THE SOUTH CAROLINA FISHERY FOR BLACK SEA BASS

(*Centropristis striata*),

1977 - 1981

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Trends in recreational catch, commercial landings, and size composition of black sea bass (Centropristis striata) in the South Carolina fishery during 1977-1981 are examined and biological aspects relevant to management are reviewed. Principal developments include (1) a relatively stable recreational catch, (2) a greatly expanded commercial fishery, (3) probable rate of fishing mortality in inshore areas prior to 1981 sufficient to produce the maximum sustainable physical yield (MSY), (4) probable rate of fishing mortality in offshore areas prior to 1981 slightly below that required to produce MSY, (5) a size composition in 1981 suggestive of excessive exploitation in the southern district, (6) a size composition in 1981 below the optimum economic level, and (7) no evidence that recruitment is being affected. If the rate of exploitation remains at the present level or increases, quotas with separate recreational and commercial allocations and a 203-mm (8.0 in.) total length minimum size limit, or a 229-mm (9.0 in.) minimum for hook-and-line fishermen and a minimum mesh regulation for trap fishermen, should be considered.

ACKNOWLEDGMENTS

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INTRODUCTION

Black sea bass (Centropristis striata) are one of the more important economic resources in South Carolina's offshore waters. During the last five years, the combined recreational and commercial catch has steadily increased to an annual level near the historical maximum. Extensive life history data have been collected and analyzed by the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) group of the Marine Resources Research Institute, permitting estimation of critical population parameters with a reasonable level of accuracy. Results of a marine recreational fishery survey by the National Marine Fisheries Service have become available. A socio-economic profile of the state's offshore recreational fishermen has been prepared and several studies of the biological and economic contributions of the artificial reef program have been completed. The statistics reporting system for the commercial fishery has been expanded and improved. Preparation of a regional management plan by the South Atlantic Fishery Management Council is nearing completion. It is therefore appropriate to review and summarize the principal findings of these diverse investigations as they relate to the South Carolina black sea bass fishery, evaluate its status, and discuss problems and procedures relevant to its future management.

METHODS

All known written material on the resource and its fishery prepared during the last five years was reviewed; information from older studies was considered where appropriate. Consensus opinions from conversations with fishermen and dealers were included, as were those from biologists and management specialists having first-hand knowledge of the resource and fishery. Landing statistics were analyzed and information on size composition from port sampling was evaluated.

FINDINGS

Unless otherwise noted, all information pertains only to the black sea bass population off South Carolina.

BIOLOGICAL ASPECTS

Peak spawning occurs offshore during March through June with passive, inshore transport of the pelagic larvae until they assume demersal or estuarine residence, the latter in areas of high salinity and live bottom. The principal estuarine nursery extends from the Isle of Palms to northern Bulls Bay and is vacated by the juveniles when water temperature drops below 10°C (Cupka et al. 1973). The percentage of larvae that reaches estuarine areas is small, however, relative to that in coastal and offshore waters (R. Beatty, College of Charleston, pers. comm.). Juveniles develop wherever the larvae have settled in demersal cover and fish $\leq$ age 1 are common to 40 m (22 fm), with no concentration in any particular depth range (R. Beatty, pers. comm.).

Distribution, age structure, and sex composition of adult black sea bass in natural live-bottom areas were documented by Waltz et al. (1979). They confirmed the observation of Cupka et al. (1973) that black sea bass move offshore as they become larger and older. These fish are protogynous hermaphrodites and although sex reversal occurs over a wide size and age range, males predominate in the larger sizes (> 220 mm or 8.7 in. SL), older ages (> 4 years), and the population in > 30 m (16 fm) of water. Mature females and males are found in all age groups, with transitional fish being most commonly age 3. The average age observed in 20-28 m (11-15 fm) was 2.4 years, while that in 40-50 m (22-27 fm) was 4.8 years. The oldest fish studied was 10 years old and few exceeded 8 years of age. Age and size composition varied greatly between the four areas (Fig. 1) regularly sampled.

Observed mean lengths-at-age in Waltz et al. (1979) indicate that sea bass grow slowly and that males are larger than females of the same age, particularly in older age groups. Males mature as small as 140 mm (5.5 in.) SL and females as small as 160 mm (6.3 in.) SL, with most of the fish > 200 mm (7.9 in.) SL (260 mm or 10.2 in. TL) being mature (Cupka et al. 1973). Males usually are at least 4 years old before reaching 445 g (1.0 lb) and females at least 5 years old. Black sea bass > 1,750 g (4.0 lb) are rarely caught off South Carolina. The largest reported was 3,515 g (7.75 lb) in 1975.

Age and size composition on artificial reefs reflect seasonal immigration from surrounding natural habitat and fishing pressure over the reefs. Buchanan (1973) and Buchanan et al. (1974) studied Paradise and Pawley's Island Reefs during June-September 1972 and June-November 1973. They concluded that abundance on the reefs also was controlled by these factors. The mean total length observed on Paradise Reef was 213 mm (8.4 in.), similar to that noted in the surrounding natural habitat. Age and size composition of fish from the Capers and Fripp Island Reefs during 1979 are shown in Table 1. The Capers site had been intensively fished in the summer, while Fripp Island Reef was unfished. Although age composition from Capers and Fripp Island during summer was virtually identical, the mean size-at-age of the Fripp Island fish was significantly

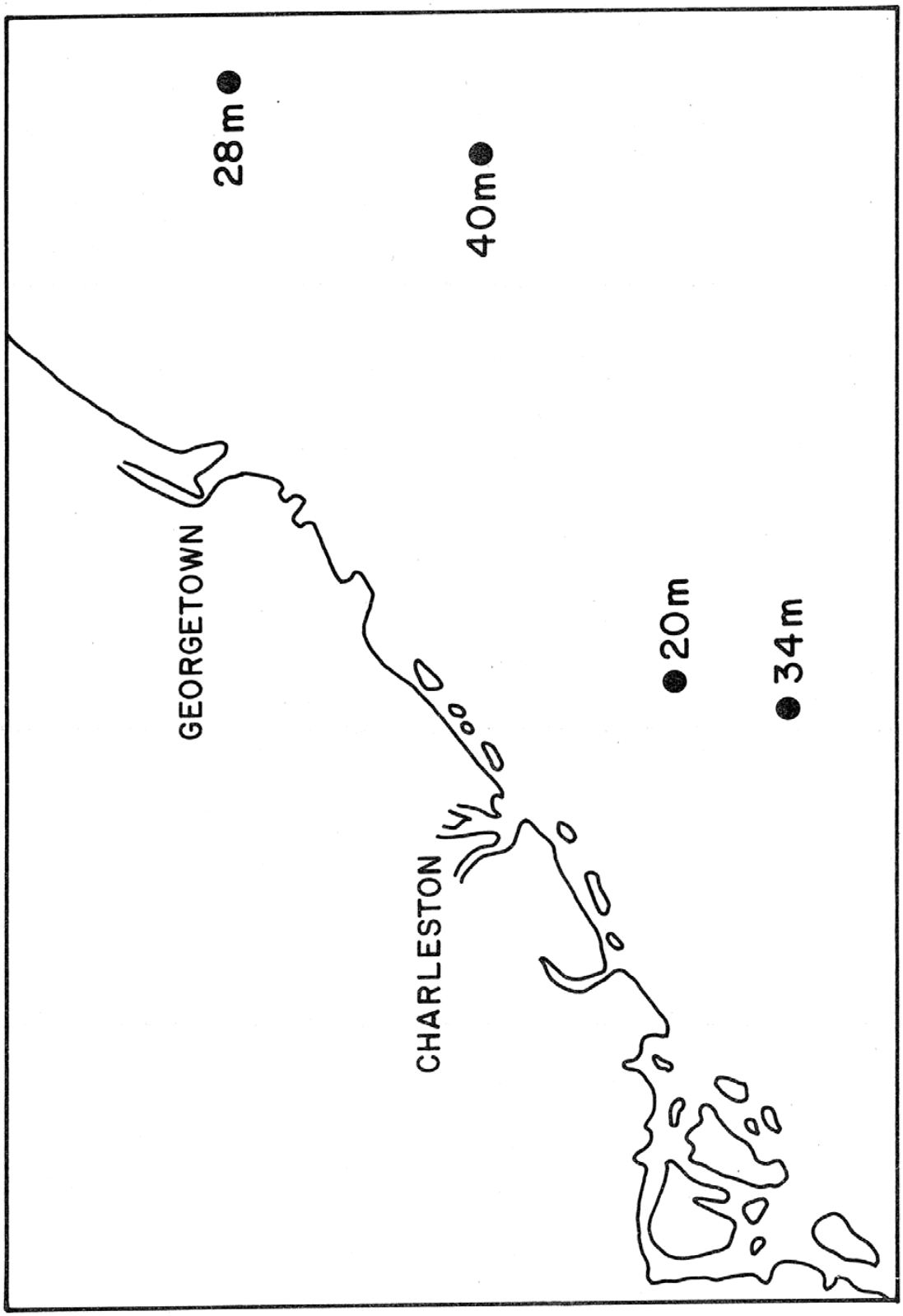

28m
40m
GEORGETOWN
CHARLESTON
20m
34m

TABLE 1. Age and size composition of black sea bass from two artifical reefs.

Reef	Month	N		Age 1	2	3	4	5	6
Capers	June	122	%	11	74	13	2	1	0
			TL mm	173	230	290	306	325	-----
			Wt g	96	221	416	454	595	-----
Fripp Id.	June	92	%	9	77	13	1	0	0
			TL mm	208	255	345	392	---	-----
			Wt g	144	273	672	997	---	-----
Capers	Dec.	108	%	3	57	28	9	0	3
			TL mm	231	260	332	357	---	433
			Wt g	190	274	557	685	---	1,092

(Source: C. Wenner, Marine Resources Research Institute)

larger.

Sea bass move onto the reefs from surrounding natural habitat in search of shelter, particularly during stormy weather (Myatt 1978). In cold months, these fish are considerably larger than during the warm months. They remain there until caught; the greater the fishing intensity, the more rapid the removal of the largest fish. The average size-at-age of the remaining fish is therefore smaller than that of fish from less heavily-fished localities.

Extent of movement is not well-known, although results from tagging suggest that it is limited. Cupka et al. (1973) reported a maximum movement of 20.4 km (11 nautical mi.) by fish released in 13-17 m (7-9 fm) of water. Early returns from an offshore (30 m or 16 fm of water) tagging study being conducted by MARMAP have been primarily from the area of release. Parker et al. (1979) found that sea bass tagged on the artificial reefs off Murrells Inlet remained close to the site where they were initially captured. Tagged sea bass from the Fripp Island Dry Dock Wreck have all been captured on the wreck (Myatt 1979). In Georgia, only 1% of recoveries came from areas other than the reef where they were tagged (H. Ansley, Georgia Department of Natural Resources, unpublished data). It should be noted that most tagging has been in the summer and that average at-large periods have not been extended (usually less than two months), thus the extent of seasonal movement is difficult to document. Fishermen believe there is movement of larger sea bass from offshore to inshore during the cold months. Any seasonal movement appears to be depth-related rather than latitudinally oriented.

The annual instantaneous rate of natural mortality is assumed to be about 0.30 (Mercer 1978, Low 1981), although a rate as high as 0.45 has been suggested (G. Huntsman, National Marine Fisheries Service, unpublished data). From catch curves of sea bass caught in MARMAP trap surveys in 1978-1979, Low (1981) estimated an annual instantaneous rate of total mortality of 0.75-0.83 for fish in < 40 m (22 fm) of water and about 0.60 for fish in > 40 m (22 fm). If natural mortality is about 0.30, the annual instantaneous rate of fishing mortality in the shallow stratum would be 0.45-0.55 and that in the deep stratum would be about 0.30. The rate of exploitation (finite rate of fishing mortality) was then about 32-38% in shallow water and 23% in deep water. These estimates are in good agreement with contemporary tag-return rates from Georgia reefs, which ranged from 29 to 44% from inshore areas and 17 to 18% from offshore areas (H. Ansley, unpublished data). Parker et al. (1979) obtained a 23% recovery rate on an artificial reef off Murrells Inlet and Myatt (1979) reported an 11% recapture rate on the Fripp Island Dry Dock Wreck. Cupka et al. (1973) obtained a 5% return rate from fish tagged with spaghetti tags off Charleston, Pawley's Island, and Little River. Many authors have commented on the unreliability of retention of such tags by reef fishes, however, and the the rates reported by Parker et al. (1979), Myatt (1979), and Cupka et al. (1973) imply artificially low exploitation rates because of unaccounted tag loss.

Black sea bass are fully recruited to the inshore exploited population between ages 3 and 4 and to the offshore population by age 5, although they become partially vulnerable to fishing gear (particularly hook-and-line) between ages 1 and 2.

RECREATIONAL FISHERY

There is no systematic sampling program that provides estimates of recreational catch and effort by private and charter boats on a routine basis. From a mail survey of private boat offshore anglers in 1977, Liao and Cupka (1979a) estimated that 31% of them engaged primarily in bottom fishing. Black sea bass was by far the most important species for these anglers and represented 15% of the total fish catch (presumably by numbers; the report does not specify what the unit of catch was). Liao and Cupka (1979b) estimated that fishing over the artificial reefs accounted for 26% of the total days of offshore fishing by private boat anglers in 1977. Total expenditures attributable to this effort amounted to about $2.24 million. Black sea bass represented most of the bottomfish caught by these anglers. Liao and Cupka (1979b) estimated that the total number of fishing days by private boat anglers on the artificial reefs in 1977 was 33,550, with an average catch per angler-day of 4.5 fish (species not identified). Since effort was measured in boat-days and CPUE was calculated as "fish" per angler-day, it is impossible to derive an accurate catch estimate by expansion of these data: 150,000 sea bass would be a reasonable estimate. Since the mean size of fish from artificial reefs during the summer peak of fishing activity is about 230 mm (9.0 in.) TL, equivalent to a mean weight of about 175 g (0.39 lb), a rough estimate of this catch by weight would be about 58,000 lb.

Given the limited data available, it is impossible to derive even a rough estimate of the probable level of annual catch by private boat anglers over natural habitat.

Documents used by the South Atlantic

Fishery Management Council to prepare the reef fish (snapper-grouper) plan contain an estimate of 14,900 lb for the total (1978) private boat catch. Considering information from other sources, this estimate is conservative.

The Council estimate of the (1978) South Carolina charter boat catch (36,871 lb) is probably much too high. Black sea bass were not even included in the (1977) catch composition reported by Liao and Cupka (1979a). Fishing over the artificial reefs accounted for only about 14% of the charter trips in 1977 and most of this effort consisted of trolling (Liao and Cupka 1979b). This suggests that the South Carolina charter boat catch is insignificant.

Black sea bass are the most important component of the inshore headboat catch off the Carolinas (Huntsman 1976) and 45% of the headboat fishermen interviewed by Liao and Cupka (1979a) in 1977 reported catching them. From interviews of headboat captains, Liao and Cupka (1979b) determined that about 10% of the headboat trips in 1977 involved fishing over the artificial reefs, with black sea bass being the target species. The total direct economic impact associated with the reef trips was $254,436 (Liao and Cupka 1979b).

Liao and Cupka (1979b) estimated that there were 109,044 headboat angler-trips in 1977. From information in Moore et al. (1980), three headboats specialized in snapper-grouper trips, where the incidental catch of black sea bass is insignificant. These boats carried an average of 6,300 anglers per boat in 1977, based on Liao and Cupka's (1979b) survey results. Thus there probably were about 90,100 headboat anglers on black sea bass trips in 1977. Liao and Cupka (1979b) reported an average catch rate of 6.4 fish and 4.8 lb per angler-trip for such fishermen. If this consisted entirely of black sea bass (which was not the case), the maximum headboat catch in 1977 would have been about 432,600 lb. This is in good agreement with the maximum estimate of 424,200 lb calculated by the National Marine Fisheries Service (G. Huntsman, unpublished data). The maximum estimate prepared by the National Marine Fisheries Service for 1978 was 392,700 lb.

The marine recreational fishery survey conducted for the National Marine Fisheries Service estimated that the total recreational catch of sea bass in South Carolina during 1979 was 446,000 fish, about 18% of the total number of marine fish caught and the second most-numerous species after spot, Leiostomus xanthurus (National Marine Fisheries Service 1980). No weight estimate was given, but a 1.0-lb average individual weight would be consistent with other information.

COMMERCIAL FISHERY

More than 90% of the South Carolina commercial catch during the last three years was produced by the trap fishery. Less than 3% came from trawling and the remaining 6-7% represented incidental catch by snapper reel fishermen (Table 2). Gear and techniques of the trap fishery remain basically the same as described by Rivers (1966) and Mc Donald (1974). Although many different types of traps have been tested in both commercial usage and research activities (Powles and Barans, undated Marine Resources Research Institute manuscript), the Chesapeake Bay wire crab trap with 38-mm (1.5 in.) hexagonal mesh is of proven effectiveness, readily available, inexpensive, and the most widely employed gear. Although trawling is productive on the winter grounds off the Virginia capes, sea bass off South Carolina are not highly vulnerable to this method. One probable explanation is that they are not densely concentrated over the flat bottom normally fished by local trawlers, nor are they abundant in the 60-100 m (30-50 fm) depth range frequently trawled in winter and early spring.

A diverse assemblage of commercial boats engages in the sea bass fishery. When crabbing falls off with the onset of cold weather and the sounds are closed to shrimping in December, many small boats turn to trap fishing. A few large, double-rigged shrimpers are occasionally attracted to the fishery if prices are high. A few charter and private boat fishermen also participate. Most snapper reel fishermen do not fish for sea bass unless bad weather forces them off the offshore grounds or the price becomes attractive.

Most commercial fishing takes place on the "blackfish banks," areas of low-relief, live-bottom in 20-35 m (10-17 fm) from southeast of Charleston to due east of Savannah and between Murrells Inlet and Little River. Hard, "washboard" bottom, characterized by low-relief ledges and gullies, also produces good catches. "Regular" commercial fishermen (individuals with suitable vessels who routinely participate in the fishery) seldom fish inshore of 20 m (11 fm) or on the artificial reefs; these areas are most frequently utilized by the "part-time" fishermen (individuals with marginal vessels who fish only occasionally).

Most fishermen make one or two-day trips, partly because the grounds are close to port and partly because the fish are marketed in the round and need to be shipped promptly. Although fishermen commonly referred to catches of 15-20 boxes (1,500-2,000 lb) per trip-day, the average catch per trip-day during March 1979-January 1980, as calculated from trip tickets, was 395 lb for "part-time" fishermen (62 trip-days) and 805 lb for "regular" fishermen (70 trip-days)

TABLE 2. Monthly commercial landings by gear, 1979 - 1981 (in thousands of pounds) (G. Ulrich, Office of Conservation, Management, and Marketing, unpublished data).

Year	Month	Hook-and-Line				Trap				Trawl			
		Sml.	Med.	Lrg.	Uncl.	Sml.	Med.	Lrg.	Uncl.	Sml.	Med.	Lrg.	Uncl.
1979	Jan.	1.0	0.7	0.7	0.7	7.0	5.2	6.9	15.7	0.1	0.1	0.3	---
	Feb.	0.3	0.4	0.6	0.1	5.3	4.9	8.6	21.7	0.3	0.4	1.1	---
	Mar.	0.1	0.2	0.7	0.1	6.1	6.8	12.9	7.0	0.1	0.1	0.6	0.1
	Apr.	---	0.1	0.3	1.6	3.9	3.1	4.7	4.5	---	---	---	---
	May	0.4	0.7	1.7	0.5	1.0	0.9	2.0	2.3	---	---	---	---
	June	0.2	0.3	0.5	0.1	----	----	----	0.9	---	---	0.1	---
	July	1.0	0.9	1.6	---	----	----	----	----	---	---	---	---
	Aug.	0.2	0.3	0.3	0.3	3.4	1.7	3.4	0.1	---	---	---	---
	Sep.	0.2	0.2	0.3	0.7	0.3	0.3	0.5	----	---	---	---	---
	Oct.	---	---	---	0.2	3.3	1.8	2.5	3.3	---	---	---	---
	Nov.	0.1	---	0.1	0.1	6.6	4.9	4.0	8.9	---	---	---	---
	Dec.	---	---	---	0.4	4.5	2.1	2.7	7.5	---	---	---	---
1980	Jan.	0.2	0.1	0.1	0.1	19.9	14.8	15.4	0.1	0.1	---	---	0.1
	Feb.	---	---	---	---	13.6	8.1	14.3	3.1	---	---	---	---
	Mar.	---	---	---	0.1	2.3	2.0	4.3	0.2	---	---	---	0.1
	Apr.	---	---	0.2	0.1	4.1	3.3	7.2	----	---	---	---	---
	May	---	---	---	0.1	5.3	2.3	6.4	0.6	---	---	0.1	---
	June	---	---	0.1	0.3	0.8	0.8	0.8	1.7	---	---	---	---
	July	0.5	0.2	0.4	0.5	0.8	0.6	0.8	----	---	---	---	---
	Aug.	0.9	0.3	0.4	0.7	2.5	1.8	1.8	----	---	---	---	---
	Sep.	0.8	0.2	3.2	0.2	0.3	0.2	0.2	2.8	---	---	---	---
	Oct.	0.2	---	1.2	2.1	1.3	1.3	1.6	----	---	---	---	---
	Nov.	0.6	0.3	1.4	---	4.7	4.3	4.2	----	---	---	0.1	---
	Dec.	0.2	0.4	1.2	0.1	10.0	9.4	9.8	0.1	---	---	0.1	---
1981	Jan.	---	0.1	0.5	---	24.5	19.9	24.3	15.4	---	---	---	0.6
	Feb.	---	0.1	0.5	0.3	18.3	13.2	13.2	----	---	---	0.1	0.2
	Mar.	0.2	0.5	1.3	0.4	34.2	19.9	22.8	----	---	---	0.2	0.5
	Apr.	2.7	2.0	3.6	0.6	11.8	8.1	9.1	----	2.6	0.1	1.8	0.3
	May	0.8	1.5	3.4	0.1	29.3	16.2	15.7	----	0.4	---	0.6	---
	June	0.3	1.0	2.0	0.2	22.2	13.2	9.5	----	0.5	---	0.5	---
	July	0.7	1.0	1.5	---	19.7	9.0	7.5	----	0.1	---	0.1	---
	Aug.	0.5	1.0	2.7	---	17.0	7.3	8.6	----	---	---	---	---
	Sep.	1.4	1.3	2.1	---	9.2	9.9	14.3	0.1	---	---	---	---
	Oct.	0.2	0.7	0.9	0.2	13.4	10.9	13.1	----	---	0.3	0.8	---
	Nov.	0.2	0.8	2.0	0.2	10.1	8.8	9.0	----	---	---	0.1	0.3
	Dec.	0.3	0.7	1.4	---	9.1	10.9	10.1	----	---	---	---	---

(G. Ulrich, Office of Conservation, Management, and Marketing, unpublished data). Mean trap CPUE during 1981 by month and district is shown in Table 3, based on a minimum of five landings per district per month.

Annual landings by district are summarized in Table 4. The relative contribution from each district has varied considerably from year to year. Available data are inadequate to form any conclusions regarding trends in relative abundance by area.

Size grading is somewhat subjective and therefore variable from dealer to dealer, depending on immediate order requirements, price structure, availability of fish of each size, etc. The guidelines are (1) "small," < 335 g (0.75 lb), (2) "medium," 336-567 g (0.75-1.25 lb), and (3) "large," > 568 g (1.25 lb). Some dealers have an additional category for fish > 1.0 kg (2.2 lb) because they return a lower price than fish in the 568-1,000 g range. "Larges" are preferred, as reflected by their high unit value (Table 4). "Mediums" are marginally profitable and "smalls" are frequently unmarketable except through local dealers. Most of the "larges" are shipped to the New York market, where there is a strong ethnic (Oriental) demand for them. This market is dominated by fish from northern states (particularly North Carolina and Virginia) and the price reflects their supply. Average unit value is greatest during summer and early fall. There is considerable short-term variation in price and the market is highly unpredictable. Since the fish are sold in the round and trap-caught sea bass are full of highly-perishable bait, they must be sold promptly. This curtails the dealers' option to hold them until the market improves.

The annual trends in size composition by district are summarized in Table 5.

The statewide percentage of "larges" has declined as total annual landings have increased. After an initial drop, the contribution of "mediums" has stabilized, while the percentage of "smalls" has increased. Most of the size decrease is due to the increased percentage of "smalls" landed in the central and southern districts.

The monthly commercial landings statewide by size category are listed in Table 6 and the trend in percentage contribution of "smalls" is shown in Fig. 2. Since the contribution of "mediums" has remained relatively constant, the trend in percentage contribution of "larges" is roughly the opposite of that for "smalls."

DISCUSSION

The recreational catch, attributable primarily to headboat anglers, appears to have remained relatively stable over the last five years. There is no reason to suspect that the level of headboat fishing participation will increase significantly. It will probably parallel the trend in tourism, since 67% of the headboat anglers interviewed in 1977 were from out-of-state. The level of participation by private boat anglers can be expected to increase due to the increasing population in coastal metropolitan areas. Most of the private boat fishermen would be utilizing inshore areas such as the artificial reefs. It is reasonable to anticipate a modest increase in recreational fishing effort in coastal waters, with offshore effort continuing at about the present level.

The annual commercial catch has increased to the highest level attained since the record years of 1969 and 1970 (Fig. 3). Much of this increase may be due to improved markets and part may be attributable to unfavorable alternative fishing opportunities (e.g. poor shrimping for inshore boats). Given the past erratic performance of this fishery and the highly volatile market, it is difficult to forecast the trend in commercial landings and participation. The dramatic decline after 1972, while in part due to poor markets, could have resulted from a decrease in average size, with resultant low demand. It is interesting to note that the 7-year interval spanning the "valley" approximates the average lifespan. It is not entirely unlikely that the 1983-1984 commercial catch will follow the trend of a decade ago.

Any increase in inshore fishing effort will probably be accompanied by a decrease in average individual size, which is already small during peak fishing periods in isolated, intensively fished locations such as the artificial reefs. The probable level of fishing mortality in inshore areas is already sufficient to produce MSY. Assuming that fishing mortality is directly proportional to nominal fishing effort, any increase in inshore effort will probably require imposition of management controls, unless catches of even smaller fish are considered acceptable.

The estimate of probable fishing mortality in offshore areas is slightly below the thresh-hold level generating MSY, but it should be emphasized that this refers to a period before the recent drastic increase in commercial landings. I estimated that the percentage composition of a simulated commercial catch from an unfished population would be 29% "small," 23% "medium," and 48% "large." The latter value is very close to that (45%) observed in 1977, after three years of insignificant commercial exploitation. Given the fishing mortality rates estimated to be in effect, the hypothetical composition of the commercial catch would

TABLE 3. Average monthly South Carolina commercial trap catch per unit of effort (pounds per landing) of black sea bass by district during 1981.

Month	Southern	Central	Northern
January	2505	2874	1700
February	-	1465	2135
			(1601 lb/day)
March	-	2134	1100
		(1961 lb/day)	(869 lb/day)
April	-	980	1092
May	-	1739	654
June	1839	-	-
July	1568	932	-
August	-	826	-
September	1190	-	1105
October	660	-	1386
November	1523	-	744
			(677 lb/day)
December	1519	-	1204

TABLE 4. Annual summary of size composition and value of commercial landings by district.

Year	District[A]	1000 Pounds Small	Medium	Large	Mixed	Average $ lb Small	Medium	Large	Total Pounds	Total $
1977	All	0.9	1.5	2.1	12.0	----	----	----	16,590	-------
1978	Northern	-----	-----	-----	6.5	----	----	----	6,500	4,505
	Central	4.6	7.1	11.3	24.2	0.27	0.49	0.75	47,193	24,716
	Southern	2.2	2.5	3.0	3.9	0.15	0.50	0.90	11,539	5,547
	All	6.8	9.6	14.3	34.5	----	----	----	65,232	34,768
1979	Northern	10.5	7.3	4.8	56.0	0.24	0.49	0.79	78,532	35,777
	Central	30.1	22.9	44.3	17.7	0.24	0.48	0.77	115,031	59,214
	Southern	9.7	9.9	10.6	4.0	0.22	0.42	0.70	34,219	16,577
	All	50.3	40.1	59.7	77.7	----	----	----	227,782	111,568
1980	Northern	44.1	38.3	51.0	5.2	0.46	0.80	1.42	138,610	116,219
	Central	21.0	10.8	25.9	5.6	0.42	0.72	1.19	63,241	43,644
	Southern	1.7	1.4	2.1	1.2	0.34	0.67	1.18	6,387	5,226
	All	66.7	50.6	79.0	12.0	----	----	----	208,238	165,089
1981	Northern	64.2	62.8	81.3	0.6	0.33	0.59	1.27	208,818	167,531
	Central	58.9	28.5	51.5	2.4	0.35	0.64	1.28	141,262	87,516
	Southern	116.1	72.8	64.4	17.2	0.33	0.76	1.51	270,655	202,049
	All	239.2	164.1	197.2	20.1	----	----	----	620,735	457,096

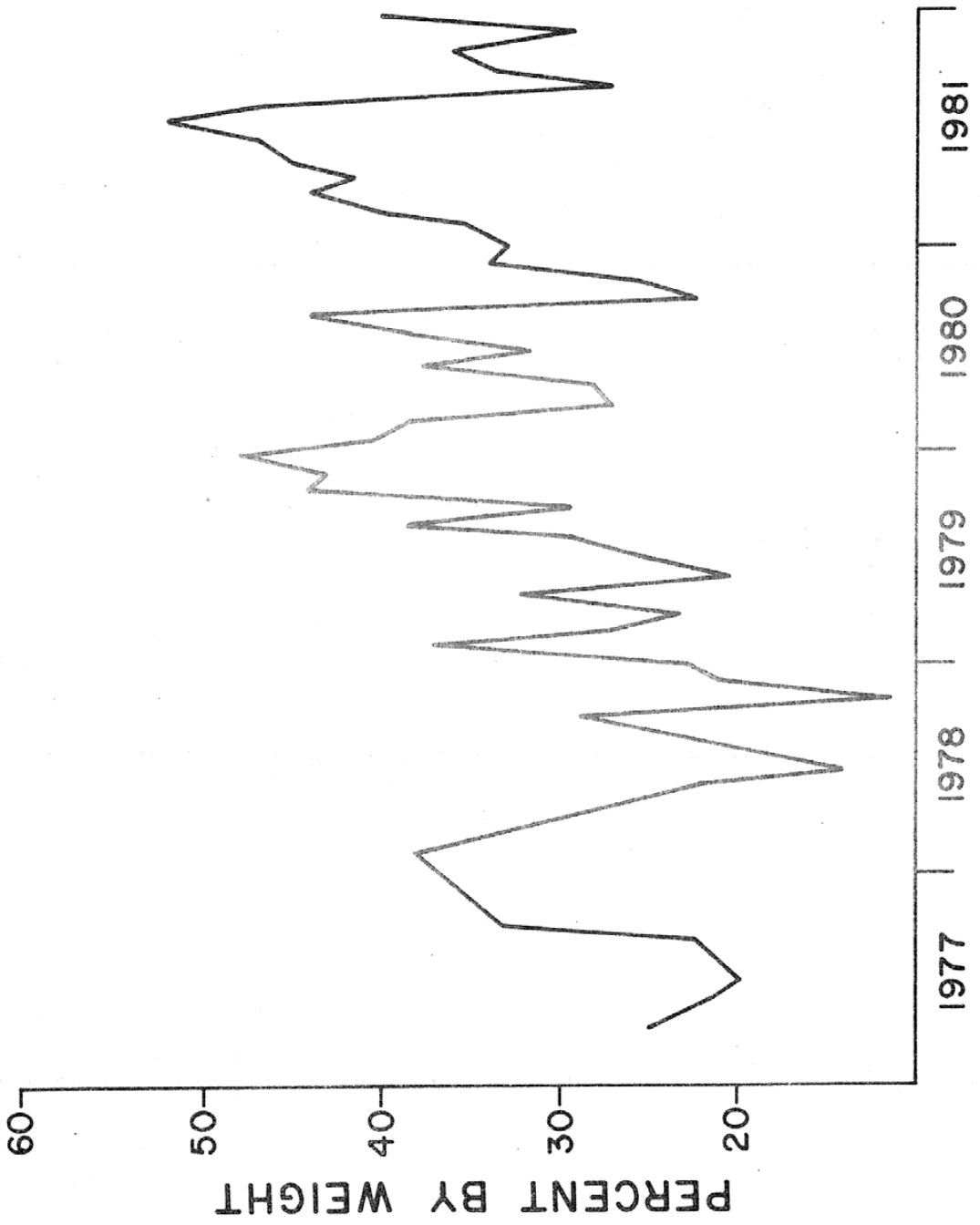
[A]Northern - Georgetown and Horry Counties
Central - Charleston and Berkeley Counties
Southern - Beaufort and Colleton Counties

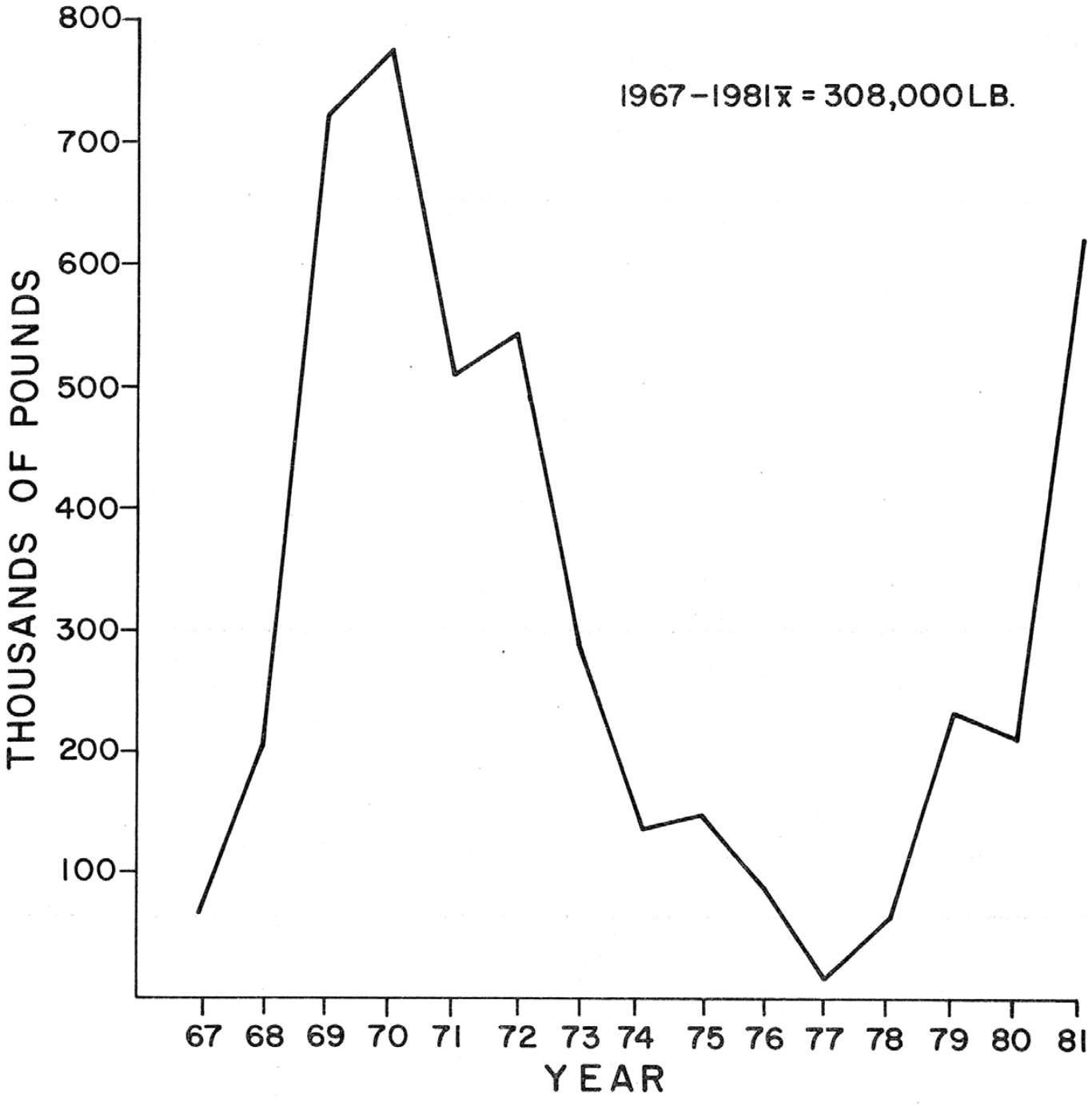
TABLE 5. Grade composition of commercial catches of black sea bass by district.

Year	District	Percent of Graded Sea Bass		
		Small	Medium	Large
1977	All	21	34	45
1978	Northern	--	--	--
	Central	20	31	49
	Southern	29	32	39
	All	22	33	45
1979	Northern	46	33	21
	Central	31	23	46
	Southern	32	33	35
	All	34	26	40
1980	Northern	33	29	38
	Central	36	19	45
	Southern	33	27	40
	All	34	26	40
1981	Northern	31	30	39
	Central	42	21	37
	Southern	46	29	25
	All	40	27	33

Table 6. Monthly commercial landings by size category (thousands of pounds).

Year	Grade	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1977	Small	----	----	0.2	----	0.3	0.2	----	0.2	0.1	----	----	----
	Medium	----	----	0.4	----	0.4	0.4	----	0.3	0.1	----	----	----
	Large	----	----	0.2	----	0.7	0.4	----	0.4	0.1	----	----	----
	Mixed	6.9	1.8	0.3	0.7	0.6	----	0.4	0.2	----	0.1	0.2	0.6
1978	Small	0.3	----	----	----	0.4	0.2	----	----	0.5	0.3	0.3	4.8
	Medium	0.4	----	----	----	0.4	0.3	----	----	0.6	1.0	0.4	6.5
	Large	0.1	----	----	----	1.0	0.9	----	0.2	0.6	1.4	1.1	9.0
	Mixed	4.4	1.0	2.2	0.3	2.1	0.5	0.5	3.9	3.0	4.0	7.7	5.0
1979	Small	8.3	6.0	7.4	4.0	2.4	0.5	1.0	3.6	0.4	5.4	6.1	5.2
	Medium	6.9	5.7	8.7	3.2	1.6	0.5	0.9	2.0	0.4	2.8	4.9	2.6
	Large	8.0	10.4	15.2	4.8	2.6	1.2	1.6	3.7	0.6	4.1	4.0	3.3
	Mixed	16.4	21.7	7.1	6.3	2.8	1.2	0.1	0.3	1.1	3.7	8.9	8.0
1980	Small	21.3	9.3	2.3	3.8	6.9	0.7	1.3	2.9	1.1	1.4	5.3	10.4
	Medium	15.5	6.5	2.0	3.0	3.0	1.7	0.8	2.0	0.5	1.3	4.5	9.7
	Large	17.7	12.6	4.4	8.1	7.1	1.7	1.3	2.8	3.5	2.8	6.0	11.2
	Mixed	0.2	3.2	0.4	0.3	0.1	0.3	0.9	1.1	3.0	2.1	----	0.3
1981	Small	24.6	18.3	34.4	28.5	30.4	23.1	15.8	17.5	9.8	13.6	12.0	11.2
	Medium	20.0	13.3	20.3	17.3	17.7	14.3	7.5	8.4	10.2	11.9	10.1	13.0
	Large	25.0	13.9	23.0	21.3	19.8	11.9	16.0	11.4	15.7	14.7	11.5	13.0
	Mixed	16.1	0.5	1.1	0.9	0.6	0.4	0.1	----	0.2	0.3	0.1	----


PERCENT BY WEIGHT
60
50
40
30
20
1977
1978
1979
1980
1981


1967–1981 $\bar{x}$ = 308,000 LB.
THOUSANDS OF POUNDS
800
700
600
500
400
300
200
100
67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
YEAR

be 44% "small," 27% "medium," and 29% "large." That the observed percentage composition deviated somewhat from these benchmarks is probably due to the tendency for dealers to upgrade their fish when high prices for "larges" prevail. Since these mortality rates approximate the exploitation level that produces MSY, the percentage size composition under MSY conditions should be close to these benchmarks. The percentage of "larges" in the 1981 commercial catch in the southern district was lower than the hypothetical value, which suggests that the rate of exploitation there exceeded the optimal level from a biological standpoint.

From the economic perspective, the commercial fishery should operate at a level of fishing effort below that needed to take MSY because of the dependence on "large" fish to make the fishery profitable. In this respect, the economics of the commercial fishery tend to prevent it from biologically overharvesting the resource for any sustained period of time. I believe this is what happened historically. Although "larges" represented 33% of the total weight of the 1981 commercial catch, they accounted for 57% of the total ex-vessel value. "Smalls" accounted for 40% of the poundage, but only 18% of the landed value. Commercial fishermen generally agreed that at least 33% of their catch had to be "larges" and that the "larges" and "mediums" combined had to represent at least 67% of the total weight to yield a profitable return. From this perspective, the fishery in the central and southern districts took too high a percentage of "smalls" in 1981.

The two management options considered by the South Atlantic Fishery Management Council are catch quotas and minimum size limits. Under the first option, the regional (Cape Hatteras to Cape Canaveral) black sea bass population is considered a single unit and a total regional catch limit for all user groups combined is prescribed. This approach assumes that the relative distribution of effort by area, season, and user group will remain unchanged from the historical pattern. It may prove inequitable in practice for two reasons. The first drawback is the lack of area subquotas. Latitudinal movement in the South Atlantic Bight is limited. Recruitment and size composition in one latitutdinal zone are therefore independent of the level of fishing in another. Catches off North Carolina would have no effect on catches off South Carolina, given the natural boundary of Frying Pan Shoals, and almost certainly would not impact the harvest off either Georgia or Florida, except under the proposed quota system. An intensive winter-spring commercial fishery off North Carolina could conceivably take most of the regional allowable catch, to the detriment of fishermen in other states. Setting of quotas state-by-state would eliminate this potential inequity. Although it can be argued that this would result in some interstate movement of vessels to circumvent impending quota limitations, the predominantly small size and limited radius of operation of most of the boats is a mitigating factor.

The second obvious deficiency of the single quota approach is the failure to account for the different seasonal intensity of recreational and commercial fishing effort. During most years, the commercial fishery has operated mainly in winter and spring, with a secondary peak of activity very late in the year. The recreational fishery is pursued mostly during summer and early fall. Obviously, an intensive commercial fishery could take most of the quota before the recreational fishery began.

In contrast to the regional quota that has been proposed, a tiered system with state subquotas and separate allocations within states for recreational and commercial fishermen would be more equitable. Allocations could be based on historical catch division. There could be a provision allowing one sector to harvest the unused portion of another's quota, with the combined catch not to exceed the state's total quota. Because of the longevity of sea bass, there could also be a provision allowing for the transfer of an unused portion of the state quota to the quota for the next year, although such cumulative allowances should not be allowed for more than two or three consective years. To function at maximum effectiveness, such a system would require a more comprehensive fishery statistics system than is currently in effect, but that is a prerequisite for any form of effective management.

The other regulatory measure proposed by the Council is a minimum size limit. The benefits of this measure include increased protection for the female brood stock, assurance of adequate numbers of males for successful reproduction, and greater utilization of the growth potential of the faster-growing males. Such a measure will not have much impact on the total annual physical yield unless it is introduced to correct a recruitment-overfishing situation. The principal negative aspect is that fishermen who depend on the shallow-water population would be disproportionately affected. The major trade-off with different limits is between the number of sea bass caught by recreational anglers and the value of the commercial catch. As the minimum size increases, the number of fish caught by recreational anglers decreases and the value of the commercial catch increases. There is virtually no difference between the effects of a 203-mm (8.0-in.) and 229-mm (9.0-in.) limit in terms of (1) total catch in weight,

(2) recreational catch in numbers of fish and weight, (3) commercial catch in weight, and (4) commercial catch in value (Low 1981).

From the recreational fishermen's perspective, the immediate impact of a 203-mm (8.0 in.) limit would be substantially less than that of a 229-mm (9.0-in.) limit in inshore areas such as artificial reefs. Of a sample (N = 142) of sea bass caught with rod-and-reel from Capers and Kiawah Reefs during summer 1979, 32% were < 203 mm (8.0 in.) and 58% were < 229 mm (9.0 in.) total length. In 28-40 m (15-22 fm) of water, 16% of the number (478) taken with rod-and reel during a research cruise were < 203 mm (8.0 in.) and 39% were < 229 mm (9.0 in.). A 254-mm (10.0-in.) limit would have substantial immediate impact. Of the fish from Capers and Kiawah Reefs, 70% were smaller than this. Over natural habitat in depths < 20 m (11 fm), 73% were < 254 mm (10.0 in.). Fifty-eight percent in depths of 28-40 m (15-22 fm) over natural habitat were < 254 mm (10.0 in.).

Of 263 "smalls" examined from commercial catches during 1979, 2% were < 203 mm (8.0 in.), 11% were < 229 mm (9.0 in.), and 31% were < 254 mm (10.0 in.). Both hook-and-line and trap-caught fish were included in the sample. When converted into weight and value equivalents, the immediate direct loss due to either a 203-mm (8.0-in.) or 229-mm (9.0-in.) limit would be negligible. Most of the economic loss would be born by trap fishermen; sea bass are an incidental catch for hook-and-line and trawl fishermen and the percentage of "smalls" in their catches is low.

The minimum retention size of the Chesapeake Bay wire crab trap (38-mm or 1.5-in. hexagonal mesh) is about 203 mm[1] (8.0 in.). Any minimum size limit larger than this would necessitate culling of the catch, which would impede normal operations. The viability of released fish hauled rapidly from deep water is questionable. Marine Resources Center personnel have placed sea bass caught with traps in 20 m (11 fm) of water into tanks immediately after they were brought on deck. Within ten minutes, these fish were bloated and floating on the surface. They recovered quickly when the bladder was lanced with a hypodermic needle and have survived for months in captivity. Because of the difference in pressure, it is speculative what their survival rate would have been if they had been thrown overboard.

If a minimum size limit > 203 mm (8.0 in) is considered appropriate for the commercial fishery, it should be accomplished through gear regulations. Escape rings on traps would probably be ineffective because trap fishermen usually retrieve their gear after soak times of 15-30 minutes. MARMAP experiments indicated that the fish enter a trap and actively feed on the bait for up to an hour (if bait is still available), during which time they are not seeking exit. The most practical and effective regulatory measure would be a minimum mesh size. This would depend on what dimensions of wire mesh are readily available. A two-year phase-in would be appropriate, since the longevity of vinyl-coated wire traps is 2-3 years and the loss/damage rate is high.

At present, the direct economic value of the black sea bass resource to South Carolina's coastal economy is considerable. If the figures in Liao and Cupka (1979b) are adjusted for inflation by 9% a year, then the direct expenditures of headboat anglers for black sea bass trips would be about $2.95 million in today's economy. The minimum estimate of direct expenditures by private boat anglers for fishing with sea bass as a principal target would be about $3.16 million. The 1981 ex-vessel value of the commercial catch was nearly $0.5 million. When operating costs of commercial fishermen and dealers are taken into account, the total direct value of the black sea bass resource in 1981 was presumably about $7.0 million.

[1] of 767 trap-caught sea bass during a fall 1979 survey, 36 (4.7%) were < 203 mm (8.0 in.), 128 were 203-228 mm (8.0-9.0 in.), and 171 were 229-253 mm (9.0-10.0 in.).

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