total N	Female:Male
Summer	15	6.50:1
Fall	98	1.09:1
Winter-Spring	25	1.78:1

Although the females do not feed during the summer birthing period and males do not feed during the spring-early summer mating interval (Springer 1960), these factors would not explain the seasonal

Table 1. Monthly CPUE (sharks per 100 hooks) for bottom longline gear.

MONTH	ALL SPECIES SC 1983-1984	ALL SPECIES FLA.[1] 1938-1946	SANDBARS SC 1983-1984	SANDBARS FLA.[1] 1938-1946
January	8.7	6.9	2.9	3.9
February	-	7.2	-	4.8
March	-	6.4	-	4.1
April	9.6	6.3	3.3	4.1
May	-	6.5	-	4.2
June	-	6.4	-	3.4
July	8.0	5.6	6.0	3.3
August	9.3	4.2	6.7	1.8
September	2.0	3.4	0.7	1.1
October	7.4	5.0	6.1	1.9
November	7.5	4.0	5.5	1.9
December	9.0	5.5	5.0	3.1
$\bar{x}$	7.7	5.6	4.5	3.1
s^2	5.9	1.5	4.2	1.4

[1]Source: Springer (1951), Table 2

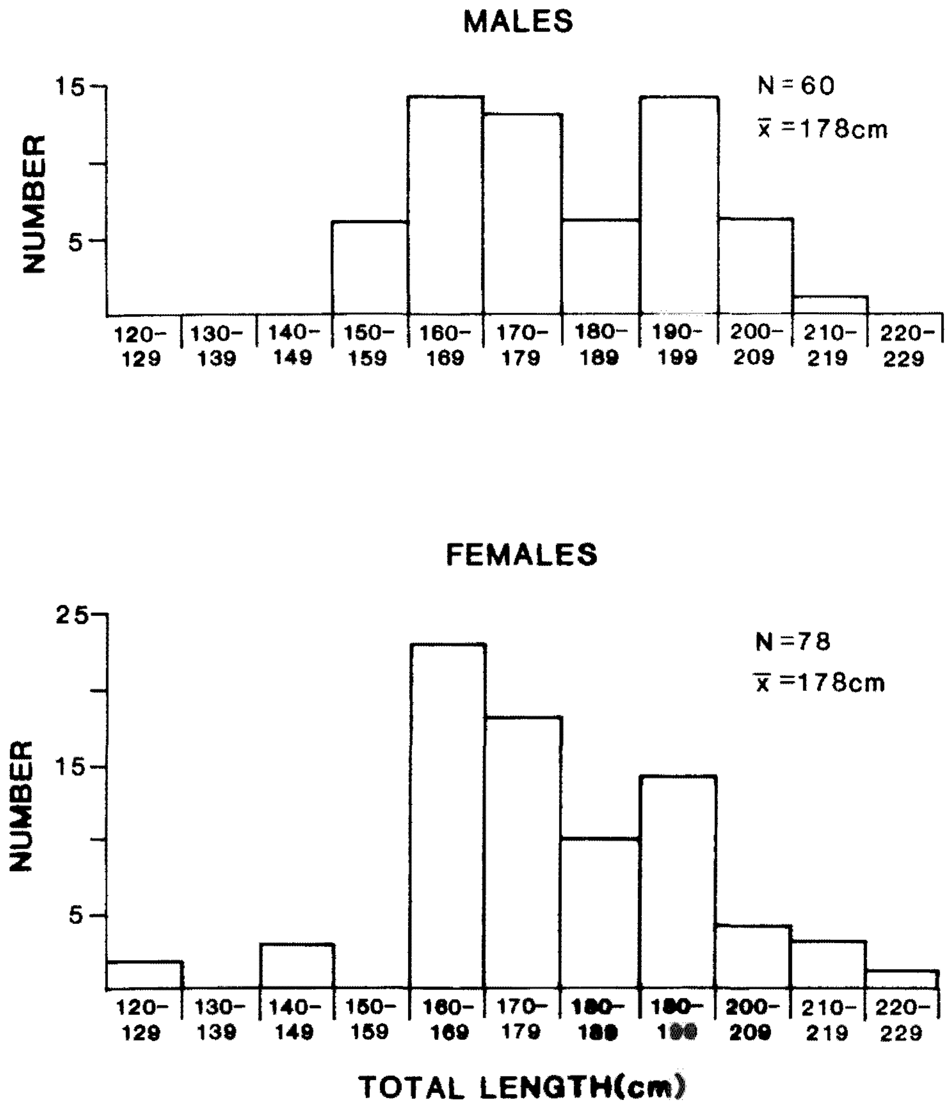

Fig. 3. Length Composition of sandbar **sharks** (*Carcharhinus plumbeus*) caught on bottom longlines off South Carolina **in dpeths** of 10-39 m.

differences that we observed. The average size (178 cm or 70 in.) is below the size range reported by Springer (1960) and well below the average size noted in Castro (1983). The average size for each sex was identical in our collections, whereas Springer (1960) reported that males in the Salerno fishery consistently averaged 10.6 cm (4.2 in.) smaller than the females. No seasonal difference in mean size was observed in either Florida or our area and our data indicate that size is independent of depth (in the range that we fished).

The sex and size composition of the other species (Table 2) were consistent with information provided by Castro (1983).

Marketing. In order to more fully assess the potential for development of a South Carolina shark fishery, preliminary evaluations of local market opportunities were conducted in conjunction with the Division's Seafood Marketing Services Section.

The development of institutional markets was considered to be a productive avenue for establishing a stable, local outlet for South Carolina sharks. Contacts were made with the S.C. Department of Corrections (DOC) by Will Lacey of the Seafood Marketing Services Section. The Department of Corrections was targeted for institutional market development for two reasons: 1) we felt they would be interested in a high protein product at a relatively low cost to meet nutritional needs and 2) they possessed the facilities necessary for skinning and portioning the dressed carcasses.

Meetings were held with Corrections Staff to explain the shark project and the edible attributes of sharks. Marketing personnel prepared and served shark appetizers to convince the staff that shark was indeed palatable. The general concensus was the the product was good but it would have to be carefully introduced to the inmates to avoid the impression that they were being utilized as "guinea pigs". Another meeting was arranged and shark samples were served to the Inmate Advisory Council where it was well received. At this time, it was decided by Corrections Staff to introduce project-produced shark on a trial basis.

Sharks caught during survey activities were delivered to the Department of Corrections abbatoir for skinning and portioning. According to prison officials, acceptance of shark has been very good and the DOC is presently negotiating to obtain supplies on a regular basis from South Carolina producers.

A cooperative program with the National Marine Fisheries Service Seafood Technology Laboratory (Charleston, S.C.) was also initiated to characterize the edibility characteristics of various shark species and size categories within species. Preliminary results of this work prepared by Malcolm B. Hale are summarized in Appendix 3. The assessment of edibility characteristics was done by a trained taste panel using standard testing protocol of the National Nomenclature Project. A list of U.S. shark markets is available from:

Virginia Slosser
NMFS, NOAA
9450 Koger Blvd.
St. Petersburg, Fla. 33702

As noted in the Introduction, the present recreational catch of large sharks in South Carolina, about 70% of which apparently are released, suggests that the commercial catch could be increased substantially. The amount of edible shark meat released in 1979 could have been on the order of 378,300 kg (834,000 lb). Our overall, unadjusted CPUEs (sharks per 100 hooks) for all species combined of large sharks (i.e., excluding dogfishes and sharpnose sharks) of 6.2 and for sandbar sharks only (4.7) compare favorably with those reported for the commercial fishery in Florida during 1936-1950. After adjustment for time of day to make the data more comparable to commercial operations, our hook-up rate of 10% is identical to that in the more recent Florida fishery (Hamilton 1976). Species composition appeared to be similar in the two areas, with sandbar sharks comprising 58% of the catch by number in both the South Carolina and Salerno fisheries.

Springer (1951) noted that, during 12 years of managed and limited fishing (in the Salerno fishery), there was no indication that fishing affected the availability (here equivalent to apparent abundance) of the most abundant species (sandbar sharks). Based on his published data (1951, Table 1), the annual average catch of sandbar sharks during 1938-1946 (before the fishery expanded to other areas and depths) was 3,280 adults. The grounds extended from Jupiter to Bethel Shoal (Vero Beach) in depths of 20-100 m (10-50 fm), equivalent to a surface area of about 725 km^2 (280 $mi.^2$). The average annual yield was then about 4.5 adult sandbar sharks per km^2, or, using our observed carcass weight of 16.2 kg (35.8 lb), about 72 kg/km^2. Springer's (1951) data therefore indicate that this is a yield that can be taken from an area over a period of years without adversely affecting stock abundance.

The distance from Charleston, South Carolina to Savannah, Georgia is about 113 km (70 mi.) and the area between the 10-m (5-fm) curve and the shelf break averages about 64 km (40 mi.) in width. Since the catch rate of sandbars showed no pronounced difference with bottom type, we can omit the influence of this variable. Although the catch rate in 30-39 m (15-19 fm) was lower than that in shallower water, much of this appeared due to increased competition for the hooks from other species; it is likely that the abundance of adult sandbars was also independent of depth out to the shelf break. If we assume that the prescribed area represents a homogeneous habitat with a uniform density of animals and apply the yield estimates derived from Springer's data, then the potential annual yield of sandbar sharks alone from this area might be on the order of 521,000 kg (1,150,000 lb) carcass weight, equivalent to a catch of 32,500 sharks. It is interesting to note that the estimated 1979 South Carolina recreational catch of large sharks was 60,000 individuals. This figure multiplied by an estimated sandbar contribution of 58% gives an

Table 2. Sex and size composition of sharks (excluding sandbars) taken on bottom longline gear.

SPECIES	SEX	N	TL RANGE (cm)	$\overline{TL}$ (cm)	$\overline{KG}$[1]
Tiger	Male	13	129 - 345	234	
	Female	13	96 - 367	177	22
Scalloped Hammerhead	-	5	226 - 261	243	-
Dusky	Female	1	-	265	43
Silky	Male	1	-	207	26
Lemon	Male	1	-	273	41
Sand Tiger	Male	1	-	230	39
	Female	1	-	117	-
Sharpnose	Male	2	91 - 94	93	
	Female	23	51 - 105	94	2
Smooth Dogfish	Female	34	101 - 121	113	2.6

1
Carcass weight

estimate of 34,800 sharks. This figure (32,500 sandbar sharks), which we may tentatively consider as a proxy for MSY, may therefore not be too unrealistic. When other species are taken into account, the South Carolina commercial shark harvest can be increased substantially.

The most efficient gear for realizing this increase may be the bottom longline (in the depth range we considered). Trawling is effective only for small species such as smooth and spiny dogfish, sharpnose sharks, and bonnetheads. Of the four southeastern Atlantic states, only South Carolina has reported significant landings of such sharks as marketable incidental catch from shrimp trawling. During 1973-1975, sharks represented 9% of the total weight of fish landed by shrimpers in South Carolina, the fourth most important category (Keiser 1977). Increased utilization of the incidental catch does not appear to offer much potential for trawlers. A directed trawl fishery (for dogfishes) would be limited to mid-December through March, based on the reported seasonal availability (Bearden 1965). Bearden (1965) stated that small numbers of spiny dogfish were taken in trawl surveys in Port Royal and St. Helena Sounds, in the North Edisto River inlet, and close to the beach off Kiawah and Morris Islands when bottom water temperatures were 7.5-12.0°. Water temperatures observed at our trawl stations were higher than this, our effort was limited, and the gear wasn't the most appropriate, so it is speculative to assign much significance to our trawling results.

The surface longline does not appear to be a very efficient gear in coastal waters. In congested areas at night, it presents a navigational problem. Large sharks tangled the gear. The catch rate for sandbar sharks on surface gear (1.5 per 100 hooks) was much lower than that on bottom gear (6.3 per 100 hooks) during comparable times in the same areas, probably because this species is a bottom feeder. Since the sandbar appears to be the most abundant shark in the depths we surveyed, this detracts from the effectiveness of surface gear.

The Atlantic coast fishery during 1936-1950 used bottom setlines more than any other gear, with the typical chain line having 100 hooks spaced 7-13 m (20-40 ft) apart (Springer, 1960). A more recent limited fishery in Florida uses 8-m (25-ft) spacing (Linsin 1984). Hamley and Skud (1978) noted that catch per hook in bottom longline fisheries usually increases with increasing hook spacing, but not at a proportional rate. For large, relatively active, and somewhat solitary predators like halibut, the relative catch per hook reaches a maximum at a spacing of 12-14 m (36-42 ft) and this may hold for large sharks. Our results did not indicate any pronounced contagious distribution of hooked sharks (except for smooth dogfish), where a closer hook spacing would have been advantageous. All-metal gear, such as we used, is the preferred choice by most fishermen (Mangan 1983). Early authors (e.g., Wagner 1966) often made a point of maintaining clean, highly polished hooks, presumably to facilitate penetration. A study by Forster (1973) indicated that circle hooks are not efficient for tough-mouthed sharks.

The species composition of our catch (on bottom gear) indicated that night fishing would be most effective, since the two most abundant species (sandbars and tigers) are nocturnal feeders. Our observed CPUE bears out that assumption, as does the experience of commercial fishermen in other areas where these species represent the majority of the catch (Springer 1960, Castro 1983, Linsin 1984). The common fishing sequence takes advantage of a presumed increase in feeding activity during the early part of the evening. In the Salerno fishery, the best catch rates were made by setting in late afternoon and picking the gear up at sunrise. We experienced similar results. The smaller species (sharpnose sharks and smooth dogfish) that are abundant in winter and spring are also nocturnal and most likely to be caught at night (Castro 1983).

A developing shark fishery in Texas was hampered by fluctuations in the seasonal availability of sharks (Mangan 1983). Springer (1960) reported that some sandbar sharks are available during every month of the year from Charleston, South Carolina to Miami, Florida and considered the "...Atlantic coast from the vicinity of Charleston, South Carolina, to the northern part of Florida as the core of distribution of the principal stock of the western North Atlantic population..." He further suggested that the sandbar population is subject to constant mixing due to migratory movements. These observations reinforce the opinion that the South Carolina shark stock can support a year-round directed commercial fishery. Although there is considerable historical evidence that isolated shark populations are rapidly depleted in intensive fisheries, a wide-ranging migratory pattern tends to mitigate this (if the stock is not heavily exploited throughout its range). Even the short-term movements of species common in this area are extensive. A large female tiger shark tagged in a Hawaiian Islands study ranged over a 100 km^2 area during a 48-hour observation period (Tricas et al. 1981).

In addition to their relative abundance and availability, the species composition of sharks in Carolina waters is fortuitous from a marketing perspective. Of the species we caught, only the scalloped hammerhead is generally considered unacceptable for food, due to its red, mushy meat and high urea content (Linsin 1984, Oleson 1983). The flesh of sandbars and sharpnose sharks is of excellent quality and tiger sharks are readily accepted in the West Indies (Castro 1983). Carcass weights of < 27 kg (60 lb) are most preferred in the market and that of sandbars (16.2 kg or 35.8 lb in our study) is readily accepted. The fins contribute substantially to the profitability of shark fishing at present, given the relatively low unit value of the meat, and those from the sandbar are relatively thick and have a higher fiber content (the ingredient used for shark fin soup) than do those from most other species (Springer 1960).

Most of the boats in South Carolina that are equipped for bottom longlining are presently employed in the fishery for tilefish (Lopholatilus chamaeleonticeps) and deep-water groupers (Epinephelus niveatus and E. flavolimbatus). We compared the hypothetical trip returns for two types of shark fishing with typical trip returns in this fishery in order to evaluate the relative economic incentive for shark fishing. In one case, we based our evaluation on our observed CPUE for all species (except scalloped hammerheads) over the entire range of times in which we fished, with no adjustment to the CPUE data. In the other case, we used the unadjusted CPUE for all species (except hammerheads) as observed for night sets only. Operations statements (Appendix 2) were developed for a boat with a 5,550 kg (12,200 lb) iced fish capacity. The share system was based on a 50:50 split after deducting expenses, with the boat owner receiving 50%, the captain 20%, and each crewman (3) 10%. Fixed expenses were not considered, since these would be met out of the owner share and would vary considerably. Variable expenses were based on the following costs: (1) bait $0.60/lb, (2) ice $6.75/136-kg (300-lb) bar, (3) groceries $25.00/day, (4) diesel fuel $1.10/gal. Revenues were calculated using an ex-vessel price of $0.30/lb for meat (carcass weight) and $2.00/lb for iced fins.

In both of the shark fishing operations, yields were based on an effort of 500 hooks set per 24-hour period. Bait consumption was 0.23 kg (0.5 lb) per hook and the total amount of ice used was calculated at a ratio of 1.5:1 ice:dressed carcass weight. The fin weight yield was calculated as 6% of the carcass weight (the approximate figure we derived in our production figures). The distance to the fishing grounds was considered to be < 65 km (40 mi.).

For the tilefish operation, a daily yield of 500 kg (1,100 lb) dressed weight for 3,000 hooks was assumed, equivalent to actual conditions in the fishery during early 1984. Bait use was calculated at the rate of 0.09 kg (0.20 lb) per hook and a 1.25:1 ice:fish ratio was assumed. Revenues were calculated on the basis of an ex-vessel price of $0.91/lb. The distance to the fishing grounds was considered to be > 80 km (50 mi.), with higher fuel usage than in the shark fishery. Other conditions were the same as for the shark fishery cases.

In comparing the results from each operation, it is obvious that particular parameters may vary considerably from the values we have used, depending on current market conditions, an individual operator's circumstances, etc. Some boats require a higher ice ratio than others, for example. Still, the comparisons serve to give a rough idea of the economic feasibility of a directed shark fishery compared to the current deep-water bottom longline fishery.

Oleson (1983) noted that a small, inshore shark fishery was the most profitable because of its much lower overhead (primarily for less fuel and ice). One of the major expenses in bottom longlining is bait. In the tilefish case (using the figures assumed above), the ratio of gross return:bait cost per hook is 2.81:1. In the night shark fishery, with the value of the fins not included in the gross return, the ratio is 3.66:1. The difference in meat yields, of course, is much higher in favor of the shark fishery. In comparing the share-out figures, a nighttime shark fishery would yield roughly comparable returns to those currently available from the deep-water longline fishery. A day or mixed-time shark fishery, at present, would yield returns that would be considered marginal by South Carolina fishermen.

It appears that both the status of the resource and market potential are conducive to the development of an expanded commercial shark fishery off South Carolina and Georgia. The initial increase in effort and landings will probably be dependent on the availability of guaranteed (contracted) markets, several of which are being set up. Simply sending the product to New York on a consignment basis almost surely will not prove economically feasible, at least in the initial stage of development. The eventual magnitude of a fully developed fishery is difficult to forecast in the absence of definitive estimates of stock size and recruitment. The latter has proven to be a major limitation on the sustainability of directed shark fisheries. The most common species of large sharks in our area (sandbars and tigers) have long gestation periods (from about nine months in sandbars to over a year in tigers). Mating for large sharks is a complex, frequently unsuccessful (and presumably frustrating) procedure (some species appear to be the marine equivalent of the panda) and Springer (1960) noted that the percentage of gravid females in the adult sandbar population is quite low (15-30%). The number of pups in a litter is also low (an average of nine for sandbars), although the tiger shark is an exception (with litters of 35-55, according to Castro 1983). This combination of low reproductive success, long gestation periods, and small litters results in a very low rate of recruitment due to reproduction. Recruitment as a function of growth appears to be low also, since several of the species, including sandbars, have been shown through tagging studies to have lo life spans and exceedingly low growth rates.

The Salerno fishery during 1936-1950 was a limited and managed one from the outset, being controlled by one private firm. It demonstrated that a modest harvest of large sharks could be taken from a small area on a sustained and profitable basis over a long period of time. A maximum of five boats fished at any one time out of Salerno, and 16 appears to have been the upper limit operating off the southeastern states (Springer 1951). During the development stage of a regional shark fishery, before major commitments have been made in gear and boats, it would be sound management strategy for the South Atlantic Fishery Management Council to consider a limited entry program for this fishery. The number of participants should be restricted and landings controlled until enough is known about the biological status of the resource to permit development of a complete management strategy. In the absence of such controls, the all-too-familiar cycle of three or four years of heavy exploitation, followed by a collapse due to recruitment failure, is likely to result in this shark fishery, as it has in many others.

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Appendix I

STATION DATA.

TRAWL

DATE	TIME	START	END	DEPTH (m)	CATCH
21 FEB	1200	45498.9	45500.1	7	2 Sm. Dogfish
	1300	60481.1	60469.1		
21 FEB	1325	45495.1	45494.2	6	6 Sm. Dogfish
	1425	60483.1	60456.3		
21 FEB	1500	45479.9	45479.1	9	4 Sp. Dogfish
	1600	60441.5	60472.3		5 Sm. Dogfish
21 FEB	1630	45474.3	45473.8	9	2 Sp. Dogfish
	1730	60472.9	60450.5		2 Sm. Dogfish
22 FEB	0745	45439.9	45440.1	14	0
	0845	60390.6	60423.4		
22 FEB	0955	45470.5	45477.2	15	0
	1025	60520.9	60540.0		
22 FEB	1100	45495.7	45503.9	7	6 Sm. Dogfish
	1200	60551.8	60584.4		
22 FEB	1305	45510.3	45530.0	12	12 Sm. Dogfish
	1405	60672.6	60717.3		
22 FEB	1420	45528.0	45514.4	13	1 Sp. Dogfish
	1520	60716.0	60702.6		11 Sm. Dogfish

DATE	TIME	LORAN	DEPTH (m)	SUBSTRATE	CATCH
		SURFACE LONGLINE			
26 JUL 27 JUL	1545 0900	45255.9 60061.2	34	-	4 Tiger 1 Sandbar
16 AUG 17 AUG	1850 0755	45382.0 60439.7	24	-	2 Tiger 1 Sandbar
17 AUG	1115 1600	45380.0 60440.0	24	-	None
17 AUG 18 AUG	1630 0900	45390.9 60443.3	20	-	1 Sandbar
13 SEP	1405 1635	45442.6 60315.8	12	-	1 Sharpnose
13 SEP 14 SEP	1715 0830	45442.0 60315.0	13	-	2 Tiger 1 Lemon 1 Sharpnose
		BOTTOM LONGLINE			
26 JUL 27 JUL	1650 1330	45259.9 60072.5	34	Sand	3 Sandbar 2 Tiger
27 JUL	- -	45355.1 60162.7	22	Sand	3 Sandbar 1 Tiger
28 JUL	- -	45365.7 60190.3	20	Sand	3 Sandbar
17 AUG	1215 1700	45380.0 60440.0	20	Sand	3 Sandbar
17 AUG 18 AUG	1800 0930	45396.1 60462.9	20	Sand	3 Tiger 3 Sandbar
18 AUG	1135 1530	45431.1 60494.4	16	Sand	4 Sandbar 1 Tiger
13 SEP	1500 1530	45434.1 60320.7	14	Sand	1 Tiger 1 Sharpnose
13 SEP	1915 -	45434.5 60320.0	13	Sand	1 Sandbar
14 SEP	1400 -	45447.4 60336.0	12	Sand	None
3 OCT	1115 1600	45398.1 60448.0	19	Sand	6 Sandbar 2 Tiger

DATE	TIME	LORAN	DEPTH (m)	SUBSTRATE	CATCH
		BOTTOM LONGLINE			
3 OCT	1825	45401.3	19	Sand	3 Sandbar
4 OCT	0800	60434.1			1 Tiger
4 OCT	0930	45398.0	19	Sand	2 Sandbar
	1230	60440.9			
4 OCT	1330	45406.6	18	Sand	None
	1600	60441.7			
4 OCT	1800	45389.7	22	Hard	4 Sandbar
5 OCT	0730	60456.3			2 Tiger
5 OCT	0910	45385.5	23	Hard	None
	1300	60448.5			
5 OCT	1430	45424.4	15	Sand	2 Sandbar
	1730	60504.1			
5 OCT	1800	45424.7	16	Sand	12 Sandbar
6 OCT	0830	60503.7			2 Tiger
25 OCT	1230	45449.2	16	Hard	5 Sandbar
	1730	60649.3			2 Tiger
25 OCT	1330	45486.0	14	Sand	3 Sandbar
	1630	60684.2			1 Tiger
25 OCT	1815	45451.1	17	Hard	6 Sandbar
26 OCT	0915	60645.3			1 Tiger
					1 Hammerhead
25 OCT	1845	45446.9	17	Hard	4 Sandbar
26 OCT	0845	60653.0			
26 OCT	0945	45450.9	20	Hard	3 Sandbar
	1230	60645.1			
26 OCT	1030	45452.9	20	Hard	None
	1300	60652.2			
26 OCT	1345	45456.8	17	Hard	None
	1630	60646.2			
26 OCT	1445	45459.3	16	Hard	None
	1700	60640.0			
26 OCT	1745	45485.3	13	Sand	6 Sandbar
27 OCT	0930	60681.4			1 Tiger
26 OCT	1815	45489.3	12	Sand	6 Sandbar
27 OCT	0830	60690.3			

DATE	TIME	LORAN	DEPTH (m)	SUBSTRATE	CATCH
		BOTTOM LONGLINE			
27 OCT	1145 1600	45513.5 60699.3	12	Sand	4 Sandbar
27 OCT	1145 1600	45514.6 60692.2	12	Sand	2 Sandbar
27 OCT 28 OCT	1800 0745	45485.8 60687.0	14	Sand	1 Sandbar 1 Tiger
27 OCT 28 OCT	1800 0745	45485.0 60687.0	14	Sand	1 Sandbar
28 OCT	0900 1030	45484.4 60622.8	12	Sand	None
7 NOV	1230 1430	45417.5 60531.8	20 (100 hooks)	Hard	3 Sandbar
7 NOV 8 NOV	1630 0900	45397.3 60457.6	20	Sand	8 Sandbar 1 Silky
7 NOV 8 NOV	1630 0900	45397.3 60457.6	20	Sand	6 Sandbar 1 Tiger
29 NOV	1515 1715	45455.8 60498.0	13	Sand	3 Sandbar
29 NOV	1515 1715	45455.8 60498.0	13	Sand	3 Sandbar 1 Sharpnose
29 NOV 30 NOV	1930 0730	45392.0 60445.2	22	Hard	1 Sandbar 1 Sharpnose
29 NOV 30 NOV	1930 0730	45387.7 60436.9	22	Hard	6 Sandbar 1 Tiger 1 Sharpnose
30 NOV	1030 1315	45271.0 60298.4	39	Sand	1 Sandbar 1 Hammerhead
30 NOV	1030 1315	45275.7 60301.6	39	Sand	2 Hammerhead 1 Sharpnose
30 NOV	1445 1700	45284.0 60226.6	38	Hard	2 Sharpnose
30 NOV 1 DEC	1730 0745	45286.3 60232.6	35	Hard	2 Sandbar
30 NOV 1 DEC	1730 0745	45281.6 60232.9	35	Hard	3 Sandbar 1 Sharpnose

DATE	TIME	LORAN	DEPTH (m)	SUBSTRATE	CATCH
			BOTTOM LONGLINE		
1 DEC	0900 1200	45283.1 60225.5	35	Hard	1 Sandbar
1 DEC	0900 1200	45288.2 60228.0	35	Hard	5 Sandbar 2 Sharpnose 1 Tiger 1 Hammerhead
1 DEC	1230 1630	45284.5 60222.2	35	Hard	1 Tiger 1 Lemon
1 DEC	1230 1630	45288.1 60227.2	35	Hard	4 Sandbar 1 Tiger 1 Sharpnose
24 JAN 25 JAN	1515 0815	45288.7 60216.2	35	Hard	1 Sandbar
24 JAN 25 JAN	1515 0815	45287.7 60206.6	35	Hard	2 Sandbar 2 Hammerhead 1 Dusky
25 JAN	0930 1200	45292.6 60212.2	37	Sand	1 Sandbar
25 JAN	0930 1200	45292.3 60203.3	37	Sand	3 Sharpnose 1 Hammerhead
25 JAN 26 JAN	1600 1030	45370.2 60417.6	24 (100 hooks)	Hard	7 Sandbar 7 Sm. Dogfish 3 Tiger 1 Dusky
27 JAN	1200 1545	45384.2 60445.5	24 (100 hooks)	Hard	6 Sm. Dogfish 1 Sandbar
27 JAN 28 JAN	1700 0900	45383.8 60453.8	26	Hard	1 Sandbar 1 Sand Tiger 1 Sm. Dogfish
2 APR	1400 1800	45292.7 60206.6	36	Sand	4 Sharpnose 1 Sandbar
2 APR	1400 1800	45296.3 60214.8	36	Sand	1 Sharpnose 1 Sandbar
3 APR	0330 0800	45286.4 60216.5	38 (100 hooks)	Hard	None
3 APR	1245 1545	45412.5 60523.7	18	Hard	1 Sandbar 7 Sm. Dogfish

DATE	TIME	LORAN	DEPTH (m)	SUBSTRATE	CATCH
		BOTTOM LONGLINE			
3 APR	1245 1545	45412.1 60531.0	18	Hard	14 Sm. Dogfish
18 APR	1200 1600	45440.7 60555.5	17	Hard	2 Sandbar
18 APR	1200 1600	45437.2 60547.6	17	Hard	4 Sandbar
18 APR 19 APR	1830 0830	45400.6 60446.3	21	Sand	1 Tiger 3 Sandbar 1 Sm. Dogfish
18 APR 19 APR	1830 0830	45402.1 45439.9	21	Sand	4 Sandbar
19 APR	1200 1500	45292.3 60204.6	37	Sand	1 Sand Tiger 2 Tiger 1 Sandbar 5 Sharpnose
19 APR	1200 1500	45291.4 60196.7	37	Sand	1 Sandbar 4 Sharpnose
19 APR	1530 1830	45289.2 60210.0	35	Sand	1 Sandbar 1 Tiger
19 APR	1530 1830	45289.1 60202.3	35	Sand	1 Tiger 3 Sandbar 2 Sharpnose
19 APR 20 APR	1930 0700	45291.7 60204.6	35	Sand	2 Sandbar
19 APR 20 APR	1930 0700	45289.2 60210.0	35	Sand	1 Scal. Hhd. 1 Sharpnose 4 Tiger 3 Sandbar

Appendix 2

OPERATIONS STATEMENTS.

SHARK OPERATION CASE ONE

Assumptions:

1. Three (3) days fishing.
2. Daily effort - 500 hooks (total 1,500).
3. CPUE 7.78 sharks per 100 hooks, average yield 16.8 kg (37 lbs) carcass weight per shark.

DAILY OPERATIONS

Expenses:

Groceries	$ 25.00
Bait (113 kg or 250 lb)	150.00
Ice (775 kg or 1,700 lb)	38.25
Total	213.25

Gross Revenues:

Meat (653 kg or 1,440 lb)	432.00
Fins (39 kg or 85 lb)	170.00
Total	602.00

TRIP BALANCE

Expenses:

Groceries	75.00
Fuel (75 gal.)	82.50
Bait (339 kg or 750 lb)	450.00
Ice (22 bars)	148.50
Total	756.00

Gross Revenues:

Meat (1,960 kg or 4,320 lb)	1,296.00
Fins (116 kg or 255 lb)	510.00
Total	1,806.00

NET RETURN (prior to share-out) $1,050.00

Shares:	Trip	Daily
Boat (owner)	525.00	175.00
Captain	210.00	70.00
Crewman	105.00	35.00

SHARK OPERATION CASE TWO

Assumptions:

1. Three (3) days fishing.
2. Daily effort - 500 hooks (total 1,500).
3. CPUE 9.90 sharks per 100 hooks, average yield 16.8 kg (37 lbs) carcass weight per shark.

DAILY OPERATIONS

Expenses:

Groceries	$ 25.00
Bait (113 kg or 250 lb)	150.00
Ice (1,246 kg or 2,748 lb)	61.83
Total	236.83

Gross Revenues:

Meat (831 kg or 1,832 lb)	549.60
Fins (50 kg or 110 lb)	220.00
Total	769.60

TRIP BALANCE

Expenses:

Groceries	75.00
Fuel (75 gal.)	82.50
Bait (339 kg or 750 lb)	450.00
Ice (27 bars)	182.25
Total	789.75

Gross Revenues:

Meat (2,492 kg or 5,495 lb)	1,648.50
Fins (150 kg or 330 lb)	660.00
Total	2,308.50

NET RETURN (prior to share-out) $1,518.75

Shares:	Trip	Daily
Boat (owner)	759.38	253.13
Captain	303.75	101.25
Crewman	151.88	50.62

TILEFISH OPERATION

Assumptions:

1. Three (3) days fishing.

2. Daily effort - 3,000 hooks (total 9,000).

3. CPUE 0.17 kg (0.37 lb) per hook.

DAILY OPERATIONS

Expenses:

Groceries	$ 25.00
Bait (272 kg or 600 lb)	360.00
Ice (624 kg or 1,375 lb)	30.94
Total	415.94

Gross Revenues:

Dressed Fish (500 kg or 1,100 lb)	1,001.00

TRIP BALANCE

Expenses:

Groceries	75.00
Fuel (150 gal.)	165.00
Bait (816 kg or 1,800 lb)	1,080.00
Ice (14 bars)	94.50
Total	1,414.50

Gross Revenues:

Dressed Fish (1,500 kg or 3,300 lb)	3,003.00

NET RETURN (prior to share-out) $1,588.50

Shares:	Trip	Daily
Boat (owner)	794.25	264.75
Captain	317.70	105.90
Crewman	158.85	52.95

Appendix 3

EDIBILITY CHARACTERISTICS.

Table 3.1 Average values of panel ratings for edibility characteristics of shark species supplied by South Carolina Marine Resources Division.

	SHARK SPECIES						
	Sandbar	Silky	Lemon	Scalloped Hammerhead	Tiger (Large)	Tiger (Small)	Atlantic Sharpnose
Attribute:							
Darkness	2.51	2.88	2.45	2.82	2.77	2.32	2.00
Hardness	3.03	1.88	4.05	2.95	5.37	1.85	2.60
Flakiness	0.56	2.00	0.50	0.69	0.07	0.85	1.60
Chewiness	3.07	1.88	4.29	4.22	5.94	2.29	2.60
Fibrousness	2.35	2.25	3.67	2.93	3.35	2.29	2.40
Moistness	2.76	4.00	2.93	1.80	2.10	3.95	2.60
Oily Mouth Coating	0.48	0.25	0.85	0.49	0.81	0.51	0.60
TIF[1]	3.21	3.38	3.77	3.54	3.53	3.60	3.20
Sweetness	0.46	0.25	0.42	0.29	0.59	1.69	0.20
Saltiness	1.47	1.75	1.67	1.74	1.98	1.49	1.20
Sourness	2.46	2.25	3.08	3.33	2.86	2.58	2.20
Gamey	0.43	0.0	0.67	1.03	0.73	0.52	0.40
Fish Oil	0.11	0.0	0.0	0.0	0.13	0.11	0.20
Shellfish	0.41	0.25	0.13	0.0	0.57	0.17	0.20
Earthy	0.48	1.25	0.74	0.73	0.42	0.47	0.20
Mouth Drying	1.20	1.00	1.97	2.49	0.99	0.62	1.80
No. of Tests	4	1	2	2	2	4	1

[1] Total intensity of the flavor

Table 3.2 Average sensory panel ratings for selected finfish species and attributes (for reference).

SPECIES:	Gag Grouper	Red Porgy	Southern Flounder	Swordfish	King Mackerel
Darkness:	1.87	2.55	2.37	2.98	4.66
Hardness:	4.11	3.15	1.88	2.10	3.31
Fibrousness:	3.54	2.90	2.57	3.14	4.02
Moistness:	2.66	2.50	2.98	3.31	2.60
T I F[1]:	2.78	3.00	2.32	3.42	4.00
Sourness:	1.11	2.03	0.97	2.84	1.76

[1] Total intensity of the flavor