

**SOUTH CAROLINA MARINE RECREATIONAL
FISHERY STATISTICS SURVEY**

1987

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TABLE OF CONTENTS

	Page
List of Tables	iii
List of Figures	v
ACKNOWLEDGMENTS	1
INTRODUCTION	1
METHODS	1
Telephone Survey	1
Intercept Survey	2
Trip Estimation Procedure	2
Participation Estimation Procedure	3
Catch Estimation Procedures	3
RESULTS	3
Annual Overview	3
Shore Mode	7
Effort and Participation	7
Species Preference	7
Catch	7
CPUE	7
Charterboat Mode	13
Effort and Participation	13
Species Preference	13
Catch	13
CPUE	13
Private Boat Mode	21
Effort and Participation	21
Species Preference	24
Catch	24
CPUE	24
Length Composition	24
DISCUSSION	32
Methodology	32
Overview	32
Shore Mode	38
Charterboat Mode	39
Private Boat Mode	40
Length Composition	41
Black Sea Bass	41
Red Drum	41
Spotted Seatrout	41
REFERENCES	42

	Page
APPENDIX I	43
Status Report on Recreational Fishing Success in the Southern District	43
APPENDIX II.	54
Status Report on Recreational Fishing Success in the Charleston Harbor Area.	54

LIST OF TABLES

Table	Page
1. Estimated effort (in numbers of trips) in South Carolina during 1987 by wave and mode	4
2. Estimated total catch (in numbers of fish) by South Carolina recreational fishermen in 1987 compared with estimated 1986 landings	5
3. Estimated Type A catches by weight (kg) in all modes by wave	8
4. Estimated total number of fish caught by South Carolina recreational fishermen by fishing zone	9
5. Target species of shore-based fishermen during July-December	11
6. Estimated total catches in the shore mode by wave	12
7. Distribution of charterboat effort sampled during July-November	15
8. Charterboat effort at artificial reefs during July-November	16
9. Target species of charterboat anglers during July-November	17
10. Estimated total catches in the charterboat mode by wave	18
11. Effort and catches of charterboat fishermen interviewed during July-November.	19
12. Catch rates (in fish per angler-trip) of charterboat fishermen	20
13. Distribution of private boat effort sampled during July-December.	23
14. Distribution of private boat effort on artificial reef sites during July-December	25
15. Target species of private boat fishermen, by season, district, and fishing area.	26
16. Estimated total catches in the private boat mode by wave	27

List of Tables - Continued:	Page
17. Frequency of occurrence of individual species in catches of private boat fishermen, by district and season	29
18. Catch per unit of effort (CPUE) estimates by season and district, measured in number of fish per angler-trip.	30
19. CPUE estimates for red drum and spotted seatrout by season and district, measured in number of fish per angler-trip	31
I-1. Distribution of 1987 sampling effort in the Southern District.	44
I-2. Distribution of 1987 sampling effort in the Central District	45
I-3. 1987 catch and effort data for the Southern District	46
I-4. 1987 catch and effort data for the Central District	47
II-1. Numbers of interviews and relative effort by fishing area, July-December 1987	57
II-2. Catch rates of private boat fishermen by geographic area.	57
II-3. Species preferences (i.e., target species) of private boat fishermen by fishing area, July-December 1987	58
II-4. Total catch of private boat fishermen by fishing area, July-December 1987	58

LIST OF FIGURES

Figure	Page
1. Catch rates of shore-based fishermen during July-December, 1987	14
2. Catch rates of king mackerel by charterboat anglers during July-November, 1987	22
3. Catch rates of Spanish mackerel by charterboat anglers during 1 July - 19 September, 1987	22
4. Length distribution of king mackerel, July-November, 1987	33
5. Length distribution of Spanish mackerel, July-September, 1987	33
6. Length distribution of black sea bass in coastal (0-3 miles) and offshore (EEZ, 3 miles) zones	34
7. Length distribution of red drum	35
8. Length distribution of spotted seatrout	36
9. Length distribution of flounders	37
I-1. Location of interview sites in relation to areas closed by the 1986 resolution	48
I-2. Length distribution of red drum, July-December 1987	52
I-3. Length distribution of spotted seatrout, July-December 1987	53
II-1. Geographic areas and principal launching sites	56

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INTRODUCTION

Marine recreational fishing is of major social and economic importance in South Carolina. Surveys conducted during the last ten years indicate that at least 8% of all residents living within 50 miles of the coast go salt water fishing at least occasionally (U.S. Department of Commerce 1984, 1985a, 1985b, 1986). During the 1980's, estimated annual participation has included an average of about 200,000 resident and 260,000 nonresident anglers. The average yearly effort of all fishermen has been about 1.4 million trips. It is estimated that recreational anglers now spend at least \$200 million a year in direct and indirect expenditures associated with marine fishing (Low et al. 1986).

Two of the primary responsibilities of the Marine Resources Division are the orderly development of marine resources, including recreational usage, and the management of these resources for the best interests of the state's citizens. Both tasks require knowledge of the extent to which the resources are being exploited and by whom. This requirement has caused management agencies to promote expanded and more detailed surveys in order to define the levels of marine recreational fishing catch and effort. Support for such improved statistical reporting has been evident at all levels of marine fisheries management.

At the local level, Division personnel have conducted numerous studies. These have addressed a diverse variety of recreational fishing activities, but they typically have been restricted to specific types of fishing, particular locations, and short time intervals. At the regional level, the National Marine Fisheries Service (NMFS) has monitored headboat activity since the early 1970's. Since 1979, the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) has collected catch and effort data on shore, charterboat, and private boat angling. Although these data have been obtained on a state-by-state basis, their application has been for regional management. The sampling level and resultant precision reflect their purpose. National surveys, addressing rather

broad aspects of recreational fishing, have been conducted every five years by the U.S. Fish and Wildlife Service (USFWS). Data for South Carolina's fisheries, as compiled from these various sources, are summarized for 1977-1986 in Low et al. (1987).

South Carolina's coastal population is growing in conjunction with increased coastal development. Overall participation by both resident and nonresident anglers in marine sport fishing has been increasing also, at an average annual rate of about 3-4%. Effort (number of fishing trips) has concurrently grown at an average annual rate of approximately 10% (Low et al. 1987). Consideration of these aspects led the Marine Resources Division to evaluate various methods for a comprehensive, statewide annual survey of marine recreational fishing activity. Several techniques were studied during 1985 and 1986, with the results being summarized by Low et al. (1986). In the same time frame, other states (e.g. Georgia) took part in the MRFS on a cooperative basis with NMFS, conducting the field intercept portion. After extensive review of the various options available, the Division entered into a cooperative agreement with NMFS for participation in the MRFS, with funding support from the USFWS under the Wallop-Breaux expansion program. Beginning in July 1987, Division personnel assumed responsibility for the on-site intercept portion and also conducted supplemental Division sampling where feasible.

This report describes survey efforts and results for 1987. Data provided for March-June were furnished by NMFS. Figures for July-December reflect the Division's participation. Data from the supplemental sampling are included where appropriate and are so identified.

METHODS

The MRFS has two components: 1) a telephone survey of households to obtain information on participation and 2) an on-site intercept survey to collect catch, effort, and demographic data. Prior to 1988, no sampling was done in South Carolina during January and February because of low levels of angling activity and high survey costs. NMFS has estimated that less than 12% of both total effort and catch occurs during this period. During the rest of the year, data were collected in two-month sampling waves. This information was then combined to produce estimates of participation, effort, and catches for each wave.

Telephone Survey

This component was conducted by a NMFS subcontractor. In South Carolina, the telephone survey covered households in coastal counties. During March, April, November, and December (waves 2 and 6), coastal counties were designated as those in which any portion is within 25 miles of the coast, i.e., Beaufort, Berkeley, Charleston, Colleton,

Dorchester, Florence, Georgetown, Hampton, Horry, Jasper, Marion, and Williamsburg. During May-October, the geographic limit was set at 50 miles, extending coverage to include Allendale, Bamberg, Clarendon, Dillon, and Orangeburg Counties. The survey was carried out during two-week periods near the end of each wave and collected information on participation and the numbers of fishing trips by mode and location. Sample sizes were based on the square root of the county populations.

Intercept Survey

Interviews were conducted at public access points throughout coastal South Carolina. Interviews were voluntary and confidential. Procedures were as prescribed in the NMFS Intercept Interviewer Training Manual (March 1987 revision). Information collected included the type (mode) of fishing, area fished, hours fished, species sought, residency of the angler, whether or not the household had a telephone, the angler's age and sex, and catch data. Catch data routinely solicited included the species caught, their number, and disposition (e.g. released alive, used for bait, kept to eat, etc.). Where feasible, up to ten fish of each important species were measured and/or weighed.

Sample sizes (i.e., numbers of interviews) within each wave and mode were based on historical data (from previous MRFSS results) for seasonal participation. Site selection was made by a NMFS subcontractor according to a site list stratified on the basis of seasonal utilization. Public access sites were ranked according to usage rate, from north to south. The intercept sites by mode and wave were then selected by a computer scan, with preference for the highest-use access points. Because our review of data from previous NMFS surveys indicated that this procedure resulted in a disproportionate geographic distribution of sampling effort (biased toward locations in the northern district), we modified the allocation mechanism within the private/rental boat mode so as to obtain approximately equal (within wave) sample sizes in each major geographical area.

During 1987, the fishing modes sampled were shore, charterboat, and private/rental boat (equivalent in South Carolina to private boat). Shore fishing included activity from beaches, banks, docks, bridges, and piers. Charterboats were defined as those carrying up to and including six passengers for-hire. Private boats were those carrying fishermen on a non-paying basis. Anglers originating from private points of access, such as personally owned docks or private (membership) marinas, were not included in the survey.

The NMFS sampling design allocated approximately 60% of the interview effort to weekends and 40% to weekdays, with most of the sampling being conducted during the afternoons. The actual distribution of effort was not documented, but presumably conformed closely to these targets.

Sampling during waves 2 and 3 (March-April and May-June) was conducted by a NMFS subcontractor and the distribution of effort in the private boat mode conformed to the unmodified NMFS design. Division personnel took over the intercept sampling in July and the private boat sample allocations (numbers of interviews) during waves 4 (July-August), 5 (September-October), and 6 (November-December) were equal between districts. The northern district included Horry and Georgetown Counties. The central district was represented by Charleston County, while the southern district consisted of Beaufort County.

Estimates of the total numbers of participants, trips, and fish caught were derived by combining information from the two survey components. All estimates were calculated by a NMFS subcontractor according to NMFS statistical procedures. These involve tests of goodness-of-fit of the data currently being obtained, weighting adjustments, and calculations of variances. A detailed description of these procedures, particularly the rather complex variance calculations, exceeds the technical scope of this report and can be obtained from NMFS (Witzig 1988). The following descriptions are intended to provide an overview of the general approaches employed.

Trip Estimation Procedure

Trip estimates are made for each mode and fishing zone within each wave. Fishing zones are defined as inshore (estuarine areas), coastal (ocean 0-3 miles), and offshore (ocean >3 miles). Fishing prevalence rates for each mode are obtained from the telephone survey. The mean number of fishing trips in each mode per household is used in combination with the 1980 census count of full-time occupied housing units in each coastal county (adjusted for projected population growth) to estimate the number of fishing trips taken by coastal county residents with telephones. This estimate consists of the total number of full-time occupied housing units multiplied by the ratio of the number of reported fishing trips from the telephone survey to the total number of households contacted. This estimate is then multiplied by an adjustment factor, defined as the proportion of coastal county households with telephones divided by the proportion of coastal county residents in the intercept survey with telephones, to obtain the final estimated number of fishing trips by coastal county residents per mode. The 1987 South Carolina adjustment factor was 0.87265.

The estimated numbers of trips attributable to non-coastal and out-of-state anglers are based on the estimated number of trips by coastal residents and the ratios of residence categories reported from the intercept survey. The number of trips by non-coastal anglers is calculated as the number of trips by coastal residents multiplied by the ratio of non-coastal residents interviewed to coastal residents. The figure for out-of-

state anglers is obtained by multiplying the coastal trip estimate by the ratio of out-of-state anglers to coastal residents observed in the intercept survey.

Within each wave and mode, the estimated total number of trips is proportionally allocated to fishing zones based on the ratio of the number of interviews in the mode and zone to the total number of interviews conducted in the mode.

Participation Estimation Procedure

Estimates of annual participation by each residency category are derived from the trip estimates and data from the intercept survey. The numbers of participants intercepted, average number of days fished during the last 12 months by each intercepted participant, and the estimated total number of trips attributable to each group are used to prepare these statistics.

Catch Estimation Procedures

There were three catch categories sampled by the intercept survey: 1) catches retained and inspected by the creel clerks (Type A), 2) catches not inspected and used for bait, discarded dead, cleaned, etc. (Type B1), and 3) catches not inspected because they were released alive (Type B2). Estimates of total catch include fish in all of these categories, while estimates of catches "removed" include Type A and Type B1 catches. "Removed" catches are therefore equivalent to those contributing to fishing mortality (assuming that the Type B2 fish survive).

Catch expansions were calculated for each species on a wave/mode/zone basis. For each category of catch, the appropriate catch-per-unit-of-effort (CPUE) was calculated as the total number of fish reported divided by the total number of trips reported in that sampling cell. This CPUE estimate was then multiplied by the total number of estimated trips for that wave/mode/zone. Some of the shore catches were reported for incomplete trips. An adjustment factor was calculated for each fishing zone to account for the proportion of the catch which would have been caught during the remaining part of the fishing trip. The average hourly catch rate for each species reported for the zone was used to adjust the catch.

Catch estimates by weight were based on the estimated numbers of fish caught multiplied by average weights determined from the intercept survey in the appropriate sampling cells.

RESULTS

Annual Overview

A total of 4,126 telephone interviews were conducted during March through December. From this information, it was estimated that 363,000 anglers made approximately 1,457,000 trips. Distribution of this effort by wave and mode is summarized in Table 1 (the totals do not add to the final NMFS estimate because

it is based on updated census data not used in preparing the itemized estimates shown here). Based on the data in Table 1, 52% of all trips were made in the private boat mode, 43% in the shore mode, and 5% in the charterboat mode. About 44% of the trips in the shore mode were made by coastal residents, 14% by non-coastal residents, and 42% by out-of-state anglers. Most (77%) of the charterboat trips were made by out-of-state residents, with the remainder about equally divided between coastal and non-coastal state residents. In the private boat mode, the majority of the effort (69%) was attributable to coastal residents. The remaining effort was about evenly divided between non-coastal residents (15%) and fishermen from out-of-state (16%). Compared to 1986, overall annual participation declined by about 3%, while total effort increased 14% (based on data contained in NMFS 1987). Approximately 88% of all fishermen interviewed during 1987 were males and 12% were females. Male anglers dominated in all waves and modes. The average ages of male and female anglers were 39 and 37 years, respectively. The majority (51%) of the male anglers ranged in age from 30-49. Teens and youths comprised about 8%, while those 60 and above accounted for 11%. Women in the 20-39 year old bracket represented 47% of the female angling population. Teens and youths accounted for about 14%, while women 60 and above represented 10% of the total population of female anglers.

Estimated total catches for all waves and modes combined are listed in Table 2¹. Figures for 1986 are also shown for comparison. In spite of the estimated increase in effort, overall landings appeared to decline by about 9% (by numbers of fish caught). Substantial decreases were evident in reported landings of offshore pelagic species, coastal pelagics, and inshore recreational bottomfish. Estimated catches of offshore pelagics were only 8% of those reported in 1986. With the exception of bluefish, catches for coastal pelagic species were down sharply in 1987. King mackerel landings were only 29% of the previous year's estimated catch and the Spanish mackerel catch was 42% of the estimated 1986 total. Bluefish catches increased by 24%. Landings of all important species of inshore bottomfish were also down sharply from the estimated 1986 levels. The aggregate catch of the most popular sciaenids (i.e., kingfishes, spot, and croaker) was down 55% and sheepshead landings were off by 67%.

Trends were mixed for preferred inshore species. The total catch of red drum was 172% greater than that estimated for 1986, while that of spotted seatrout in 1987 was down about 23%. Flounder landings were down 30%.

¹The 1987 total shown does not equal the totals shown in Table 4 or added from Tables 6, 10, and 16 (each slightly different). This is due to rounding, updating of some tables, etc.

Table 1. Estimated effort (in numbers of trips) in South Carolina during 1987 by wave and mode.

<u>Mode</u>	<u>Coastal Residents</u>	<u>Non-coastal Residents</u>	<u>Out-of-State Residents</u>
Wave 2 (March-April)			
Shore	15,902	8,788	15,065
Charterboat	0	0	0
Private Boat	48,235	7,074	20,580
Wave 3 (May-June)			
Shore	48,106	10,204	42,275
Charterboat	1,999	758	8,754
Private Boat	82,710	20,677	13,019
Wave 4 (July-August)			
Shore	71,369	21,411	67,800
Charterboat	4,049	3,978	22,520
Private Boat	176,275	37,038	43,211
Wave 5 (September-October)			
Shore	86,029	35,424	106,271
Charterboat	1,344	1,984	15,554
Private Boat	88,907	22,431	22,023
Wave 6 (November-December)			
Shore	44,786	13,136	21,893
Charterboat	626	563	4,441
Private Boat	105,897	21,885	16,237

Table 2. Estimated total catch (in numbers of fish) by South Carolina recreational fishermen in 1987 compared with estimated 1986 landings (1986 data from NMFS 1987). Figures are in thousands. NR = none reported.

Species	"Removed"	Released	1987 Total	1986 Total
<u>Offshore Pelagics</u>				
Dolphin	<1	<1	1	72
Little tunny/bonito	5	3	8	34
Tunas/mackerels	4		4	65
<u>Offshore Bottomfish</u>				
Black sea bass	338	455	793	531
Sea basses	10	14	24	<30
Groupers	5	<1	6	<30
Vermilion snapper	5	3	8	<30
Other snappers	<1	<1	<1	<30
Red pogy	19	4	23	<30
Other pogies	33	14	47	NR
Grunts	9	15	24	NR
Triggerfish	<1		<1	<30
<u>Coastal Pelagics</u>				
King mackerel	72	1	73	254
Spanish mackerel	64	5	69	163
Bluefish	158	39	197	159
Jack crevalle	31	38	69	69
Blue runner	<1		<1	NR
Amberjacks	2	4	6	33
Jacks	<1	1	2	<30
Barracuda	3	8	11	62
<u>Inshore Gamefish</u>				
Red drum	468	66	534	196
Spotted seatrout	337	109	446	576
Summer flounder	45		45	NR
Southern flounder	63	4	67	206
Flounders	18	14	32	NR
Weakfish	16		16	78
<u>Inshore Bottomfish</u>				
Kingfishes	400	102	502	1,049
Spot	580	266	846	1,863
Croaker	142	88	229	616
Black drum	23	<1	23	<30
Sheepshead	22	1	23	70
Pompano	88	12	100	159
<u>Miscellaneous</u>				
Sharks	104	290	394	207
Skates/rays	7	40	47	32
Eels	4	7	11	<30

Species	"Removed"	Released	1987 Total	1986 Total
Herrings	5		5	57
Catfishes	162	491	653	253
Toadfish	20	189	209	138
Searobins			9	<30
Pigfish	87	26	113	<30
Pinfish	350	370	720	173
Silver perch	46	17	63	<30
Mulletts	94	16	110	84
Puffers	17	14	31	70
Others	77	119	196	-
Total	3,961	2,866	6,828	7,527

due primarily to a large decrease in the estimated catch of southern flounder.

The aggregate catch of offshore bottomfish appeared to have increased moderately. The estimated catch of black sea bass, which accounted for most of the landings, was up 49% over the 1986 figure.

The aggregate catch of catfishes, toadfish, and pinfish improved by 180%.

The estimated total weight of Type A (i.e., inspected) catches made in all modes is shown in Table 3. Distribution of the estimated total catch (in numbers of fish) by fishing zone is listed in Table 4.

Most of the additional information from the annual MRFSS will be summarized in the statistics published annually by NMFS. The following discussion refers to the portion of the 1987 MRFSS in which the Division participated, i.e., waves 4, 5, and 6 (July-December) and addresses topics not covered in the published NMFS data summaries. Data from the supplemental Division sampling have been used where appropriate to expand sample sizes and/or provide information on aspects not adequately covered in the NMFS survey.

Shore Mode

Effort and Participation - Wave quotas during the NMFS portion of the survey were 30. These were increased to 90 during waves 4, 5, and 6. In addition, 44 interviews were obtained during Division sampling. Sampling effort during July-December was distributed as follows (including Division interviews):

	Northern	Central	Southern	Total
July	42	9	15	66
August	20	15	5	40
September	31	19	25	75
October	38	2	0	40
November	47	24	12	83
December	0	4	6	10
Total	178	73	63	314

About 30% of the MRFSS interviews during this period were based on incomplete trips. All of the Division interviews represented complete trips.

The majority of the interviews during July-December was made in the northern district. Although eight sites were sampled there, 67% of the MRFSS interviews were obtained at two locations (Kingfisher and Cherry Grove piers). Nearly 85% of the total number of interviews in the northern district addressed pier fishermen and 48% of the total shore sample (during July-December) represented anglers on Grand Strand piers. The lack of interviews in this area during December reflects the cessation of operations of most piers by early December. Although five sites were visited in the central district, 74% of the interviews came from Breach Inlet (the bridge and adjacent beach). About one-third of the interviews from the southern district came from Paradise Pier.

The bulk of the total shore sample therefore represents anglers who fished from manmade structures, as opposed to those fishing from banks or the surf.

The distribution of fishing effort during July-December was as follows (including Division data):

	Northern	Central	Southern
<u>July-September</u>			
Hrs. Fished	345.5	149.0	170.0
Av. Hrs. per Completed Trip	3.8	3.2	3.4
Av. Trips during last 2 months	4.5	6.1	2.6
<u>October-December</u>			
Hrs. Fished	322.0	87.0	62.5
Av. Hrs. per Completed Trip	4.3	2.6	2.0
Av. Trips during last 2 months	4.3	7.5	2.3

About 35% of the fishermen interviewed during the summer had made no shore-based trips during the previous two months, compared to 14% in the fall. This probably reflects the tendency of more anglers to begin fishing after the start of the summer season. Fishermen in Charleston County expended higher levels of individual effort, as measured by the average number of trips made per month. This probably is a function of the fact that a higher percentage of the central area fishermen are local residents, with increased fishing opportunity.

Species Preference - About 69% of the fishermen interviewed during July-December indicated no preference as to target species (Table 5), a proportion that did not vary substantially between areas and seasons. Of those fishermen who did state a preference, spot, flounders, and kingfishes (in descending order) were the most often identified. This selection is biased by the high percentage of Grand Strand pier fishermen in the sample, since neither spot nor kingfishes were mentioned (with one exception) by anglers elsewhere.

Catch- Estimated total catches of fish by shore anglers by wave and species category are listed in Table 6. Spot and kingfishes, two of the most popular species, represented 42% of the total catch by number of fish. Inshore gamefishes, primarily red drum, comprised about 6%. Miscellaneous species, most of which are not considered desirable by anglers, made up about 36% of the total shore catch.

CPUE - About 42% of all shore fishermen interviewed during July-December reported catching no fish. The percentage of unsuccessful trips was slightly higher during the fall. There was no appreciable difference in the failure rate between areas (44% in the northern district, 41% in the central, and 37% in the southern area).

Table 3. Estimated Type A catches by weight (kg) in all modes by wave, as provided by NMFS. Catches are shown in thousands of kg.

Species	Mar.- Apr.	May- June	July- Aug.	Sep.- Oct.	Nov.- Dec.	Total
<u>Offshore Bottomfish</u>						
Black sea bass	18	7	44	8	1	78
Others	1	2+	7+	5+	1	16
<u>Coastal Pelagics</u>						
King mackerel	10	74	109	73	31	297
Spanish mackerel		3	36	15		54
Bluefish	4	9	17	18	1	49
<u>Inshore Gamefish</u>						
Red drum	28	6	31	167	103	335
Spotted seatrout	2		20	28	157	207
Summer flounder			20	1	1	22
Southern flounder			16	14	1	31
<u>Inshore Bottomfish</u>						
Kingfishes	13	10	28	18	1	70
Spot			3	41	1	45
Croaker			16	4	1	21
Black drum		1	7	4	1	13
Sheepshead	4	2	8	2		16
<u>Miscellaneous</u>						
Sharks		5	43	4		53
Catfishes	3	2	19	7		31
Pinfish		1	6	14		21
Others	12	72	126	43	50	303
Total	95	194	556	467	350	1,662

Table 4. Estimated total number of fish caught by South Carolina recreational fishermen by fishing zone. Numbers are shown in thousands.

Species	Inshore	Coastal (0-3 mi.)	Offshore
<u>Offshore Pelagics</u>			
Dolphin			<1
Little tunny/bonito		<1	9
Tunas/mackerels			6
<u>Offshore Bottomfish</u>			
Black sea bass	201	137	492
Sea basses	8		13
Groupers	3	<1	1
Vermilion snapper			12
Other snappers			1
Red porgy	1		23
Other porgies		44	4
Grunts		15	13+
Triggerfish			<1
<u>Coastal Pelagics</u>			
King mackerel		5	82
Spanish mackerel	<1	39	42
Bluefish	99	93	4
Jack crevalle	43	19	3
Blue runner		<1	
Amberjacks		<1	7
Jacks	<1	2	1
Barracuda		<1	14
<u>Inshore Gamefish</u>			
Red drum	499	17	<1
Spotted seatrout	432	8	<1
Summer flounder	11	26	4
Southern flounder	38	21	<1
Flounders	14	16	
Weakfish	11	3	
<u>Inshore Bottomfish</u>			
Kingfishes	80	401	
Spot	146	629	<1
Croaker	193	26	1
Black drum	22	<1	
Sheepshead	18	<1	3
Pompano	4	91	
<u>Miscellaneous</u>			
Sharks	221	142	16
Skates/rays	24	19	<1
Eels	8	<1	

Species	Inshore	Coastal (0-3 mi.)	Offshore
Herrings			5
Catfishes	601	23	4
Toadfish	149	38	12
Searobins	3	5	
Pigfish	96	1	10
Pinfish	484	177	45
Silver perch	27	30	2
White perch	37		
Mulletts	63	37	3
Puffers	21	<1	
Others	157	34	4
Total	3,717	837	2,100

Table 5. Target species of shore-based fishermen during July-December (includes data from Division sampling).

Spp.	Northern		Central		Southern		Total	
		No.	Spp.	No.	Spp.	No.	Spp.	No.
July-September								
Any	57	Any	39	Any	31	Any	127	
Spot	18	Catfish	2	Flounders	7	Spot	18	
Flounders	7	Flounders	1	Sharks	4	Flounders	15	
Pompano	4	Red Drum	1	Red Drum	2	Pompano	4	
King Mackerel	3					Sharks	4	
Kingfishes	3					Red Drum	4	
Red Drum	1					King mackerel	3	
						Kingfishes	3	
October-December								
Any	57	Any	16	Any	15	Any	88	
Spot	13	Flounders	7	Spotted Seatrout	2	Spot	14	
Kingfishes	11	Red Drum	5	Red Drum	1	Kingfishes	11	
Red Drum	3	Spot	1			Red Drum	9	
Bluefish	1	Bluefish	1			Flounders	7	
						Bluefish	2	
						Spotted Seatrout	2	

Table 6. Estimated total catches in the shore mode by wave, as provided by NMFS. Catches are shown in thousands of fish.

Species	Mar.- Apr.	May- June	July- Aug.	Sep.- Oct.	Nov.- Dec.	Total
<u>Offshore Bottomfish</u>						
Black sea bass	4	9	23	54	2	92
Groupers				2		2
<u>Coastal Pelagics</u>						
Spanish mackerel			5			5
Bluefish	16	10	9	74	28	137
Jack crevalle				25		25
<u>Inshore Gamefish</u>						
Red drum	1		5	72	3	81
Spotted seatrout			2			2
Weakfish	<1	3				4
Summer flounder		3	16	<1		20
Southern flounder	2	16		7	<1	26
Flounders			7	8	3	18
<u>Inshore Bottomfish</u>						
Kingfishes	49	12	193	111	72	437
Spot	10	28	39	351	184	612
Croaker		6	14	10	11	41
Pompano			75	10	6	91
<u>Miscellaneous</u>						
Sharks	3	36	64			103
Pigfish				74	2	76
Pinfish		13	32	161	111	317
Skates/rays	12		5	7	<1	25
Eels	<1		2			3
Catfishes	<1	4	7	54		66
Toadfish	<1	1	27	25		54
Searobins				5		5
Mulletts	13		21	17	2	53
Silver perch		1	12	12	10	35
Puffers			4	10	3	17
Sea basses					<1	<1
Others			14	124	<1	139
Total	112	147	578	1,218	439	2,494

Catch rates for all species combined, as determined from the MRFSS data only, are summarized below (in fish per hour fished):

	Northern	Central	Southern
July-September	1.2	1.4	1.2
October-December	1.0	3.2	1.2

The high value for the central area during the fall was attributable to several very large catches; with these removed, the catch rate was nearly the same as in the other areas. The overall catch rates for all anglers during July-December (with Division data included) were 4.3 fish per trip and 1.2 fish per hour fished. Figure 1 shows the comparative distribution of CPUE in fish per trip in each district.

Charterboat Mode

Effort and Participation - Wave quotas were as follows:

Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
47	247	207	162	90

During July-November, a total of 459 anglers were interviewed during the MRFSS and 35 in Division sampling, distributed as follows:

	Northern	Central	Southern	Total
July	45	0	46	91
August	43	44	38	125
September	55	40	46	141
October	16	3	4	23
November	47	35	32	114
Total	206	122	166	494

About 42% of the interviews were obtained in the northern district, 24% in the central area, and 34% in the southern district. Interviews were collected at four marinas in the northern district, two in the central area, and four in the southern district, with 28 boats being represented in the July-November sampling.

During July-November, the average charterboat trip included four fishermen. About 45% of the trips included three hours or less of fishing time, with little difference in this characteristic between seasons (Table 7). Shorter trips were most popular in the southern district, whereas about 68% of the trips from northern ports were all-day efforts. About 90% of all charterboat fishermen reported fishing more than three miles offshore (i.e., in the EEZ). Inshore trips (in estuarine areas) were reported only from the southern district, where they represented about 7% of the total trip effort.

About 34% of the total angler trips reported during July-November were made to artificial reefs. Relative effort at the reefs was greatest in the southern district (52% of all ocean trips reported) and lowest in the central district (17%). About 94% of the anglers who fished the reefs indicated that pelagic species (including the designation "any", which refers to general trolling) were their target. Table 8

summarizes these data. The numbers of anglers who identified specific sites were as follows:

Northern	
Ten-Mile Reef	24
City of Richmond Wreck	23
General Sherman Wreck	15
Central	
Kiawah (4KI)	11
Southern	
Savannah Tower	42
R7	8
Hilton Head Reef	6
Fish America	4
Betsy Ross	3

Species Preference - Nearly all offshore anglers interviewed during July-November targeted pelagic species, either in the form of general trolling (with "any" the target species) or fishing specifically for mackerels (Table 9). Only 2% of the offshore fishermen indicated a preference for bottom species. About 46% of the offshore anglers identified king mackerel as their preferred species. Slightly less than 4% of the total number of anglers went on inshore trips and these fishermen sought red drum and spotted seatrout during the fall.

Catch - The estimated total catch by wave is listed in Table 10. During July-November, interviewed fishermen indicated that about 32% of the fish they caught were released, consisting mostly of small bottomfish. Despite the typical fishing method of choice (trolling) and the preferred species (king mackerel) of most of the anglers, the most abundant fish in the catch was black sea bass (39% of the total number of fish caught). Mackerels represented about 27% of all fish landed by number.

CPUE - About 18% of the fishermen interviewed during the summer (July-September) reported that they had caught no fish, a rate that was rather uniform between areas. The failure rate was higher during the fall, apparently because of bad weather that contributed to a high failure rate in the central area at times when interviews were conducted. In other areas, the fall rate was about the same as that during the summer, so a sampling artifact appears to have been implicated. During the entire July-November period, about 24% of all anglers reported catching no fish.

Catch and effort data are listed in Table 11 and CPUE results are summarized in Table 12. Effort targeted at pelagic species includes trips by anglers who specified a pelagic species (most commonly king mackerel) as their target and trips for which no particular species was indicated (i.e., "any"). Bottomfish effort includes only those trips by anglers who specified such species (primarily black sea bass) as their target.

The number of directed bottomfish trips (N = 10) was too small to permit a meaningful

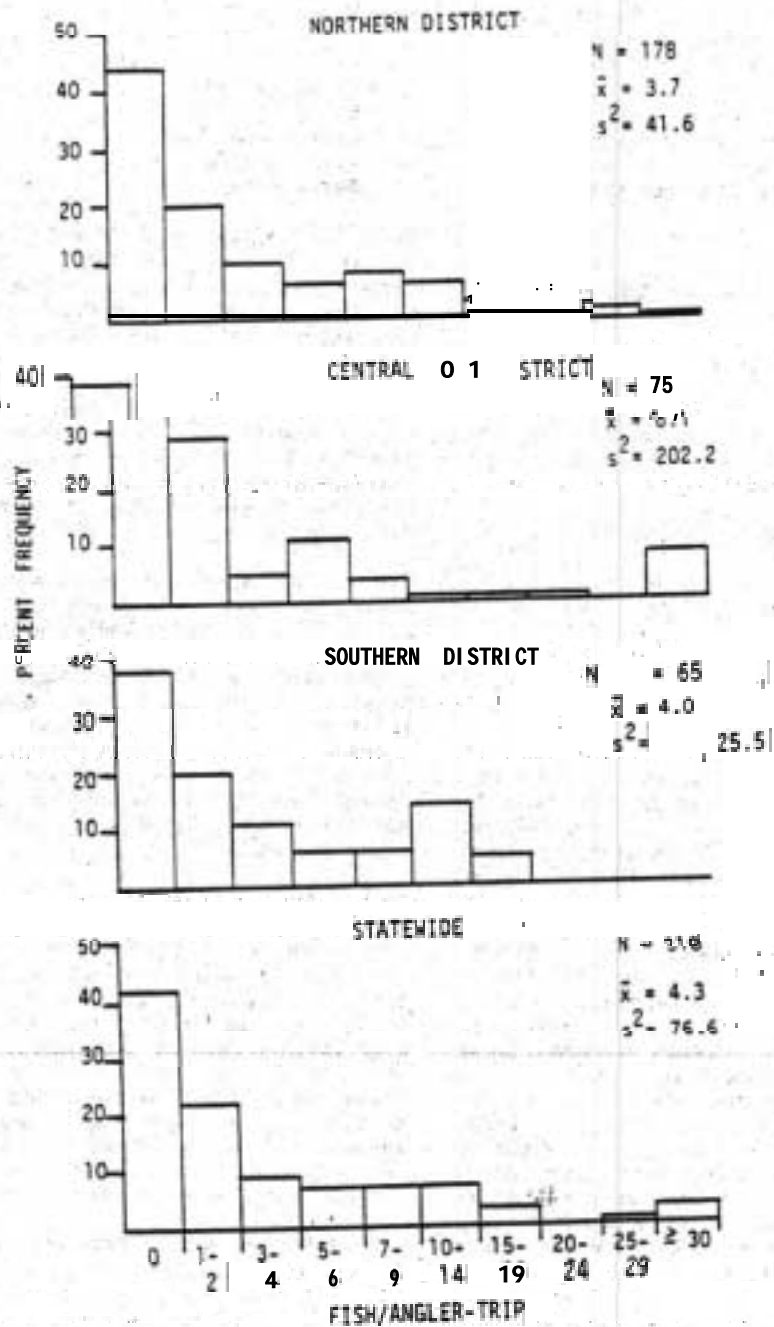


Fig. 1. Catch rates of shore-based fishermen during July-December 1987.

Table 7. Distribution of charterboat effort sampled during July-November (includes Division data).

	Northern	Central	Southern	Total
	July-September			
Number of boat trips (approximate)	35	21	33	89
	October-November			
	16	9	11	36
	July-September			
Number of angler-trips				
≤3 hours fishing	41	41	85	167
>3 hours fishing	102	43	45	190
	October-November			
≤3 hours fishing	24	27	5	56
>3 hours fishing	39	11	31	81
	July-September			
Total hours of fishing	684.5	310.0	411.5	1,406.0
	October-November			
	303.0	123.0	149.5	575.5

Table 8. Reported charterboat effort at artificial reefs during July-November (includes Division data).

	Northern	Central	Southern	Total
July-September				
<u>Angler-Trips</u>				
Pelagic	57	21	58	136
Bottomfish	4	0	0	4
Total	61	21	58	140
October-November				
Pelagic	0	0	22	22
Bottomfish	6	0	0	6
Total	6	0	22	28
Total				
Pelagic	57	21	80	158
Bottomfish	10	0	0	10
Total	67	21	80	168
<u>Angler-Hours</u>				
July-September				
Pelagic	286.5	53.5	174.0	514.0
Bottom	20.0	0	0	20.0
Total	306.5	53.5	174.0	534.0
October-November				
Pelagic	0	0	94.0	94.0
Bottom	36.0	0	0	36.0
Total	36.0	0	94.0	130.0
Total				
Pelagic	286.5	53.5	268.0	608.0
Bottom	56.0	0	0	56.0
Total	342.5	53.5	268.0	664.0

Table 9. Target species of charterboat anglers during July-November (includes Division data).

Northern		Central		Southern		Total	
July-September							
King Mackerel	59	Any	43	King Mackerel	54	Any	146
Any	56	King Mackerel	28	Any	47	King Mackerel	141
Sharks	10	Mackerels	13	Spanish Mackerel	15	Spanish Mackerel	22
Spanish Mackerel	7			Tarpon	8	Mackerels	13
Bottomfish	7			Red Drum	3	Sharks	10
Wahoo	2			Barracuda	3	Tarpon	8
Amberjack	2					Bottomfish	7
						Red Drum	3
						Barracuda	3
						Wahoo	2
						Amberjack	2
October-November							
King Mackerel	33	King Mackerel	24	King Mackerel	19	King Mackerel	76
Any	30	Any	14	Any	7	Any	51
				Spotted Seatrout	5	Spotted Seatrout	5
				Grouper	3	Grouper	3
				Red Drum	2	Red Drum	2
Total							
King Mackerel	92	Any	57	King Mackerel	73	King Mackerel	217
Any	86	King Mackerel	52	Any	54	Any	197
Sharks	10	Mackerels	13	Spanish Mackerel	15	Spanish Mackerel	22
Spanish Mackerel	7			Tarpon	8	Mackerels	13
Bottomfish	7			Red Drum	5	Sharks	10
Wahoo	2			Spotted Seatrout	5	Tarpon	8
Amberjack	2			Grouper	3	Bottomfish	7
				Barracuda	3	Red Drum	5
						Spotted Seatrout	5
						Grouper	3
						Barracuda	3
						Wahoo	2
						Amberjack	2
Artificial Reef Anglers							
July-September							
King Mackerel	28	Any	19	Any	26	Any	60
Any	15	King Mackerel	2	King Mackerel	16	King Mackerel	46
Sharks	10			Spanish Mackerel	15	Spanish Mackerel	15
Black Sea Bass	4			Barracuda	1	Sharks	10
Amberjack	2					Black Sea Bass	4
Mackerels	2					Amberjack	2
						Mackerels	2
						Barracuda	1
October-November							
Any	6	0		King Mackerel	19	King Mackerel	19
				Any	3	Any	9

Table 10. Estimated total catches in the charterboat mode by wave, as provided by NMFS. Catches are shown in thousands of fish.

Species	May- June	July- Aug.	Sep.- Oct.	Nov.- Dec.	Total
<u>Offshore Pelagics</u>					
Dolphin	<1	<1			2
Tunas/mackerels	2	3			5
Little tunny/bonito	<1	3	2	1	7
<u>Offshore Bottomfish</u>					
Black sea bass	5	141	15	4	165
Red porgy	<1	6	3	<1	11
Porgies		3			3
Vermilion snapper	<1	10	2	<1	14
Red snapper			<1		<1
Other snappers	<1		<1		2
Groupers	<1	<1	1	<1	4
Grunts		10		<1	11
Triggerfish	<1			<1	2
Sea basses			<1		<1
<u>Coastal Pelagics</u>					
King mackerel	15	23	23	8	69
Spanish mackerel	6	30	5	<1	42
Bluefish	2	13			15
Jack crevalle	1	1	<1		3
Jacks		4	<1		5
Amberjacks	<1	3	<1	<1	6
Barracuda	1	8	3	<1	13
<u>Inshore Gamefish</u>					
Spotted seatrout			<1	6	7
Red drum				3	3
<u>Inshore Bottomfish</u>					
Kingfishes		<1			<1
Black drum				<1	<1
<u>Miscellaneous</u>					
Sharks	3	7	2	<1	13
Catfishes	2	2			4
Herrings	<1				<1
Toadfish	<1			<1	3
Pinfish	<1	19	<1	<1	22
Pigfish		<1			<1
Silver perch				<1	<1
Others	<1		1	<1	3
Total	43	290	60	25	418

Table 11. Effort and catches of charterboat fishermen interviewed during July-November (includes Division data).

	Northern	Central	Southern	Total
July-September				
<u>Pelagic Species Targeted</u>				
Non-reef Areas				
Anglers	82	63	62	207
Hours Fished	361.5	256.5	196.5	814.5
Pelagics	147	95	94	336
Bottomfish	487	138	4	629
Artificial Reefs				
Anglers	61	21	58	140
Hours Fished	282.0	53.5	172.0	507.5
Pelagics	129	29	107	265
Bottomfish	19	0	1	20
<u>Bottomfish Targeted</u>				
Non-reef Areas				
Anglers	3	0	0	3
Hours Fished	16.5	0	0	16.5
Pelagics	0	0	0	0
Bottomfish	115	0	0	115
Artificial Reefs				
Anglers	4	0	0	4
Hours Fished	20.0	0	0	20.0
Pelagics	6	0	0	6
Bottomfish	123	0	0	123
<u>Inshore Species Targeted</u>				
Anglers	0	0	13	13
Hours Fished	0	0	54.0	54.0
Fish Caught	0	0	40	40
October-November				
<u>Pelagic Species Targeted</u>				
Non-reef Areas				
Anglers	57	47	4	108
Hours Fished	267.0	123.0	16.0	406.0
Pelagics	144	21	0	165
Bottomfish	33	52	0	85
Artificial Reefs				
Anglers	5	0	22	27
Hours Fished	30.0	0	94.0	124.0
Pelagics	4	0	23	27
Bottomfish	12	0	6	18
<u>Bottomfish Targeted</u>				
Non-reef Areas				
Anglers	0	0	3	3
Hours Fished	0	0	15.0	15.0
Pelagics	0	0	2	2
Bottomfish	0	0	20	20
Artificial Reefs				
Anglers	0	0	0	0
<u>Inshore Species Targeted</u>				
Anglers	0	0	7	7
Hours Fished	0	0	24.5	24.5
Fish Caught	0	0	143	143

Table 12. Catch rates (in fish per angler-trip) of charterboat fishermen (includes results from Division sampling).

	Northern	Central	Southern	Total
July-September				
<u>Pelagic Species Targeted</u>				
Non-reef Areas				
Pelagics	1.8	1.5	1.5	1.6
Bottomfish	5.9	2.2	-	3.0
Artificial Reefs				
Pelagics	2.1	1.4	1.8	1.9
October-November				
<u>Pelagic Species Targeted</u>				
Non-reef Areas				
Pelagics	2.5	0.4	-	1.5
Bottomfish	0.6	1.1	-	0.8
Artificial Reefs				
Pelagics	-	-	1.0	1.0

evaluation of catch rates. The following comments refer only to trips for pelagic species or those where no preference was stated. They also apply only to the period July-November.

The overall catch rates for pelagic species in non-reef areas were 1.6 fish per trip and 0.4 fish per hour fished. Over artificial reefs or in their immediate vicinity, the corresponding values were 1.7 fish per trip and 0.5 fish per hour fished. It should be noted that bottomfish (primarily black sea bass) were also taken during many of the trips targeted at pelagic species, presumably as an alternative to poor fishing for the preferred species.

The most preferred species was the king mackerel, thus the relative fishing success for it must be considered an important index of the charterboat fishery's status. Figure 2 shows the relative distribution of catch rates (based on trips where pelagic species or "any" were targeted). In non-reef areas, the statewide CPUEs were 0.9 king mackerel per trip and 0.24 fish per hour of effort (based on MRFSS and Division data combined). At reef sites, the equivalent figures were 0.7 fish per trip and 0.20 fish per hour. Catch rates in both non-reef and reef areas were highest in the northern district, somewhat lower in the central area, and much lower in the southern part of the state, regardless of season. With data for the southern area omitted, the catch rates in non-reef areas and at reef sites were roughly equal (about 1.1 fish per trip). The hourly catch rate was slightly greater (0.275) in non-reef areas than at reef sites (0.250).

Of those fishermen interviewed during the MRFSS, slightly more than half (52%) reported catching no king mackerel (based on anglers who targeted pelagic species or indicated no preference). About 14% reported catching a limit of three fish or more.

Spanish mackerel were the next most popular and frequently caught pelagic species. A closure was imposed in the EEZ beginning September 19 and automatically applied to state waters as well. Figure 3 shows the relative distribution of catch rates during the period prior to closure. Fishing success for Spanish mackerel is somewhat difficult to accurately evaluate. Although relatively few anglers reported this species as their preference, fishermen trolling for pelagic species in general often caught it. This was especially true near artificial reefs and in areas fairly close to shore. Many of the anglers who trolled, however, were unlikely to catch Spanish mackerel because they either fished terminal gear intended for larger species or trolled far offshore. There is no objective standard for separating these categories of effort. The figure is based on data for trips in which either pelagic species or "any" were targeted.

Fishing success for the most frequently

caught bottom species, black sea bass, is also difficult to assess because of the problem of directed vs indirect effort. Although black sea bass were the most abundant catch of charterboat fishermen, very few anglers directed their efforts for them. Most of the catch was apparently made by fishermen who began their trip in search of king mackerel or other pelagic species and resorted to bottomfishing after poor success for the target species. Black sea bass catch rates tended to be either very low (one or two fish per angler, obviously incidental catches) or rather high (e.g. 20 or more). Many of the fish were released.

Catch and effort parameters for the major species caught by charterboat fishermen are summarized below. These are based on MRFSS data collected during July-November. The CPUE estimator is in fish per trip. N = trips.

Based on trips targeted at the species or any for mackerels; all trips for black sea bass:

King Mackerel	Spanish Mackerel	Black Sea Bass
N = 410	N = 285	N = 454
\bar{x} = 0.96	\bar{x} = 0.49	\bar{x} = 0.84
s^2 = 1.56	s^2 = 0.79	s^2 = 15.84

Based only on trips with reported catches of the species:

King Mackerel	Spanish Mackerel	Black Sea Bass
N = 198	N = 89	N = 38
\bar{x} = 1.97	\bar{x} = 1.52	\bar{x} = 10.08
s^2 = 1.04	s^2 = 0.86	s^2 = 98.01

Private Boat Mode

Effort and Participation - Wave interview quotas for the MRFSS were as follows:

Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Total
86	112	375	327	204	1,104

During July-December, an additional 170 interviews were obtained during supplemental Division sampling. Distribution of all interviews during this period was as follows:

	Northern	Central	Southern	Total
July	106	117	102	325
August	27	12	28	67
September	63	69	86	218
October	56	98	40	194
November	53	22	50	125
December	50	76	21	147
Total	355	394	327	1,076

The distribution of fishing effort during July-December by district and fishing zone is shown in Table 13. About 9% of the anglers reported fishing in the EEZ (i.e., the ocean beyond three miles) and 15% fished in coastal ocean waters (0-3 miles). The relative amount of effort in ocean areas was appreciably greater during the summer.

There was little difference in average trip duration by area, season, or fishing zone. Most trips included about four hours of

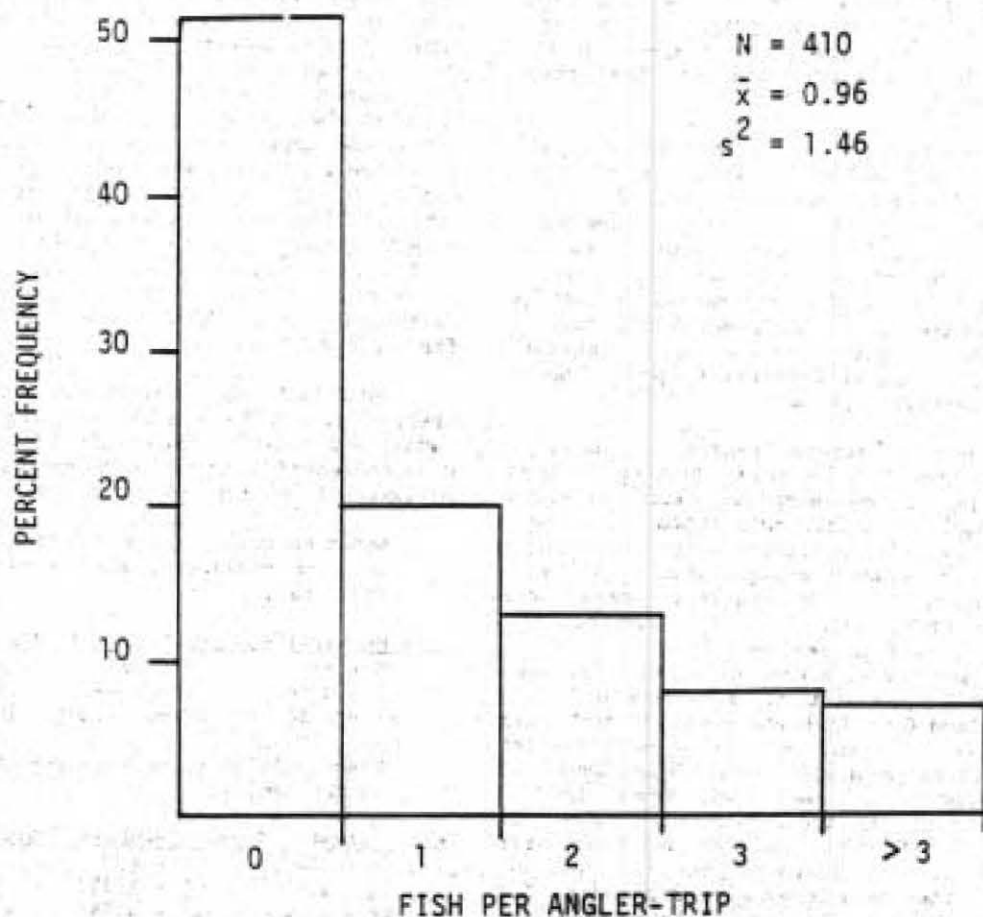


Fig. 2. Catch rates of king mackerel by charterboat anglers during July-November, 1987. MRFSS data only.

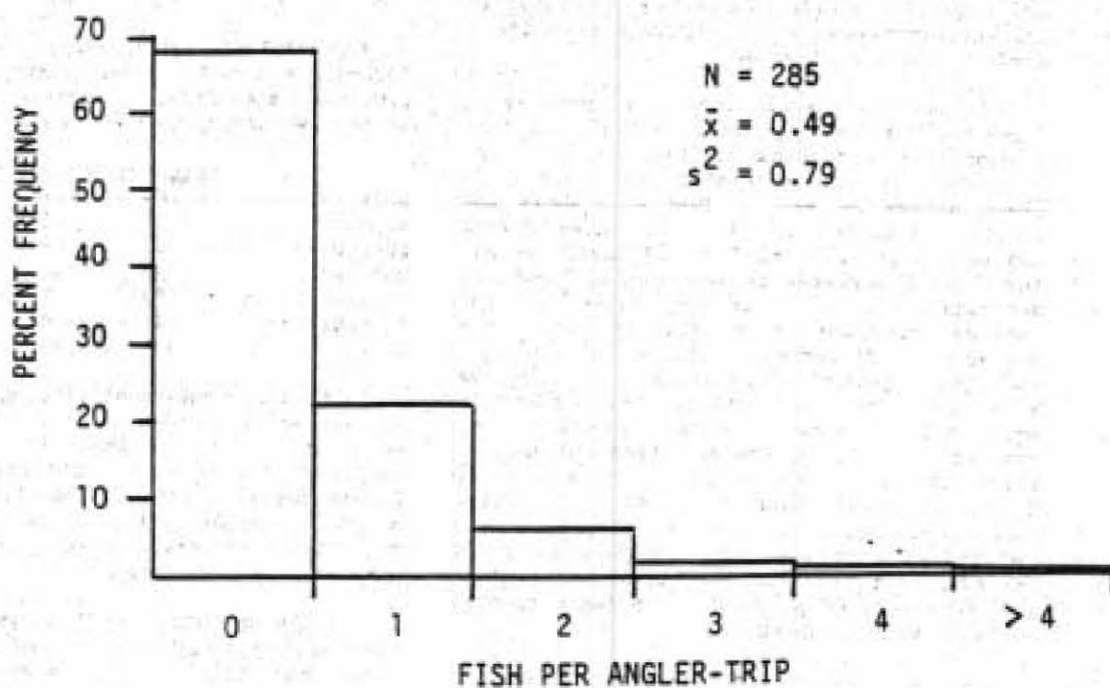


Fig. 3. Catch rates of Spanish mackerel by charterboat anglers during 1 July-19 September, 1987. MRFSS data only.

Table 13. Distribution of private boat effort sampled during July-December (includes Division data).

	Northern	Central	Southern	Total
<u>Number of Angler-Trips</u>				
July-September				
Ocean (> 3 miles)	29	40	21	90
Ocean (0-3 miles)	67	42	11	120
Inshore (river, etc.)	100	116	184	400
October-December				
Ocean (> 3 miles)	8	0	2	10
Ocean (0-3 miles)	33	2	2	37
Inshore (river, etc.)	118	194	107	419
Total				
Ocean (> 3 miles)	37	40	23	100
Ocean (0-3 miles)	100	44	13	157
Inshore (river, etc.)	218	310	291	819
<u>Hours Fished</u>				
July-September				
Ocean (> 3 miles)	127.5	178.0	80.5	386.0
Ocean (0-3 miles)	284.5	137.0	29.5	451.0
Inshore (river, etc.)	434.0	414.0	713.5	1,561.5
October-December				
Ocean (> 3 miles)	34.0	0	12.0	46.0
Ocean (0-3 miles)	157.0	12.0	8.0	177.0
Inshore (river, etc.)	581.5	806.5	488.5	1,876.5
Total				
Ocean (> 3 miles)	161.5	178.0	92.5	432.0
Ocean (0-3 miles)	441.5	149.0	37.5	628.0
Inshore (river, etc.)	1,015.5	1,220.5	1,202.0	4,498.0

fishing on the average. Most fishermen, regardless of season or location of fishing, appeared to average about three trips per month.

About 36% of all ocean trips were made to artificial reefs or their immediate vicinity. Nearly 90% of the artificial reef effort was reported during the summer. Table 14 shows the distribution of reef effort by district, season, and target species group (July-December data only). The utilization (number of trips) of specific reef sites was as follows:

<u>Northern</u>	
Paradise Reef	28
Unknown	11
Ten-Mile Reef	10
Pawleys Island	3
Hector	2
<u>Central</u>	
Capers (R8)	5
Unknown	2
<u>Southern</u>	
Unknown	7
Hunting Island	5
Fripp Island	3
Savannah Tower	3
General Gordon	3
Boiler Reef	2

Species Preference - Table 15 lists the species preferences by district and season as determined during the July-December sampling period. King mackerel was the overwhelming species of choice for offshore anglers (51%). Spanish mackerel and black sea bass were the next most popular species. Anglers fishing in coastal waters (0-3 miles) indicated a wide variety of target species, although king mackerel was the most frequently named (by about 20% of the anglers). Red drum and spotted seatrout were most preferred species targeted by inshore fishermen, although flounders were popular during the summer.

Catch - The estimated total catch in each wave is listed in Table 16. During July-December, about 44% of the total catch was reported released. The most numerous species in the catch were black sea bass, catfishes, red drum, and spotted seatrout. Black sea bass represented about 15% of the total catch by number. About 25% of the estimated total landings (by number) was comprised of inshore species normally considered gamefish; the majority of these were red drum and spotted seatrout (each representing 11% of the total catch). Miscellaneous species, most of which are considered undesirable by anglers, made up about 40% of the total catch.

The frequency with which various species were landed (i.e., the numbers of anglers reporting them) is listed in Table 17. These data pertain to the summer and fall seasons only. More anglers reported catching red drum than any other species. The numbers of fishermen reporting spotted seatrout, pinfish,

and catfish were also appreciable. Perhaps the most significant aspect of the frequency of occurrence vs magnitude of the landings is that the most frequently reported species also tended to be those that were landed in the greatest numbers. The major exception was flounders, with individual catches seldom exceeding more than a few fish per angler.

CPUE - About 35% of the anglers fishing in the EEZ during July-December reported catching no fish, compared to 29% in coastal waters and 24% in inshore areas. The percentages of unsuccessful fishermen were consistently lowest in the northern district. There was relatively little difference in the failure rate of inshore fishermen by district (27% in the southern, 25% in the central, and 20% in the northern).

Catch rates by season, area, and fishing zone as determined from data collected during July-December are summarized in Table 18. CPUEs have been calculated as average-of-ratios statistics, where group catches have been converted into angler catches by dividing total group catch by the number of fishermen in the group. The figures in Table 18 are based on catches of all species combined. Catch rates in coastal waters were consistently lower than those in other zones.

Catch rate estimates for red drum and spotted seatrout, the two highest priority recreational species in inshore waters, are summarized in Table 19. Catch rates based on all inshore trips include data for many trips in which the species was not targeted and therefore relatively unlikely to have been caught. The alternative CPUEs have been based only on data from trips for which the species was either specified as the target or was reported caught. CPUE estimates include released fish. Very few limit (20 fish of each species per person per day) catches of either red drum or spotted seatrout were observed.

Catch rates of pelagic species during July-December were nearly identical for ocean anglers who fished over artificial reefs and in non-reef locations (calculated as the sum of fish caught divided by the total number of trips in the appropriate category). The CPUEs were about 0.5 fish per trip in each category. The overall average catch rate of bottom species was somewhat higher on reef sites (7.8 fish per trip) than in non-reef areas (5.1 fish per trip). These estimates include data for anglers fishing in the coastal zone, since many reported fishing on reef sites during at least a portion of their trip.

Length Composition

All information described here was obtained during the July-December sampling and includes results from both the MRFSS and Division sampling.

The length distribution of king mackerel is shown in Figure 4. Nearly all of these fish were caught by charterboat anglers in the

Table 14. Distribution of private boat effort on artificial reef sites during July-December (includes Division data).

	Northern	Central	Southern	Total
<u>Number of Angler-Trips</u>		July-September		
Pelagic Species	32	7	1	40
Bottom Species	23	0	21	44
		October-December		
Pelagic Species	0	0	2	2
Bottom Species	8	0	0	8
		Total		
Pelagic Species	32	7	3	42
Bottom Species	31	0	21	52

Table 15. Target species of private boat fishermen, by season, district, and fishing area (includes Division sampling). Numbers are anglers identifying a species.

		<u>Ocean > 3 miles</u>	<u>Ocean 0-3 miles</u>	<u>Inshore</u>		
July-September						
Northern	King Mackerel	12	Any	19	Red Drum	31
	Spanish Mackerel	8	King Mackerel	17	Flounders	25
	Black Sea Bass	7	Flounders	15	Any	24
	Bottomfish	1	Spanish Mackerel	8	Drums	6
	Any	1	Red Drum	7	Seatrout	5
					Croaker	4
					Spot	3
Central	King Mackerel	32	Any	14	Any	50
	Black Sea Bass	4	King Mackerel	13	Red Drum	30
	Bottomfish	2	Tarpon	5	Seatrout	11
	Any	2	Red Drum	4	Flounders	9
			Spanish Mackerel	2	Sharks	4
			Bluefish	2	Sheepshead	4
			Sharks	1	Black Sea Bass	2
			Kingfishes	1	Bluefish	2
				Kingfishes	1	
				Spot	1	
Southern	Any	7	Sharks	3	Any	46
	King Mackerel	5	Mackerels	2	Red Drum	43
	Spanish Mackerel	5	Red Drum	2	Mackerels	33
	Sharks	1	Any	2	Seatrout	21
	Flounders	1			Sharks	19
	Black Sea Bass	1			Flounders	12
	Bluefish	1			Sheepshead	6
					Black Sea Bass	3
				Weakfish	2	
				Black Drum	1	
October-December						
Northern	Black Sea Bass	6	Spot	14	Red Drum	44
	King Mackerel	2	Any	9	Seatrout	28
			Red Drum	3	Spot	26
			Black Sea Bass	3	Any	17
			Weakfish	2	Flounders	2
			Sheepshead	1	Black Sea Bass	1
			Flounders	2	Seatrout	106
Central	(no trips)				Red Drum	51
					Any	29
					Spot	5
					Flounders	3
					Sharks	2
Southern	Bluefish	2	Any	2	Red Drum	48
					Seatrout	39
					Any	17
					Spot	3
					Sharks	2

Table 16. Estimated total catches in the private boat mode by wave, as provided by NMFS. Catches are shown in thousands of fish.

Species	Mar.- Apr.	May- June	July- Aug.	Sep.- Oct.	Nov.- Dec.	Total
<u>Offshore Pelagics</u>						
Little tunny/bonito	2		<1			2+
Tunas/mackerels		<1				<1
<u>Offshore Bottomfish</u>						
Black sea bass	93	113	290	48	29	573
Sea basses	13		6	2		21
Groupers	<1			<1		1
Snappers	<1					<1
Red snapper			<1			<1
Porgies			3	<1	42	45+
Red porgy	1	7	7			15
Grunts			18			18
Triggerfish			<1			<1
<u>Coastal Pelagics</u>						
King mackerel	4	7	6	1		18
Spanish mackerel		2	7	28		37
Bluefish	4	18	10	7	3	42
Jack crevalle		<1	6	33		39+
Blue runner			<1			<1
Amberjacks			1	<1		1+
Barracuda		<1	<1	<1		1+
<u>Inshore Gamefish</u>						
Red drum	15	6	46	228	139	434
Spotted seatrout	4	5	50	85	289	433
Weakfish		3	4	3	1	11
Summer flounder			20	<1	1	21+
Southern flounder		6	18	6	8	38
Flounders			8	2	3	13
<u>Inshore Bottomfish</u>						
Kingfishes	3	12	11	10	9	45
Spot	8	51	29	44	73	205
Croaker		28	114	37	1	180
Black drum		3	11	5	3	22
Sheepshead	8	3	8	3	<1	22+
Pompano			3	1		4
<u>Miscellaneous</u>						
Sharks	4	77	173	10		264
Skates/rays	<1	2	8	7	1	18+
Eels	<1	<1		6		6+
Catfishes	14	131	327	78	8	558
Toadfish	10	31	69	35	<1	145+

Species	Mar.- Apr.	May- June	July- Aug.	Sep.- Oct.	Nov.- Dec.	Total
Pinfish	6	30	81	102	152	371
Mulletts	31	19			<1	50+
Herrings		5				5
Puffers		2	1	2		5
Searobins			3			3
Pigfish			8	24		32
White perch					37	37
Others		<1	3	21	26	50+
Total	224	564	1,354	839	844	3,825

Table 17. Frequency of occurrence of individual species in catches of private boat fishermen, by district and season. Values are the numbers of fishermen reporting a catch of the particular species.

	Northern	Central	Southern	Total	Northern	Central	Southern	Total
Inshore								
July-September								
October-December								
Priority Species								
Red Drum	25	50	50	125	12	89	55	176
Spotted Seatrout	3	33	28	64	6	86	41	133
Flounders	25	14	16	55	14	27	7	48
Secondary Species								
Croaker	38	22	25	85	8	14	3	25
Spot	12	7	7	26	35	15	5	55
Kingfishes	8	9	6	23	8	7	6	21
Bluefish	16	6	1	23	5	0	3	8
Black Drum	2	8	4	14	3	3	5	11
Sheepshead	2	5	4	11	0	6	7	8
Weakfish	3	3	0	7	1	0	2	3
Pompano	2	2	1	5	0	0	0	0
Ocean								
Pelagic Species								
Spanish Mackerel	21	5	4	30	0	0	0	0
King Mackerel	5	6	0	11	1	0	0	1
Amberjacks	3	1	1	5	2	0	0	2
Barracuda	1	1	1	3	0	0	0	0
Little Tunny	0	1	0	1	0	0	0	0
Blue Runner	0	1	0	1	0	0	0	0
Tarpon	0	1	0	1	0	0	0	0
Bottom Species								
Black Sea Bass	43	17	15	75	27	1	0	28
Grunts	2	1	0	3	0	0	0	0
Spotted Pinfish	0	0	2	2	2	0	0	2
Red Porgy	2	4	0	6	0	0	0	0
Tomtate	4	0	0	4	0	0	0	0
Whitebone Porgy	2	0	0	2	4	0	0	4
Scup	2	0	0	2	0	0	0	0
Gag	1	0	0	1	0	0	0	0
Grouper	0	0	0	0	0	1	0	1
Knobbed Porgy	1	0	0	1	0	0	0	0
Porgies	0	0	0	0	2	0	0	2
Triggerfish	1	0	0	1	0	0	0	0
Red Snapper	0	1	0	1	0	0	0	0
Tautog	0	0	0	0	1	0	0	1
Sharks	42	36	34	112	2	0	2	4
Miscellaneous								
Catfish	33	33	78	144	17	8	12	37
Pinfish	43	16	35	94	44	26	18	88
Toadfish	22	14	13	49	12	2	0	14
Pigfish	8	1	15	24	6	2	3	11
Jack Crevalle	3	8	24	35	0	4	4	8
Rays	3	3	8	14	4	1	5	10
Rock Sea Bass	1	9	4	14	1	0	0	1
Ladyfish	1	0	10	11	0	0	0	0
Puffers	3	0	1	4	3	0	1	4
Eels	1	2	0	3	5	3	0	8
Lizardfishes	3	0	0	3	0	0	0	0
Sea Robins	2	0	1	3	0	0	0	0
Gars	1	0	1	2	1	1	0	2
Cutlassfish	1	0	1	2	0	0	0	0
Silver Perch	1	1	0	2	13	11	3	27
Needlefish	1	0	0	1	0	0	0	0
Gefftopsail Catfish	0	0	1	1	0	0	0	0
Skates	0	0	1	1	2	0	0	2
Spadefish	0	0	0	0	0	1	0	1
White Perch	0	0	0	0	8	0	0	8
Mullet	0	0	0	0	0	1	0	1
Unidentified	5	0	0	5	9	0	2	11

Table 18. Catch per unit of effort (CPUE) estimates by season and district, measured in number of fish per angler-trip. Division sampling data are included.

<u>All Species Combined</u>			
	<u>Ocean > 3 miles</u>	<u>Ocean 0-3 miles</u>	<u>Inshore (rivers, etc.)</u>
<u>July-September</u>			
Northern	$\bar{x} = 9.4$ $s^2 = 131.1$	$\bar{x} = 3.6$ $s^2 = 14.0$	$\bar{x} = 5.7$ $s^2 = 39.6$
Central	$\bar{x} = 2.4$ $s^2 = 22.4$	$\bar{x} = 2.9$ $s^2 = 37.7$	$\bar{x} = 6.1$ $s^2 = 53.4$
Southern	$\bar{x} = 7.5$ $s^2 = 103.2$	$\bar{x} = 1.2$ $s^2 = 4.8$	$\bar{x} = 6.6$ $s^2 = 88.9$
<u>October-December</u>			
Northern	(N = 10)	$\bar{x} = 18.7$ $s^2 = 394.0$	$\bar{x} = 4.5$ $s^2 = 27.9$
Central	(N = 0)	(N = 2)	$\bar{x} = 3.9$ $s^2 = 34.1$
Southern	(N = 2)	(N = 2)	$\bar{x} = 7.0$ $s^2 = 111.9$

Table 19. CPUE estimates for red drum and spotted seatrout by season and district, measured in number of fish per angler-trip. Division sampling data are included.

		<u>Red Drum</u>	
<u>July-September</u>	<u>All Inshore Trips</u>	<u>Inshore Trips Where Targeted and/or Reported as Caught</u>	
Northern	$\bar{x} = 0.28$ $s^2 = 0.56$	$\bar{x} = 0.70$ $s^2 = 1.12$	
Central	$\bar{x} = 2.25$ $s^2 = 19.53$	$\bar{x} = 5.16$ $s^2 = 30.14$	
Southern	$\bar{x} = 0.97$ $s^2 = 4.75$	$\bar{x} = 2.72$ $s^2 = 8.58$	
<u>October-December</u>			
Northern	$\bar{x} = 0.52$ $s^2 = 1.99$	$\bar{x} = 1.10$ $s^2 = 3.20$	
Central	$\bar{x} = 1.09$ $s^2 = 4.62$	$\bar{x} = 2.21$ $s^2 = 7.02$	
Southern	$\bar{x} = 2.37$ $s^2 = 12.53$	$\bar{x} = 3.55$ $s^2 = 14.59$	
		<u>Spotted Seatrout</u>	
<u>July-September</u>			
Northern	$\bar{x} = 0.07$ $s^2 = 0.23$	$\bar{x} = 1.60$ $s^2 = 3.17$	
Central	$\bar{x} = 0.79$ $s^2 = 5.06$	$\bar{x} = 3.17$ $s^2 = 13.03$	
Southern	$\bar{x} = 0.49$ $s^2 = 3.13$	$\bar{x} = 2.63$ $s^2 = 11.42$	
<u>October-December</u>			
Northern	$\bar{x} = 0.27$ $s^2 = 1.21$	$\bar{x} = 1.14$ $s^2 = 4.33$	
Central	$\bar{x} = 1.44$ $s^2 = 10.63$	$\bar{x} = 2.60$ $s^2 = 16.16$	
Southern	$\bar{x} = 1.89$ $s^2 = 30.25$	$\bar{x} = 3.20$ $s^2 = 46.65$	

EEZ. Mean total length declined slightly during the summer, then increased during the fall.

Length distribution of Spanish mackerel is illustrated in Figure 5. Most of these fish were taken by charterboat fishermen and the sample was fairly evenly divided between coastal waters and the EEZ. All fish were taken prior to the September closure. About 2% were below the legal 12 inch (fork length) minimum size.

Length frequency of black sea bass by zone of capture is shown in Figure 6. Fish caught during the summer averaged a little less than 9.0 inches, while those taken during November-December averaged about 12.0 inches. About 43% of the fish reported from state waters were undersized, compared to 16% of those from the EEZ. Most of the undersized catch appeared to be attributable to private boat fishermen (About 6% of the limited charterboat sample was undersized).

Size composition of red drum is shown in Figure 7. During September 1987, about 85% of the sample was less than 14.0 inches, which was the legal minimum (total) length during June-August. During the fall (1987), about 44% were less than 14.0 inches. The mean total length (14.3 inches) of fish from the Charleston area (N = 144) was slightly less than that (15.1 inches) of fish caught in other parts of the state.

Length distribution of spotted seatrout is shown in Figure 8. About 4% of the total measured catch was below the minimum legal size (12.0 inches total length). About 26% of the fish caught during the summer were released, which probably reflects the percentage of fish caught that were undersized. The percentage (24%) released during the fall was very similar. The average length (14.1 inches) of spotted seatrout retained in the Charleston area (N = 138) was a little smaller than that (14.9 inches) of fish retained elsewhere (N = 202).

Size composition of flounder catches is shown in Figure 9. A plan for the management of summer flounder being prepared by the Middle Atlantic Fishery Management Council has proposed a 13.0 inch minimum size for that species north of North Carolina. About 67% of the summer flounder sample was below this standard. Southern flounders averaged somewhat larger.

DISCUSSION

Methodology

Several aspects of the MRFSS methodology have caused concern as to the validity of its results. Some of these aspects are generalized ones inherent in the procedures and have been cited by many sources within NMFS and various other agencies. Others tend to be unique to the circumstances prevailing in South Carolina. A brief discussion of the more universal limitations of the MRFSS

follows, while some of its specific limitations are considered in the appropriate subsections.

The main criticism of the MRFSS has been the relatively low level of reliability associated with its catch estimates. This is reflected by the large coefficients of variation (and implied low levels of precision) typically associated with catch estimates, particularly those of species not frequently caught. NMFS has determined that the intercept portion of the survey contributes much more to error of the catch estimates than does the telephone component. Because large coefficients of variation commonly are associated with small sample sizes, one corrective measure is to increase the sample sizes. This is particularly true at the state level, where samples in the various wave/mode/area/species cells usually are inadequate to detect even gross differences in apparent catch rates. This has been the principal justification for substantial expansion of sample coverage in the intercept portion of the MRFSS under cooperative agreements with the states.

There are limitations, however, to the improvement in precision that can be obtained through increased sample size. Practical considerations, most notably the costs associated with an on-site creel census, effectively control the extent to which coverage can be increased. A recent study (Hegggenes 1987) of stratified random creel surveys concluded that consistency in the fishing pattern can be more important than sample size as a determinant of precision of CPUE estimates when fishing intensity is relatively low. Increased species variety also lowers the precision of CPUE estimates. Finally, anglers targeting different species tend to have different fishing patterns, which contribute to increased inconsistency of fishing activity and decreased precision of CPUE estimates.

These are all relevant factors given the observed characteristics of the South Carolina fishery. During most of the year, anglers target a diverse group of species, many of which require specialized techniques for appreciable results. Many other anglers have no species preference and catch a diverse assemblage of fish. The fishery in all areas and modes is a multispecies one as a result. In some seasons and areas, fishing intensity is typically low in terms of the number of anglers likely to be intercepted at a given location. Given these realities, the most pragmatic approach to the interpretation and use of the MRFSS catch data for management purposes is to recognize that there is a rather high level of imprecision associated with them and select management options that accept a wide tolerance range in catch levels.

Overview

A recent overview of marine recreational fisheries in the southeastern United States, based on data obtained in the MRFSS, was

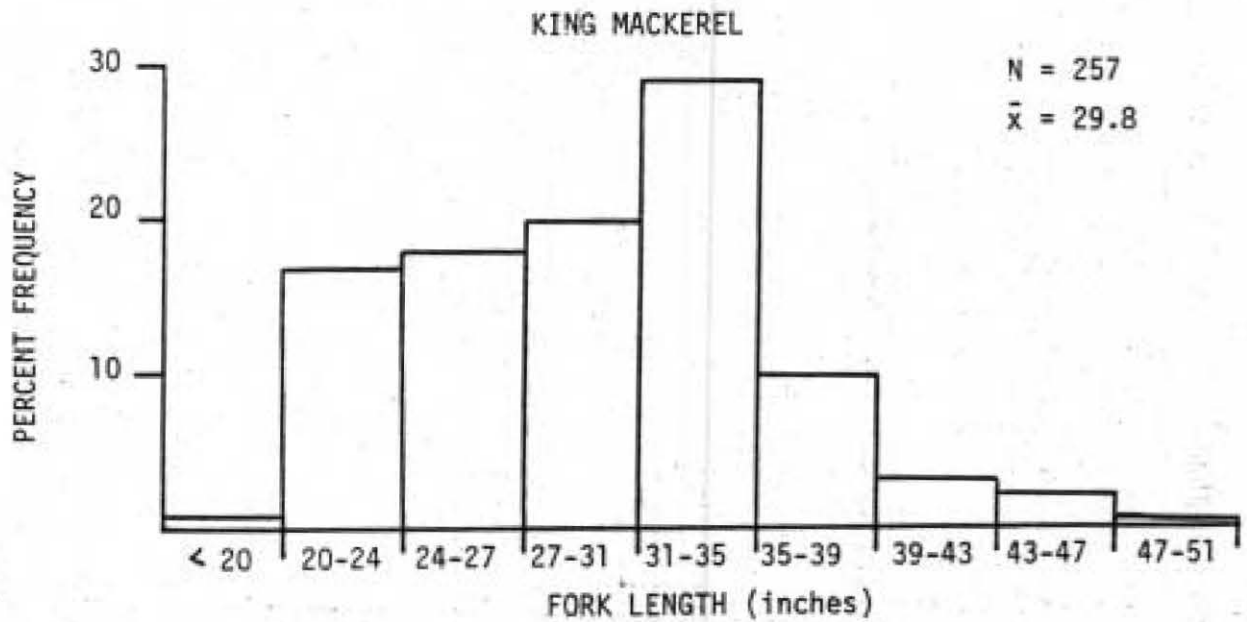


Fig. 4. Length distribution of king mackerel, July-November 1987.

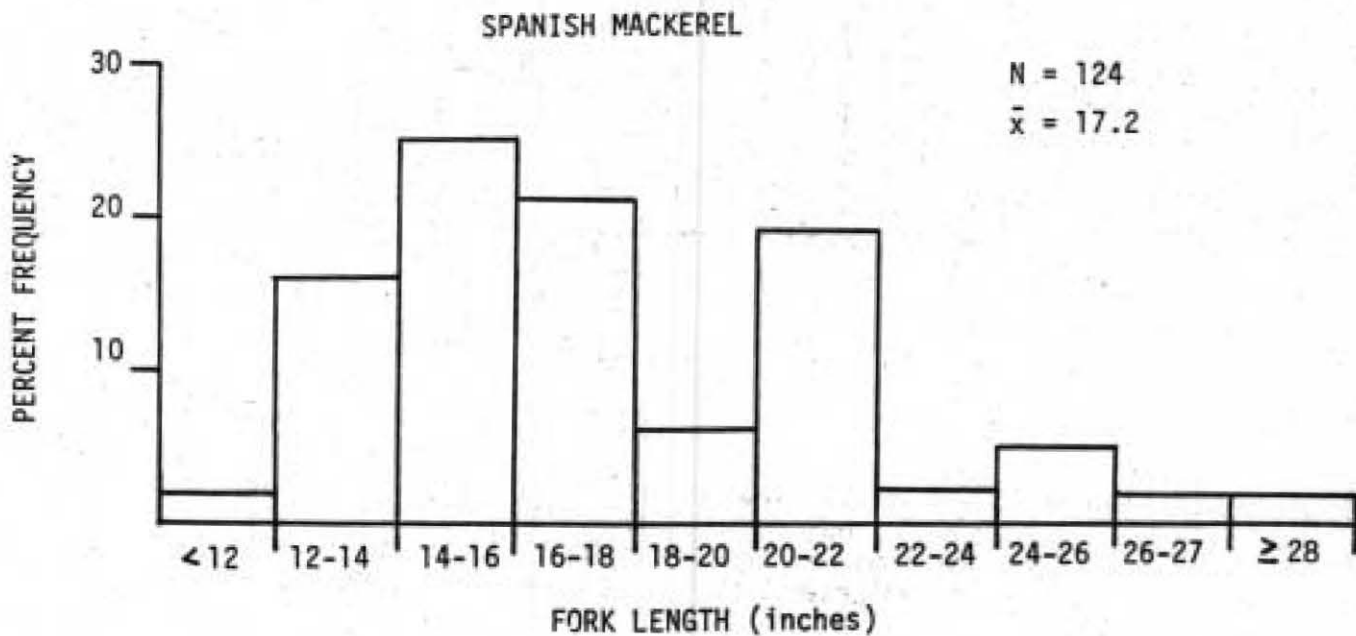


Fig. 5. Length distribution of Spanish mackerel, July-September 1987.

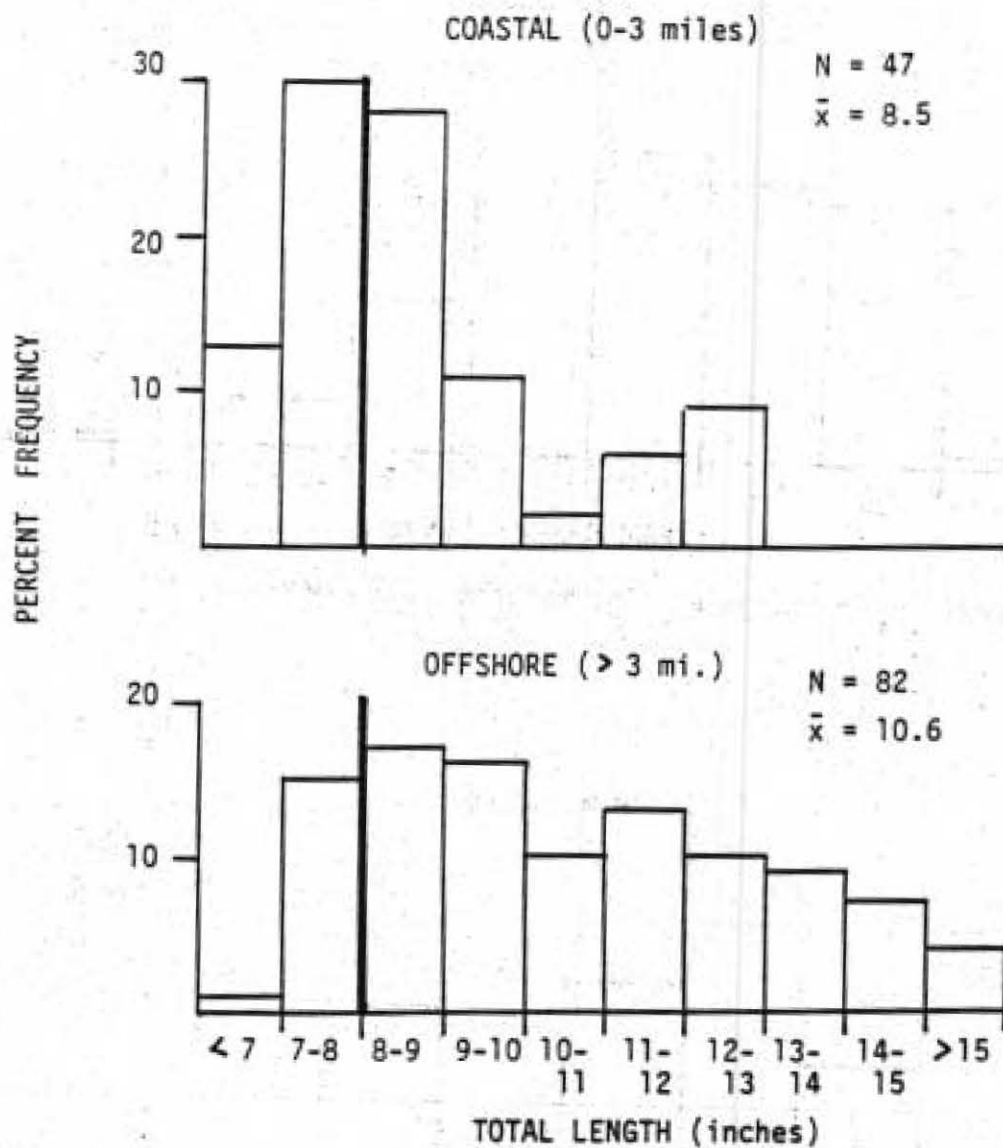


Fig. 6. Length distribution of black sea bass in coastal (0-3 miles) and offshore (EEZ, >3 miles) zones. The minimum size limit (8.0 inches total length) is indicated by the heavy vertical line.

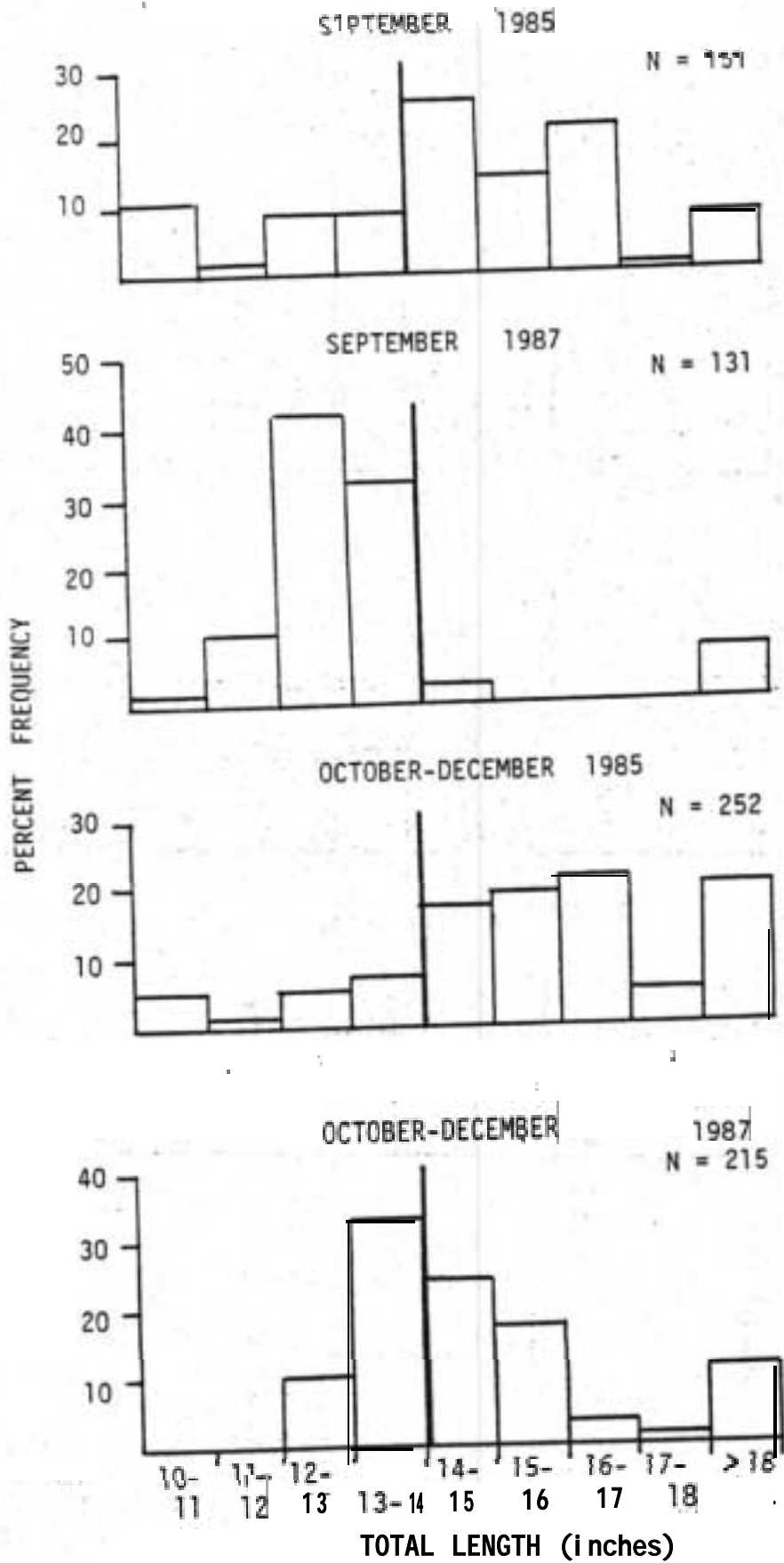


Fig. 7) Length distribution of red drum. The June-August minimum size limit (14 inches) is indicated by the heavy vertical line.

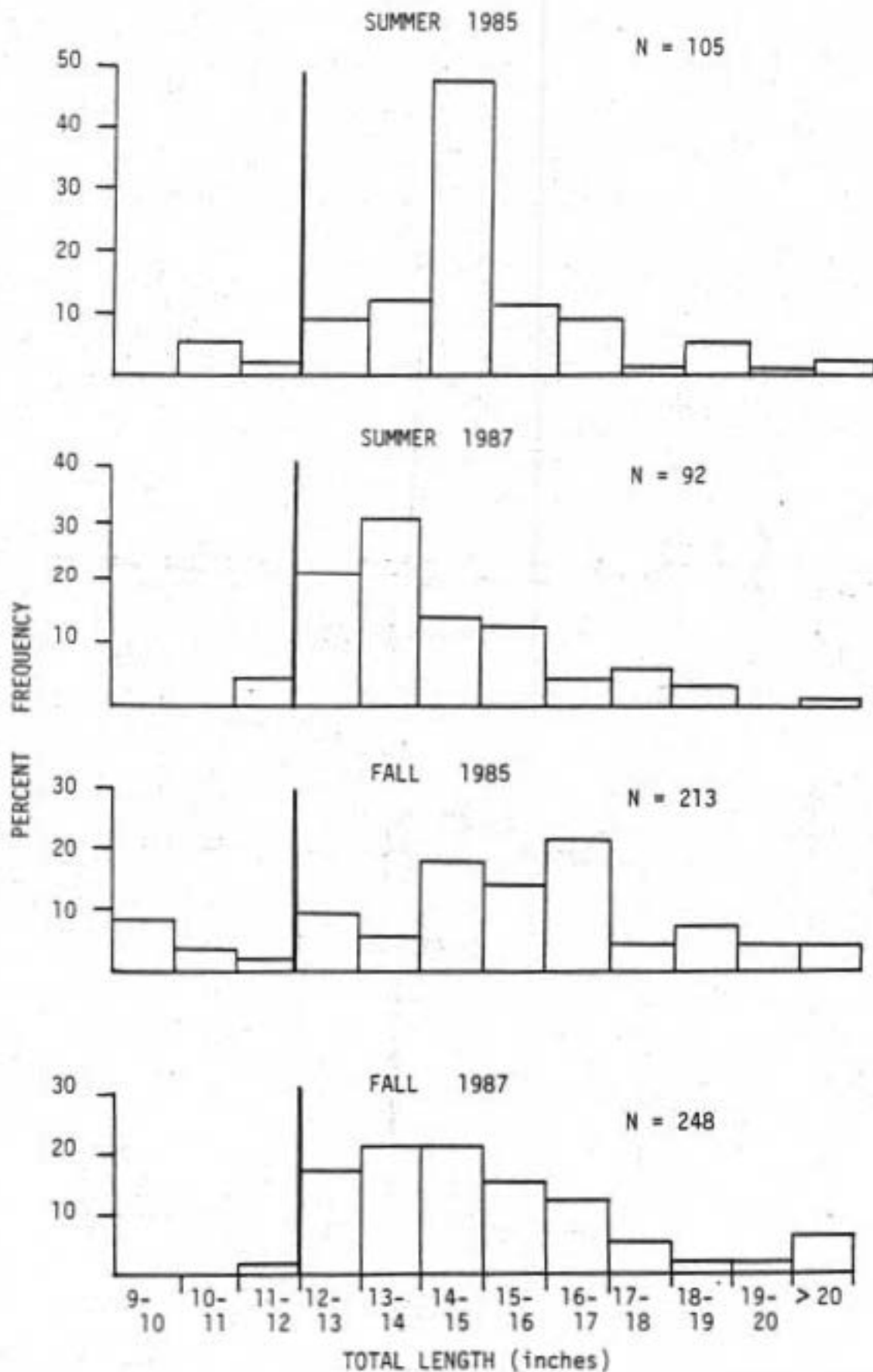


Fig. 8. Length distribution of spotted seatrout. The minimum size limit (12 inches) is indicated by the heavy vertical line.

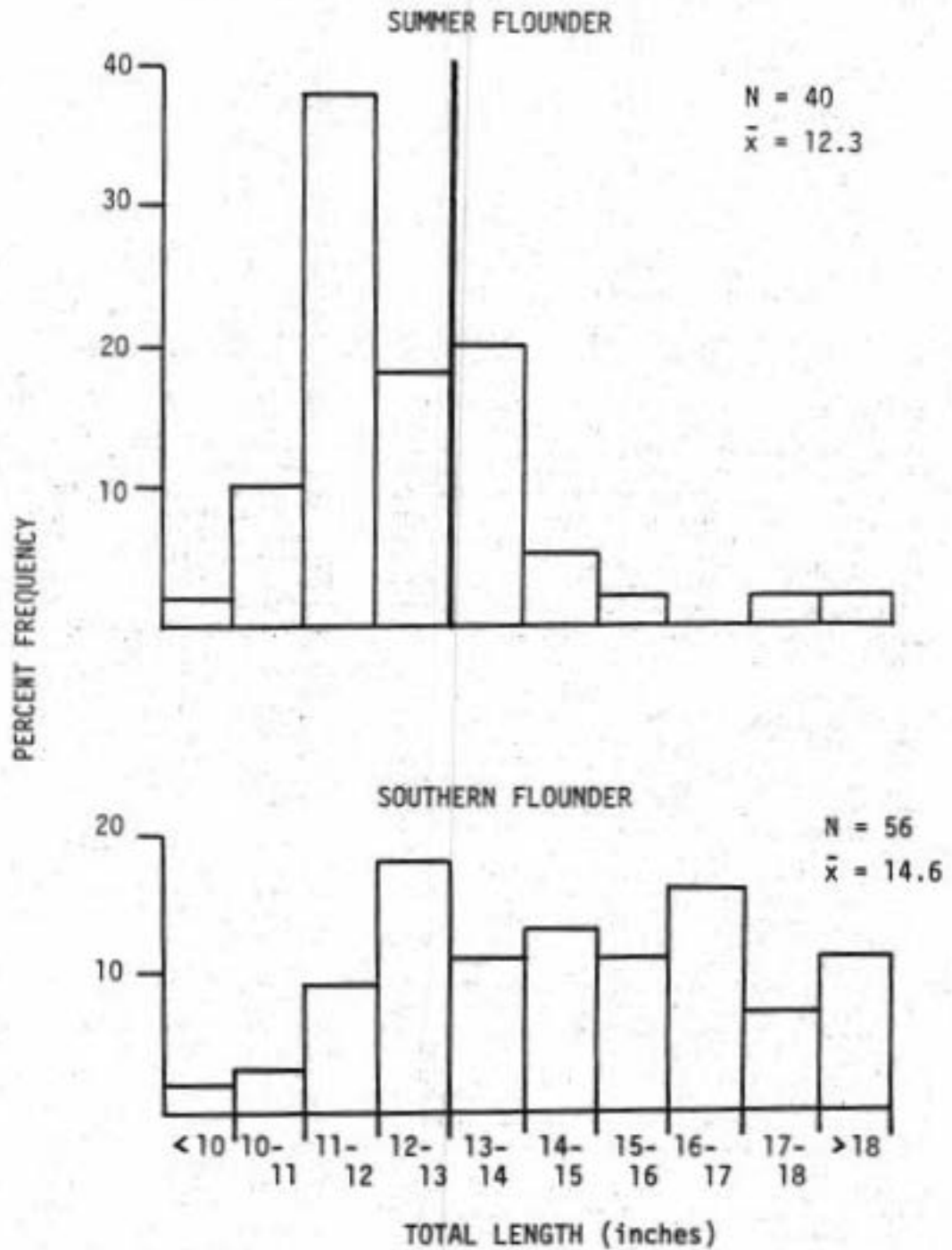


Fig. 9. Length distribution of flounders. The proposed Mid-Atlantic area minimum size limit (13 inches) is indicated by the heavy vertical line.

prepared by Schmeid and Burgess (1987). The results of the 1987 survey suggest that South Carolina's marine sport fishery generally conformed to the regional pattern.

A 1981 study (KCA 1983) found that South Atlantic recreational anglers averaged about 23.5 days of salt water fishing per year. In 1987, South Carolina fishermen apparently averaged considerably less effort (16.5 days). The most active fishermen lived in the coastal zone and averaged almost 27 days of effort. Non-coastal state residents averaged about 12 days and out-of-state anglers about 8 days.

Schmeid and Burgess (1987) reported that most fishing by resident anglers takes place from private boats and manmade structures (piers, bridges, etc.), while visiting anglers in the South Atlantic are most likely to fish from beaches, banks, headboats and charterboats. The 1987 results in South Carolina indicate that visiting anglers do patronize the charterboats extensively, but are most likely to fish from public piers when they go shore fishing. Results from a 1977 study of offshore fishermen also suggest that visiting out-of-state anglers account for the majority of headboat passengers (Liao and Cupka 1979b).

In 1985, the overall average catch rate of South Atlantic fishermen was 5.6 fish per trip (Schmeid and Burgess 1987). Results from the 1987 survey indicate that the rate for that year in South Carolina was about 4.7 fish per trip. In the South Atlantic region, about 13% of the landed catch by weight in 1985 was taken in inshore areas (bays, sounds, and rivers), 29% in the coastal zone (0-3 miles), and 58% in the EEZ (Schmeid and Burgess 1987). Species composition of the estimated landed catch in 1987 by fishermen in South Carolina suggests that the total catch was fairly evenly divided between inshore areas and ocean waters, although the catch in the coastal zone appeared to be the lowest of the three area categories. In numbers of fish, about 55% of the 1987 catch was made inshore, 13% came from coastal waters, and 32% was taken offshore. In 1985, the catches of South Atlantic recreational anglers were dominated by spot, black sea bass, bluefish, and croakers. The 1987 South Carolina survey results confirm that spot and black sea bass were prominent in the landings (first and second, respectively, by number), but pinfish, catfish, red drum, kingfishes and spotted seatrout also contributed substantially. Catches of croaker and bluefish were far less in comparison.

Schmeid and Burgess (1987) reported that about 56% of the regional anglers interviewed in 1985 did not specify a particular species preference. Of those that did, spotted seatrout, red drum, bluefish, and king mackerel were the most often identified. Surveys in recent years have consistently identified red drum as the most popular target of South Carolina anglers, with spotted seatrout and flounders also being popular with inshore anglers. King mackerel has been the

consistent dominant target species of ocean fishermen.

Shore Mode

Almost half of the total number of shore anglers interviewed during July-December were fishing from Grand Strand piers. The last comprehensive survey of fishing activity on these structures was conducted by the Division in 1974 (Hammond and Cupka 1977). This early survey included the period from April through November, whereas the present results refer to July through November. Although Hammond and Cupka (1977) observed a wide variation in the residency of pier anglers from month to month, the overall level of out-of-state fishermen observed was 57%. During the 1987 survey, 47% of the anglers interviewed were nonresidents, virtually all of them from North Carolina.

Fishermen interviewed during the 1987 survey averaged substantially more fishing time per visit (4.5 hours) than did anglers in 1974 (3.3 hours). Species preferences were similar. In 1974, 71% of the fishermen expressed no preference; in 1987, 80% were in this category. The percentages of anglers seeking spot and kingfishes, the most popular species, differed little between the two surveys. The most notable difference in catches was the scarcity of croakers observed during the 1987 survey. About 28% of the 1987 catch was released, whereas 39% was either released or given away in 1974. Catch rates were very similar (4.05 fish per trip for the overall 1974 period vs 4.11 for July-November of 1987).

The overall impression is that the pier fishery in 1987 was not substantially different from that in 1974 in terms of the characteristics of the fishermen and their fishing success.

Two limitations of the MRFSS that apply specifically to the pier fishery are the sporadic availability of the fish and the level of incomplete trips included in the data. The most popular and abundant species, spot, is notorious for appearing in brief runs, when the bulk of the catch is taken. The presence or absence of the creel clerk during such times can significantly influence the overall catch estimates. A graphic example of this is illustrated in the shore mode data for the central district (see Figure 1). Because of the high percentage of 0 values (i.e., no catch reported), the sample mean for a data array typical of shore fishing CPUE can be substantially biased by inclusion of a very small number of large observations. For example, consider the data array shown for the central district as equivalent to that which might describe a set of observations for the pier fishery in which the creel clerk happened to be present during a run of fish (say spot) for a small portion of his overall sample. Consider one of the other series, say that for the northern area, as representative of the data set that would have been obtained if the clerk had missed all of the runs. The resulting difference in the sample means can

be very substantial. In fact, for the data shown for the central district, the catches reported by three anglers (out of a total of 75) comprised 46% of the total catch. If CPUE data for these three anglers are omitted, the revised sample mean is 3.6 (which is virtually identical to that shown for the northern district). Thus, the chance interception of a few anglers with very large catches can significantly alter the sample mean, with serious implications regarding estimation of the total catch as derived through extrapolation.

For maximum sampling efficiency (as measured in the number of interviews obtained per hour of on-site time), the clerk must also attempt to visit the piers at times when there will be substantial numbers of fishermen departing. Otherwise, a substantial portion of the interviews is likely to be based on incomplete trips. The NMFS estimation procedure for determining catches from incomplete trips is suspect for the pier fishery, given the sporadic availability of the popular species, since it is based on the hourly catch rate reported for the trip at the time the angler is interviewed. Both of these sampling problems could be addressed through the use of a passive exit-point survey instrument, e.g., a card questionnaire deposited in a collection box.

Charterboat Mode

The last comprehensive Division study that addressed the South Carolina charterboat fishery was conducted during 1977 (Liao and Cupka 1979a). In that year, 48% of the anglers were from out-of-state (primarily North Carolina). In 1987, 77% of the fishermen interviewed during the NMFS were from out-of-state (with North Carolina fishermen again being prominent).

Some comparisons of relative fishing success observed during the two surveys are summarized below:

	1977	Jul-Nov 1987
Charterboat anglers catching king mackerel	40%	41%
Charterboat anglers catching bottomfish	10%	14%
Charterboat anglers fishing at artificial reefs	15%	34%
Fish/trip, non-reef users	3.1	4.3
Fish/trip, reef users	2.9	2.7
Fish/hr, non-reef users	0.4	1.1
Fish/hr, reef users	0.3	0.7

The average trip duration in 1977 was nearly twice that observed in the 1987 survey; this accounts for the apparent discrepancy in CPUE as measured in fish per hour fished. The figures shown here for 1987 differ from those

presented earlier because of the need to make them comparable in calculation to those from the 1977 study. Calculations include anglers who targeted bottomfish because the 1977 angler preferences were not specified and the data presumably included all trips.

It appears that there was relatively little difference in charterboat fishing success between these two years. CPUE of non-reef fishermen was either comparable to or slightly higher than that of reef users, depending on the target species, species caught, etc. Yet, the percentage of angler trips made to the reefs has more than doubled. The reefs are most heavily used by boats from northern and southern ports; captains from the Charleston area seldom went to the reef sites. This may reflect the distribution of reef sites, their perceived quality as fishing locations, alternate availability of productive natural habitat, captains' experience, etc.

During 1982-1985, NMFS contracted charterboat captains in a logbook reporting program. For South Carolina, sufficient data are available only for 1985. In that year, 4% of the reported charterboat effort was directed at estuarine (i.e., inshore) areas and 96% was spent in the ocean. These percentages are similar to those observed during 1987. In 1985, the principal species caught by trolling, which represented 93% of the charterboat effort, were king mackerel (49% of the catch by number) and Spanish mackerel (13%). Black sea bass represented 47% of the fish caught by other methods and was the only bottom species taken in appreciable numbers (Brusher and Palko 1987). These same species dominated the 1987 landings.

In the NMFS logbook study, CPUE was reported as the number of fish caught per boat-hour of fishing. For king mackerel during 1985 in South Carolina, two average annual catch rates (based on the same data) have been published. Brusher and Palko (1987) listed 1.11 fish per boat-hour, while Trent et al. (1987) reported 1.24. When divided by four (the average number of anglers per boat), the equivalent CPUE in fish per angler-hour would range from 0.28 to 0.31. The CPUE observed during July-November 1987 was about 0.24 king mackerel per angler-hour. Given the allowances associated with conversion, rounding off, etc., the overall charterboat success rate in 1987 therefore appeared to be comparable to that reported for 1985. Trent et al. (1987) noted, however, that CPUE appeared to be highly variable from season to season within and between years (for 1983 and 1985) but tended to peak in the fall.

As mentioned previously, it is difficult to define a meaningful index for CPUE of Spanish mackerel, the other important pelagic species for South Carolina charterboats. Palko et al. (1987) reported an average annual CPUE of 0.44 fish per boat-hour in 1985 (Brusher and Palko listed it as 0.30). The

approximate value for 1987 (July-September) appears to have been somewhat higher, but the NMFS workers documented significant seasonal variability in the catch rate of this species. In 1985, August was by far the best month and June fishing was very poor, whereas limited data for 1983 indicated peak fishing during June, followed by August (Palko et al. 1987).

Charterboat catch rates for black sea bass based on all trips are probably relatively meaningless. The average annual CPUE reported for black sea bass in 1985 by Brusher and Palko (1987) appears to have been about the same as that observed for 1987 (approximately 1.00 fish per boat-hour).

Both king and Spanish mackerel fisheries are subject to closure if NMFS determines that recreational quotas are going to be exceeded. The majority of both species appears to be caught by charterboat fishermen in South Carolina, particularly in the case of king mackerel. The reliability of the CPUE estimates is therefore an important consideration, given the method by which the total Type A (retained) catches are estimated. Nichols (1985) evaluated the appropriateness of long-term charterboat CPUE as an index of king mackerel abundance and concluded that data for small areas from the MRFSS were too variable to provide good (i.e., precise) estimates of indices of abundance. MRFSS samples have since been enlarged considerably. For the 1987 survey data considered here (i.e., July-December), the precision level of the CPUE estimate for king mackerel was about (\pm) 12% at the 95% confidence level, which is fairly reliable. The reliability of the Spanish mackerel estimate was somewhat lower, but the lack of May-June data and the effect of the closure must be taken into account.

One aspect of the NMFS procedure used to expand the CPUE estimate in order to obtain the estimated total catch may be worth re-evaluating. At present, CPUE is based on all trips, even though no fish are caught on a substantial percentage of trips. It may be more realistic to calculate CPUE based only on those trips which take fish and base the expansions on that value while adjusting the estimate of total trips to account for those in which no fish were presumably caught. Consider the following example. The estimated total effort is 25,000 trips. CPUE based on all trips was 0.96 fish per trip ($N = 410$). The estimated catch was therefore 24,000 fish. If confidence limits are assigned as (\pm) two standard errors about the mean, the corresponding values would be 0 and 84,500; the true total catch could lie anywhere within this range. This is the current estimation procedure (somewhat simplified). Now consider a CPUE of 1.97 fish, based on 198 trips in which fish were caught. Unsuccessful trips accounted for 52% of the effort. This percentage applied to the estimated total of 25,000 trips leaves 12,000 trips during which fish probably were caught. This revised estimate of effort is then used to expand the CPUE index and obtain a catch estimate

(23,640). Note that the two estimates are virtually identical. What is different is the range of catch included within the confidence limits. With the variance (smaller) from the CPUE index associated with only those trips that caught fish used to determine the boundaries, the range is 0-52,130 fish. Thus, the reliability of the estimate obtained using the second procedure is somewhat improved, particularly where the tolerance in allowable catch quotas is small.

Very few charterboat trips were targeted at bottomfish and CPUE estimates based on incidental catches are notoriously unreliable. Most of the bottomfish caught were black sea bass. An extremely large variance was associated with the CPUE index for this species and any resulting catch estimates would have to be considered extremely speculative.

Private Boat Mode

The most recent comprehensive study of offshore private boat fishing was done by Liao and Cupka (1979a, b). In their work, the precise definition of "offshore" was not specified and there may have been some ambiguity in the responses of the fishermen. The authors considered all effort to have been in the EEZ. This was probably true for artificial reef fishermen, since all reefs at that time were located at least three miles offshore. When the 1987 results are calculated to make them comparable to those from the 1977 study, the following figures apply:

	1977	Jul-Dec 1987
Effort/surface fishing	60%	67%
Effort/bottom fishing	31%	22%
Other (mixed, etc.)	9%	11%
Trips/artificial reefs	26%	36%
King mackerel, % catch	30%	1%
Black sea bass, % catch	15%	81%
Spanish mackerel, % catch	13%	8%
Offshore bottomfish, % catch (excluding black sea bass)	5%	10%
Fish per angler/trip reef users	4.5	10.1
Fish per angler/trip non-reef users	3.8	5.4

The principal difference appears to be the juxtaposition in the representation of king mackerel and black sea bass in the catches.

All of the Division's recent surveys have confirmed the importance of red drum and spotted seatrout to inshore private boat fishermen. These are both the most preferred species and among the most frequently caught. Both comprise a substantial part of the inshore anglers retained catch. Fishing

success for these species is therefore a primary concern of both anglers and management authorities. Evaluation of CPUE for these fish is somewhat complicated by the multispecies composition of inshore landings and the fact that a large percentage of anglers do not target any particular species. Many of the fishermen who expressed no preference appeared to fish on the bottom with a variety of cut baits. Although such fishermen are fairly likely to catch some red drum, they are unlikely to catch either spotted seatrout or flounders. Fishermen who don't specifically fish for flounders are not likely to catch more than an occasional one. The vast majority of spotted seatrout were reported caught by anglers who identified them as their target species.

If CPUEs for these priority species are calculated on the basis of all inshore trips (including those directed at "any" or other species), the resulting data series will contain large numbers of 0 observations, the estimated means will be small, and the associated variances will be large. A reasonable alternative is to base the CPUE estimates only on trips in which the species was specified as the target or included in the catch. This reduces the number of 0 observations appreciably and lowers the variances somewhat. A detracting factor is that the numbers of observations (particularly in limited treatments, such as a particular river system during a specified season) then become rather small, increasing the potential for bias due to a few large catches. In either treatment, the precision level of the CPUE estimates is not especially high and the confidence limits surrounding them are therefore rather broad. This implies that it is difficult to detect significant small differences in CPUE from one area to another, etc. Categorical comparisons of fishing success indicators (such as between areas) must be interpreted with this limitation in mind.

Statistical uncertainties notwithstanding, the Division has used the 1987 survey data in several limited applications, with emphasis on the comparative catch rates of priority species between areas. One example was an evaluation of the sound/bay closure on recreational fishing. Another was the relative success rates in various parts of the Charleston Harbor area. Since these studies are most easily interpreted as discrete units, they have been included as Appendices I and II, respectively.

Statistical reliability is one aspect of the CPUE estimates. The problem of potential bias is another detracting element. Other states (e.g. Texas) that have employed on-site creel census surveys limited to public access points have questioned the implicit assumption that the characteristics of the anglers interviewed (including their catch rates and species preferences) accurately represent those of the entire angling population. In South Carolina, a substantial

(but unknown) portion of the inshore angling population originates from private points of access. Many such fishermen also fish primarily during the week, when there is proportionally less MRFSS intercept effort. It is reasonable to question whether these fishermen target the same species and experience the same fishing success as the fishermen who are intercepted by the MRFSS. Such concerns have caused at least one state (Texas) to conduct a supplementary survey to evaluate the activities of fishermen who were not intercepted by a creel census (Ferguson and Green 1987). Such a survey may be worth considering in South Carolina.

Length Composition

Black Sea Bass - A size limit has been in effect in federal waters since 1983 (and more recently in state waters). The minimum size limit is the cornerstone of the South Atlantic Fishery Management Council's management strategy for offshore reef fish. If this strategy is to have any positive effects, two things are required: 1) released undersized fish must have a significant survival rate and 2) undersized fish must be released.

This is the species most likely to respond to a minimum size limit, since most of the catch of small fish appears to be made in fairly shallow water. If there is a low level of compliance with the regulation, then little positive benefit can be expected from it. If no positive, measurable effect can be demonstrated after a reasonable period of time, then continuation of the regulation is difficult to justify.

The level of compliance with the minimum size limit on black sea bass appears to be low, particularly in state waters.

Red Drum - Comparison of results from the 1985 surveys with those obtained during 1987 illustrates the limited practical effectiveness of a static regulation in a dynamic situation. In years when the growth rate of the fish is low and a substantial portion of the population is small, the regulation needs to be extended farther into the year. This assumes that the primary objective is to transfer a certain portion of the year's recruitment into a higher yield (in terms of individual weight) bracket. The current minimum size regulation is based on this increased yield-per-recruit objective, but the setting of fixed seasonal windows results in cut-offs (at the end of the effective period, primarily) that are sometimes inappropriate. If the true objective is increased yield-per-recruit, then the minimum size should apply year-round. Alternatively, if some trade-off with yield as measured in numbers of fish caught and retained is desired, the cut-off date should be made flexible, depending on the size distribution of fish currently available and their projected growth.

Spotted Seatrout - The minimum size limit for this species is intended primarily to enhance

the prospect that females have at least one opportunity to spawn. This assumes two factors: 1) that fishing pressure, in the absence of the size limit, significantly reduces the reproductive capacity of the stock and 2) there is a direct relationship between the number of eggs cast and subsequent recruitment. There is no factual basis to substantiate either of these assumptions.

The second condition is especially speculative, given the observed wide fluctuation in populations of spotted seatrout characteristic throughout the southeastern United States. Various Division studies in progress indicate that the level of fishing mortality on spotted seatrout in South Carolina (at least in the vicinity of Charleston) is moderate to fairly low. It certainly appears to be much higher in Louisiana, where a significant commercial fishery has long been in operation. Yet, 1986 was an exceptional year for this species throughout the southeast, with outstanding catches being reported even in areas where the species was believed to be over-fished and the spawning stock at a low level. In Louisiana, for example, the estimated recreational catch in 1984 was 1,320,000 fish (the lowest in eight years). In 1986, the estimated catch was 13,038,000, by far the highest in eight years. Much of the 1986 catch probably was produced by the 1984 year class. This casts some doubt on the existence of a strong spawner-recruit relationship for this species.

Another consideration is the generally accepted view that spotted seatrout populations are particularly susceptible to winter water temperatures. Cold winters, such as were experienced during 1976-1977 and 1977-1978, have clearly had a dramatic effect on regional seatrout stocks, resulting in much lower populations following such winters. The adverse impact of cold water temperatures likely overwhelmed any effect attributable to spawning success. The net effect was the virtual elimination of a year class, regardless of its relative strength prior to the cold water stress.

The minimum size limit does result in some transfer of yield (in weight) by promoting the harvest of fish at a larger size. Studies based on population parameters for fish in the Gulf of Mexico indicate that maximum yield-per-recruit is attained at an entry size of about 14.9 inches (Condrey et al. 1985). If this critical size is appropriate in South Carolina (and it may be lower here, given the apparently substantial difference in growth rate), then the South Carolina fishery is harvesting the bulk of the spotted seatrout catch at very close to the optimal size.

Several other factors associated with minimum size limits and spotted seatrout populations should be kept in mind. In Texas, there was no increase in the proportion of large fish in sport catches observed after the minimum size limit went into effect (Meador

and Green 1986). Prior to implementation, about 40% of the Texas landings were below the legal minimum, whereas in South Carolina about 25% of the 1987 catch appeared to be undersized. Most of the South Carolina fish appear to have been released, since only 4% of the inspected catch during July-December was less than 12.0 inches. In contrast, about 12% of the catch observed retained after the size limit went into effect in Texas was undersized and 13% of the fish seen in Florida were illegal (Meador and Green 1986).

REFERENCES

- Brusher, H.A. and B.J. Palko. 1987. Results from the 1984 and 1985 charterboat surveys in southeastern U.S. waters and the U.S. Caribbean Sea. *Mar. Fish. Rev.* 49(2): 109-117.
- Condrey, R.E., G. Adkins, and M.W. Wascom. 1985. Yield-per-recruit of spotted seatrout. *Gulf Research Reports* 8(1): 63-67.
- Ferguson, M.O. and A.W. Green. 1987. An estimate of unsurveyed coastal recreational boat fishing activity in Texas. *Mar. Fish. Rev.* 49(2): 155-161.
- Hammond, D.L. and D.M. Cupka. 1977. An economic and biological evaluation of the South Carolina pier fishery. *S.C. Mar. Res. Center Tech. Rep.* 20
- Heggnes, J. 1987. Random stratified creel surveys in three Norwegian rivers with low fishing intensities. *N.A.J. Fish. Mgt.* 7(3): 363-368.
- KCA. 1983. Socioeconomic aspects of marine recreational fishing. KCA Research, Inc., Alexandria, VA. 101 p.
- Liao, D.S. and D.M. Cupka. 1979a. Economic impacts and fishing success of offshore sport fishing over artificial reefs and natural habitats in South Carolina. *S.C. Mar. Res. Center Tech. Rep.* 38.
- Liao, D.S. and D.M. Cupka. 1979b. Socio-economic profile of South Carolina's offshore sport fishermen. *S.C. Mar. Res. Center Tech. Rep.* 34.
- Low, R.A., W. Waltz, R. Martore, and C.J. Moore. 1986. South Carolina Marine Recreational Fishery Surveys, 1985 and 1986. *S.C. Mar. Res. Center Tech. Rep.* 65.
- Low, R.A., D. Theiling, and E.B. Joseph. 1987. South Carolina marine fisheries, 1977-1986. *S.C. Mar. Res. Center Tech. Rep.* 67.
- Meador, K.L. and A.W. Green. 1986. Effects of a minimum size limit on spotted seatrout recreational harvest. *N.A.J. Fish. Mgt.* 6(4): 509-518.

- National Marine Fisheries Service. 1987. Marine recreational fishery statistics survey, Atlantic and Gulf coasts, 1986. U.S. Dep. Comm., NOAA/NMFS, Current Fish. Stat. No. 8392.
- Nichols, S. 1985. A long-term catch per unit effort index for king mackerel. U.S. Dep. Comm., NOAA/NMFS, SEFC FAD Rep. MLI-85-18. 7 p.
- Palko, B.J., L. Trent, and H.A. Brusher. 1987. Abundance of Spanish mackerel, *Scorpaenopsis maculatus*, in the southeastern United States based on charterboat CPUE data, 1982-85. Mar. Fish. Rev. 49(2): 67-90.
- Schneid, R.L. and E.E. Burgess. 1987. Marine Recreational Fisheries in the Southeastern United States: An Overview. Mar. Fish. Rev. 49(2): 2-7.
- Trent, L., B.J. Palko, M.L. Williams, and H.A. Brusher. 1987. Abundance of king mackerel, *Scorpaenopsis cavalla*, in the southeastern United States based on CPUE data from charterboats, 1982-85. Mar. Fish. Rev. 49(2): 78-90.
- U.S. Department of Commerce. 1984. Marine recreational fishery statistics survey, Atlantic and Gulf coasts, 1979 (revised)-1980. NOAA/NMFS Current Fishery Statistics 8322.
- U.S. Department of Commerce. 1985a. Marine recreational fishery statistics survey, Atlantic and Gulf coasts, 1981 - 1982. NOAA/NMFS Current Fishery Statistics 8324.
- U.S. Department of Commerce. 1985b. Marine recreational fishery statistics survey, Atlantic and Gulf coasts, 1983 - 1984. NOAA/NMFS Current Fishery Statistics 8326.
- U.S. Department of Commerce. 1986. Marine recreational fishery statistics survey, Atlantic and Gulf coasts, 1985. NOAA/NMFS Current Fishery Statistics 8327.
- Witzig, J.F. 1988. Estimation of recreational fishing trips, catch, and participation. U.S. Dep. Comm., NOAA/NMFS, Washington, D.C.

APPENDIX I

Status Report on Recreational Fishing Success in the (Southern District)

Introduction

In 1986, the General Assembly passed a resolution closing designated sounds and bays to commercial shrimp trawling. Affected areas include most of Calibogue, Port Royal, and St.

Helena Sounds in the southern district (i.e., Jasper, Beaufort, and Colleton Counties) and Bulls Bay in the central district (i.e., Charleston County).

One of the factors contributing to the closure was the assertion by some recreational fishermen that trawling had a negative impact on sport fishing catch rates. Although some anglers believe that shrimp trawlers catch significant numbers of adult recreational fishes, the principal concerns expressed by recreational fishing interests were that trawling causes the destruction of the spawning grounds, interferes with spawning of economically important fishes, and destroys large numbers of juveniles of such species (Bearden et al. 1985).

Juveniles of nearly all priority inshore sport fishes inhabit estuarine areas. According to recent Division surveys (Low et al. 1986), the most preferred inshore recreational fishes are red drum, spotted seatrout, and flounders (summer and southern). Juveniles of these species are abundant in tributaries of the sounds and bays, while small summer flounders are fairly common in the sounds and bays proper. In South Carolina, red drum and spotted seatrout are vulnerable to hook-and-line as one-year old fish, with one- and two-year olds comprising the majority of the recreational catch in inshore waters.

If the cessation of trawling in the sounds and bays has had a significant impact on recreational fishing success by reducing the mortality of pre-recruit gamefish, some indication of this could be evident in the 1987 recreational fishery, since catches would depend substantially on fish spawned during 1985 and 1986. Any such effect should be most apparent in those areas where trawling had been practiced prior to the closure, since tagging studies have shown relatively short-range movements of these species during their first several years.

This report examines recreational catch and effort data from private boat anglers obtained during 1985, 1986, and 1987, in order to determine if there are any apparent trends that can be associated with the sound/bay closure. Comparisons are made between results in the three southern sound areas and the two major geographic areas in the central part of the state. The three southern areas (i.e., Calibogue, Port Royal, and St. Helena) include tributaries of the waters that were closed to trawling by the 1986 resolution. The West Ashley area of the central district includes tributaries and waters that have been closed to trawling for many years. The East Cooper area includes waterways that lead into Bulls Bay, as well as the Bay itself, although relatively little effort included in this study occurred there. Most of the reported effort in the East Cooper category took place in tributaries not directly connected to the Bay and relatively far from it (e.g. the Cooper and Wando Rivers).

Table I-1. Distribution of 1987 sampling effort in the Southern District.

Months	St. Helena			Port Royal			Calibogue		
	Site	Inshore	Offshore	Site	Inshore	Offshore	Site	Inshore	Offshore
Jul-Aug	----- MRFSS -----								
	101	5	0	97	2	0	147	0	5
	175	14	5	114	3	0	147	2	0
	175	1	0	102	15	0	147	8	2
	175	10	4	97	14	2	147	2	0
	175	10	0	99	9	0		12	7
	175	10	2		43	2			
		50	11						
	----- MRD -----								
	175	4	1						
Totals		54	12		43	2		12	7
Sep-Oct	----- MRFSS -----								
	175	1	0	97	5	0	147	2	0
	175	0	2	109	4	0	147	11	0
	175	12	0	98	8	4	147	2	0
	175	17	3	97	13	0	147	14	1
		30	5	Unknown	8	2		29	1
					38	6			
	----- MRD -----								
				98	4	0	147	11	0
				97	2	0			
Totals		30	5		44	6		40	1
Nov-Dec	----- MRFSS -----								
	175	3	0	98	12	2	147	5	0
	175	7	0	97	8	0	92	13	0
		10	0	97	2	0	147	2	0
				97	9	0		20	0
				98	5	0			
					36	2			
	----- MRD -----								
				98	3	0			
Totals		10	0		39	2		20	0
1987 Totals		94	17		126	10		72	8

101- Sam's Point
175- Russ Point

97- E.C. Glenn
98- Port Royal
99- Battery Creek
102- Grays Hill
109- Hilton Head
114- Broad River

92- All Joy
147- Pinckney Island

Table I-2. Distribution of 1987 sampling effort in the Central District.

Months	West Ashley			East Cooper		
	Site	Inshore	Offshore	Site	Inshore	Offshore
Jul-Aug	----- MRFSS -----			-----		
	73	0	3	59	5	9
	75	3	0	168	21	9
	79	6	24	57	9	2
	60	1	20	124	0	1
	129	5	0		35	21
	79	0	7			
		15	54			
	-----			-----		
				MRD		
			168	4	0	
Totals	15	54		39	21	
Sep-Oct	----- MRFSS -----			-----		
	71	7	0	57	26	4
	73	7	0	67	3	0
	180	4	3	57	27	0
	178	1	0		56	4
	76	6	0			
	79	14	0			
	76	7	0			
		46	3			
	-----			-----		
			MRD			
178	9	0	178	1	0	
78	6	0	168	4	0	
79	2	0	57	16	0	
76	2	0	168	16	0	
	19	0		37	0	
Totals	65	3		93	4	
Nov-Dec	----- MRFSS -----			-----		
	79	2	0	168	2	0
	79	5	0	57	6	0
	79	5	0	79	2	0
	76	5	0	57	13	0
		17	0	168	15	0
				57	13	0
					51	0
	-----			-----		
				MRD		
78	5	0	57	1	0	
76	4	0				
75	5	0				
79	2	0				
178	9	0				
79	2	2				
	27	2				
Totals	44	2		52	0	

Table I-3. 1987 catch and effort data for the Southern District.

	St. Helena	Port Royal	Calibogue	Total
July-September				
Angler-trips	84	61	45	190
Total fishing hours	298.0	219.0	234.5	751.5
Total fish caught	418	459	343	1,220
Red Drum	45	60	77	182
Spotted Seatrout	33	29	35	97
Flounders	7	5	3	15
October-December				
Angler-trips	10	73	31	114
Total fishing hours	35.0	320.0	172.5	527.5
Total fish caught	23	438	353	814
Red Drum	7	136	127	270
Spotted Seatrout	0	131	87	218
Flounders	6	2	1	9
Total (July-December)				
Angler-trips	94	134	76	304
Total fishing hours	333.0	539.0	407.0	1,279.0
Total fish caught	441	897	696	2,034
Red Drum	52	196	204	452
Spotted Seatrout	33	160	122	315
Flounders	13	7	4	24
Data for fishermen targeting red drum, spotted seatrout, or flounders:				
July-September				
Angler-trips	31	25	24	80
Total fishing hours	113.5	78.5	152.0	344.0
Total fish (all 3 spp.) caught	77	65	115	257
October-December				
Angler-trips	7	64	23	94
Total fishing hours	24.5	277.0	128.0	429.5
Total fish (all 3 spp.) caught	13	251	138	402
Total (July-December)				
Angler-trips	38	89	47	174
Total fishing hours	138.0	355.5	28.0	773.5
Total fish (all 3 spp.) caught	90	316	253	659

Table I-4. 1987 catch and effort data for the Central District.

	West Ashley	East Cooper	Total
July-September			
Angler-trips	54	80	134
Total fishing hours	184.0	293.0	477.0
Total fish caught	239	645	884
Red Drum	39	275	314
Spotted Seatrout	18	97	115
Flounders	3	13	16
October-December			
Angler-trips	102	147	249
Total fishing hours	363.0	667.5	1,030.5
Total fish caught	302	694	996
Red Drum	70	185	255
Spotted Seatrout	102	266	368
Flounders	14	17	31
Total (July-December)			
Angler-trips	156	227	383
Total fishing hours	547.0	960.5	1,507.5
Total fish caught	541	1,339	1,880
Red Drum	109	460	569
Spotted Seatrout	120	363	483
Flounders	17	30	47
Data for fishermen targeting red drum, spotted seatrout, or flounders:			
July-September			
Angler-trips	16	36	52
Total fishing hours	67.0	154.0	221.0
Total fish (all 3 spp.) caught	50	272	322
October-December			
Angler-trips	71	128	199
Total fishing hours	268.5	624.0	892.5
Total fish (all 3 spp.) caught	154	422	596
Total (July-December)			
Angler-trips	87	164	251
Total fishing hours	335.5	778.0	1,113.5
Total fish (all 3 spp.) caught	204	694	918

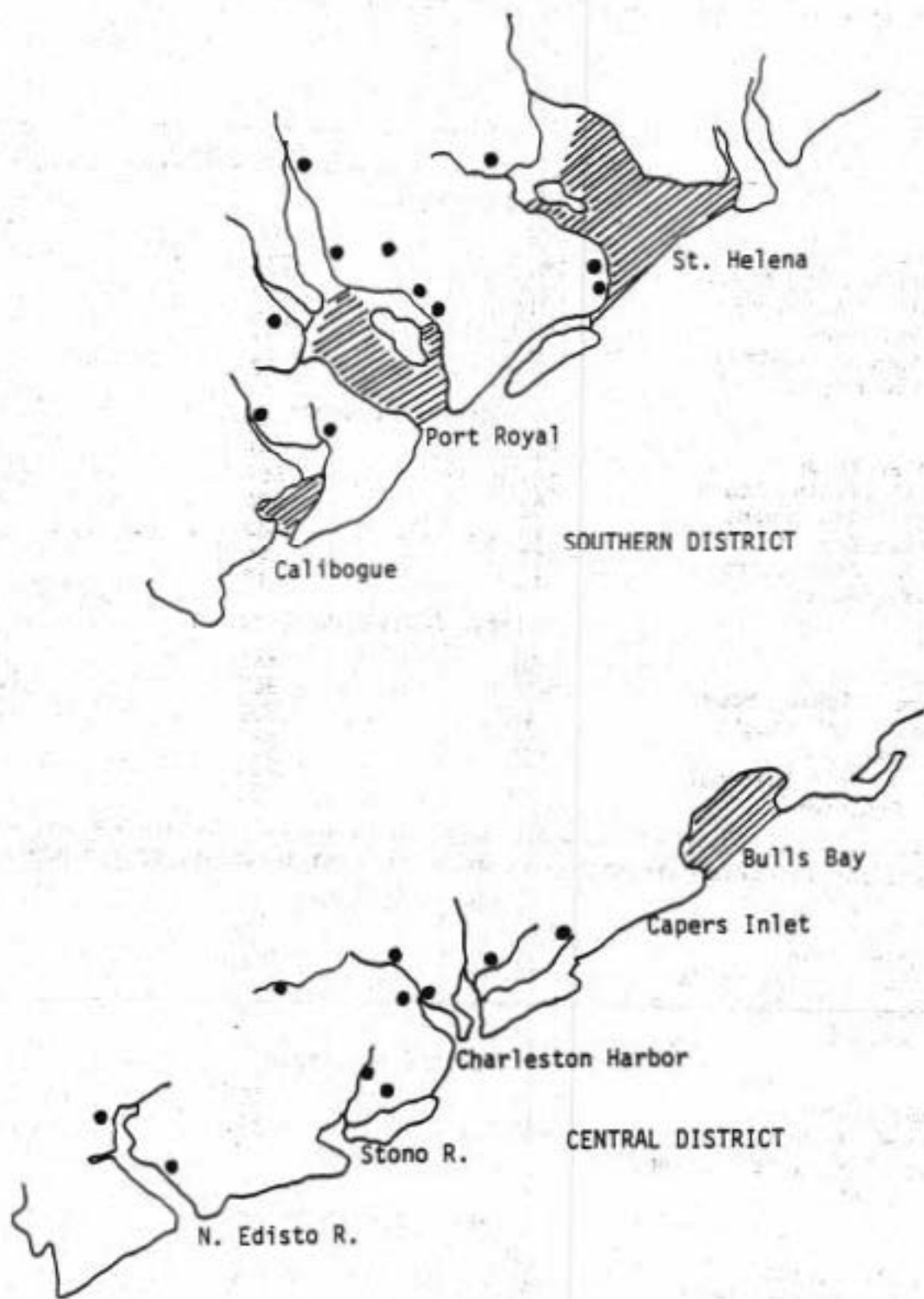


Fig. I-1. Location of interview sites in relation to areas closed by the 1986 resolution.

Methods

Data for 1985 and 1986 were obtained by the Marine Resources Division. Information was collected during a roving on-site creel census (June 1985-May 1986) and an on-site collection box survey (November 1985-December 1986). In the creel census, clerks interviewed anglers at public boat ramps as they returned from fishing. Collection boxes were posted at many of the same locations (and a few not covered during the creel census), with cards for fishermen to complete and deposit after their trip. Details of these surveys are contained in Low et al. (1986).

Data for 1987 were collected by the Division under a cooperative agreement with the National Marine Fisheries Service (NMFS). NMFS has conducted a marine recreational fisheries statistics survey (MRFSS) since 1979, primarily to obtain catch data on a regional basis. This survey also employs a roving creel census to obtain catch information, but sample sizes prior to 1987 have been too small to permit analysis at the intrastate level (e.g. between the geographic categories considered here). Distribution of the interviews has also been concentrated in a few areas (mainly the northern part of the state), with inadequate coverage elsewhere.

In 1987, the Division obtained permission from NMFS to modify the MRFS sampling design in order to obtain larger samples from a more equal geographic distribution of survey effort. The Division also conducted supplemental sampling, using the same procedures. The MRFS survey sites are computer-selected according to a long-term NMFS procedure and the Division has limited discretion in changing them. NMFS quotas also differ from season to season (being substantially larger during July-August and much reduced in November-December). The relative contribution of offshore fishermen to MRFS quotas also varies between areas and seasons. The distribution of the actual interviews obtained therefore is not equal between areas within comparable short-term intervals. Overall coverage of the various areas within the seasonal classifications assigned here is roughly equivalent for comparative purposes.

The 1987 data include figures for only those private boat fishermen who stated that they fished in inshore waters, defined by NMFS as sounds, rivers, enclosed bays, and inside inlets. Data from fishermen in coastal waters are not included. The catch and effort figures include information obtained during the Division sampling. Statistics from 1985 and 1986 probably include a few trips to coastal and offshore areas, since no distinction was made as to fishing location. This contribution is so minor as to have no appreciable influence on reported fishing success.

Table I-1 shows the distribution of actual survey effort (number of interviews) by

NMFS sampling wave in the southern district during 1987. The geographical divisions are approximate, since the exact locations of fishing activities are unknown. The groupings are based on the locations of the sampling sites and their proximity or ease of access to the sounds. Table I-2 indicates the actual distribution of interviews in the central district. Locations of fishing, particularly in the Charleston vicinity, were documented more precisely than elsewhere and the groupings are more definitive. The West Ashley area includes the southwestern side of Charleston Harbor down to Edisto Island, including the Ashley River. The East Cooper region extends from the Cooper River to McClellanville, with most of the fishing effort having occurred in the Cooper and Wando Rivers and the Intracoastal Waterway (and/or its tributaries) south of Capers Inlet.

It should be emphasized that practically all of the fishing activity addressed herein occurred in tributaries of sounds and bays, rather than in them directly. Figure I-1 is included to illustrate the significance of this.

Results

Tables I-3 and I-4 summarize catch and effort in the southern and central districts, respectively, during July-December, 1987. The lower halves refer only to statistics for those anglers who indicated specifically that they were fishing for red drum, spotted seatrout, and/or flounders. Figures for those fishermen who did not state a species preference or fished for something else are not included. The numbers of angler-trips indicated in these tables do not match the numbers of interviews in Tables I-1 and I-2 because some interviews covered effort and catches of more than one fisherman. In such cases, each angler was counted as a trip and the number of hours fished was expanded accordingly (for example, one interview might cover one angler, but the catch for a group of four; three more anglers x the number of trip-hours were then added to the total).

The percentage of the total catches accounted for by red drum, spotted seatrout, and flounders (including released fish, because of the imposition of minimum size limits in 1986) are summarized below:

	Calibogue Port	St. Royal	West Helena	East Ashley	Cooper
	<u>1987</u>				
Jul-Sep	34%	20%	21%	25%	60%
Oct-Dec	61%	61%	57%	61%	67%
TOTAL	47%	40%	22%	47%	64%
	<u>1986</u>				
Jul-Sep	--	--	--	63%	27%
Oct-Dec	--	--	--	71%	72%
TOTAL	--	--	--	66%	47%

	<u>Southern District</u>	<u>Central District</u>
	<u>1987</u>	
Jul-Sep	24%	50%
Oct-Dec	61%	66%
TOTAL	39%	58%
	<u>1986</u>	
Jul-Sep	--	51%
Oct-Dec	--	71%
TOTAL	--	59%
	<u>1985</u>	
Jul-Sep	79%	29%
Oct-Dec	97%	62%
TOTAL	90%	44%

When all species are considered in the catch, the percentages of angler-trips during which no fish were caught are summarized below:

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
1987	13%	30%	34%	30%	16%
1986	--	--	--	11%	15%

	<u>Southern District</u>	<u>Central District</u>
1987	27%	22%
1986	--	13%
1985	26%	20%

Catch rates, in numbers of fish of all species combined caught per angler per trip, were as follows:

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
	<u>1987</u>				
Jul-Sep	7.6	7.5	5.0	4.4	8.1
Oct-Dec	11.4	6.0	2.3	3.0	4.7
TOTAL	9.2	6.7	4.7	3.5	5.9
	<u>1986</u>				
Jul-Sep	--	--	--	5.1	2.5
Oct-Dec	--	--	--	4.7	2.8
TOTAL	--	--	--	4.9	2.7

	<u>Southern District</u>	<u>Central District</u>
1987	6.7	4.9
1986	---	3.8
1985	3.1	3.1

When fishing success is measured in terms of numbers of fish caught per angler per hour of fishing, the results were as listed below:

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
	<u>1987</u>				
Jul-Sep	1.5	2.1	1.4	1.3	2.2
Oct-Dec	2.1	1.4	0.7	0.8	1.0
TOTAL	1.7	1.7	1.3	1.0	1.4

	<u>Southern District</u>	<u>Central District</u>
1987	1.6	1.3
1985	0.6	0.7

Perhaps the best index of anglers' perceptions of relative fishing success is their catch rate of preferred species, in this application red drum, spotted seatrout, and flounders. Catch per effort results for these species are summarized below (includes only catches of these species by anglers who targeted one or more of the species):

Fish per Angler-Trip

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
	<u>1987</u>				
Jul-Sep	4.8	2.6	2.5	3.3	7.6
Oct-Dec	6.0	3.9	1.9	2.2	3.5
TOTAL	5.4	3.6	2.4	2.3	4.4

Fish per Hour Fished

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
	<u>1987</u>				
Jul-Sep	0.8	0.8	0.7	0.8	1.8
Oct-Dec	1.1	0.9	0.5	0.6	0.7
TOTAL	0.9	0.9	0.6	0.6	0.9

Red drum and spotted seatrout are the principal gamefish sought by inshore anglers. Catch rates of these species by anglers who targeted them are listed below for 1987:

Fish per Angler-Trip

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
Red Drum	4.1	1.7	1.3	1.0	2.3
Spotted Seatrout	2.5	1.5	0.7	1.2	1.9

Fish per Hour Fished

	<u>Calibogue Port</u>	<u>St. Royal</u>	<u>West Helena</u>	<u>East Ashley</u>	<u>Cooper</u>
Red Drum	0.7	0.4	0.4	0.3	0.5
Spotted Seatrout	0.4	0.4	0.2	0.3	0.4

Comparisons of historical catch rates are difficult because angler preferences were not recorded during some of the earlier surveys (or not known), sample sizes in the southern district were very small during some months of the early Division surveys, and survey methodologies during overlapping periods were not directly comparable. The most uniform approach is to calculate catch per unit of effort (in numbers of fish per angler-trip) as the total number of fish of the species caught divided by the total number of angler-trips during the specified interval (i.e., species preferences are disregarded). Results

obtained in this manner are summarized below:

	Red Drum	
	Southern District	Central District
Jul-Dec 1987	1.5	1.5
Jul-Dec 1986	---	0.4
Jul-Dec 1985	1.7	0.8

	Spotted Seatrout	
	Southern District	Central District
Jul-Dec 1987	1.0	1.3
Jul-Dec 1986	---	1.9
Jul-Dec 1985	0.3	0.5

In addition to interviewing anglers, creel clerks measured up to ten fish per species from an angler's catch on an opportunistic basis. Length distribution of red drum is shown in Figure 1-2 and that of spotted seatrout in Figure 1-3. A 14.0" minimum size limit was in effect for red drum during July and August, while a 12.0" minimum length applied to spotted seatrout throughout the survey. Just over half (50.3%) of all red drum measured were less than 14.0", nearly all of which were legal fish taken after 31 August, in catches from the southern district. In the central district, the corresponding figure was two-thirds (67.1%) of the total catch. About 8.5% of the fish measured in the southern area exceeded 18.0", while 12.9% of the red drum in the central district were larger than 18.0". About 6% of the spotted seatrout measured in the southern district were undersized (less than 12.0") and 5% of those in the central district were in this category.

Discussion

It must be emphasized that the three source surveys were not identical in methodologies, which necessitated somewhat different treatments of catch/effort data from each. The approaches that were taken were intended to maximize the level of comparability between the results for the different years (and surveys).

It should also be kept in mind that nearly all of the fishing activity reported on during all years did not take place in areas directly affected by the 1986 closure (i.e., the shaded areas in Figure 1-1). Most anglers indicated that they were fishing in tributaries of variable proximity to the closed areas. Recent tagging work by Division personnel has indicated that red drum and spotted seatrout do not travel extensive distances during their first year or two, a finding that conforms with previous work done on these species elsewhere in their range.

The relative contribution of preferred species (i.e., red drum, spotted seatrout, and flounders) to total catches was highly variable between areas and seasons, although somewhat consistent within areas and seasons between years. During the fall (October-December), which is the peak season for red drum and spotted seatrout, percentage

contribution was quite uniform over all areas in 1987, as was also the case in the central district in 1986. Catches during the summer (July-September) were much more variable; the contribution of red drum is the major influence during this season. When compared to previous years, the percent contribution of preferred species in the southern district was lower in 1987, while in the central district it was about the same.

During 1987, the percentage of fishermen who reported no catch varied widely from area to area, but tended to be highest from Port Royal Sound to the southwestern shore of Charleston Harbor; it was substantially lower in the Calibogue and East Cooper regions. When compared on a district-wide basis with previous years, there was virtually no change in the southern district, while the percentage of unsuccessful trips was up slightly in the central area.

Catch rates for all species combined varied substantially from area to area during 1987, particularly during the fall. Catch rates were generally highest in the Calibogue Sound vicinity, followed by the Port Royal Sound area. In the central district, they were substantially higher in the East Cooper area. Fishing success was consistently lowest in the area from St. Helena Sound to Charleston Harbor. Compared to past years, catch rates from all species combined on a district-wide basis were up in both districts, but more so in the southern area. These conclusions apply to catch rates measured both in fish per trip and fish per hour fished.

The most important index of fishing success for most anglers is probably the relative catch rate of preferred species. In 1987, catch rates of red drum, spotted seatrout, and flounders combined were very uniform during the summer, when measured in fish per hour fished. The exception was the East Cooper area, wherein angling success was much greater. During fall 1987, catch rates (in fish per hour fished) were highest in the Calibogue-Port Royal areas, and rather consistent but lower elsewhere. For the entire survey period, catch rates (in fish per hour fished) were highest and virtually identical in the Calibogue, Port Royal, and East Cooper areas. In the St. Helena and West Ashley areas, catch rates were about the same, but somewhat lower than in the other areas.

Historical comparisons of catch rates for red drum and spotted seatrout must be based on slightly different methods of calculation, because of different survey methodologies. They suggest that fishing success for red drum in the southern district was slightly lower in 1987 than in 1985, while that in the central district was considerably greater than in the previous two years. For spotted seatrout, catch rates in both districts during 1987 were substantially higher than during 1985. There are insufficient data for the southern district to calculate a value for 1986. In the central district, the catch rate for

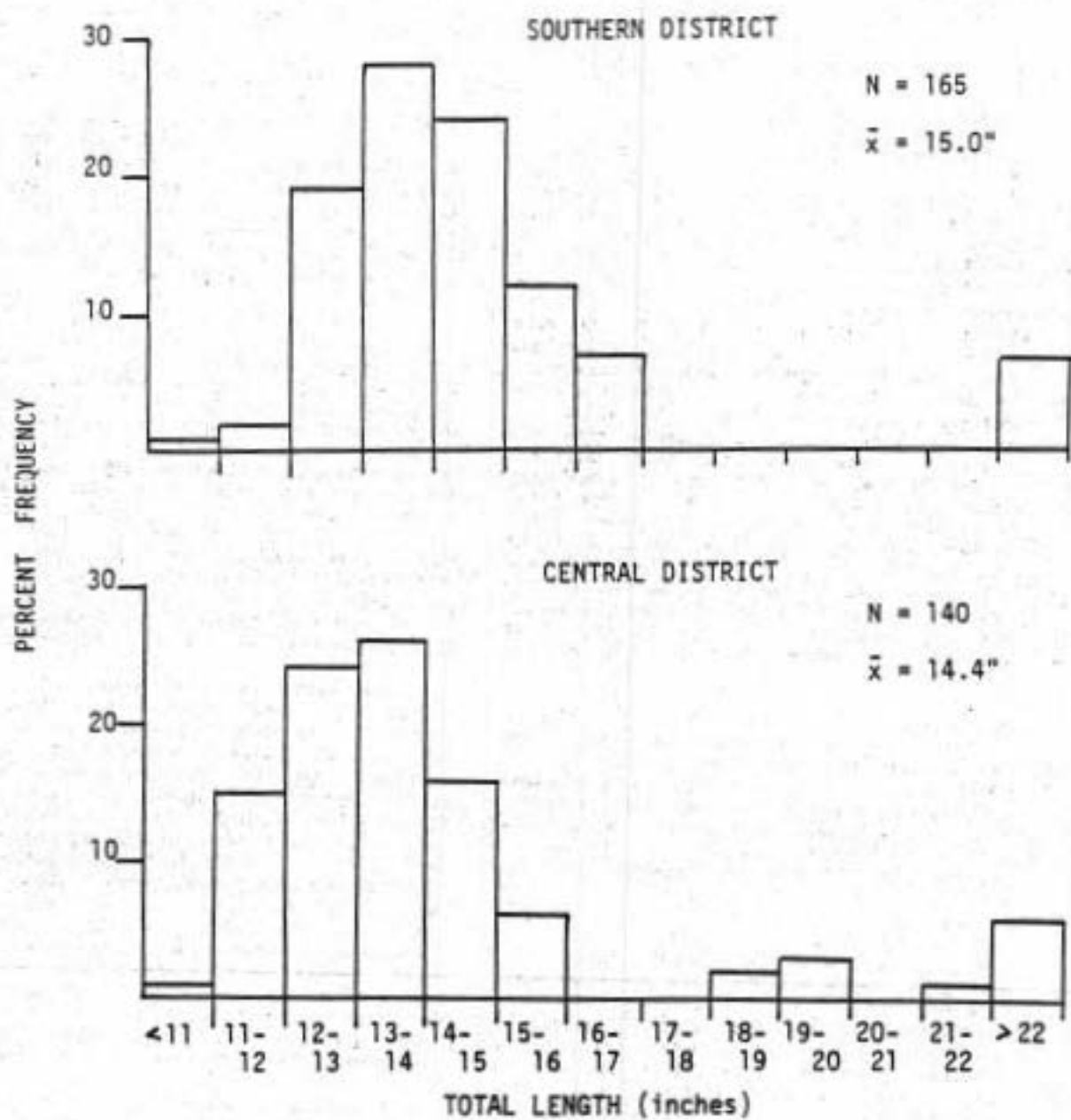


Fig. I-2. Length distribution of red drum, July-December 1987.

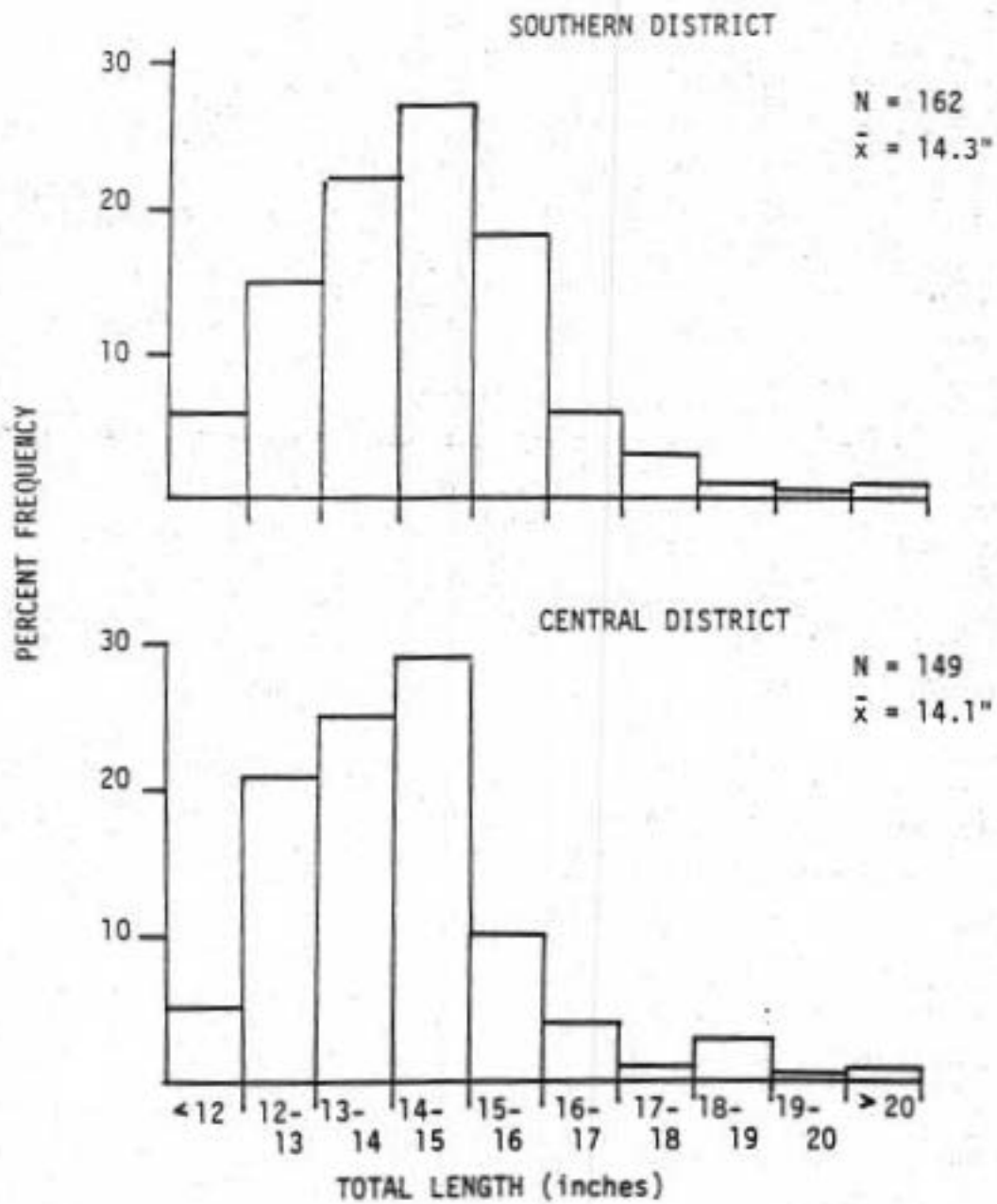


Fig. I-3. Length distribution of spotted seatrout, July-December 1987.

seatrout in 1986 was considerably above that reported in 1987. This is to be expected, since 1986 was generally an excellent year for this species throughout its range, as well as in South Carolina.

Length composition of both red drum and spotted seatrout catches was virtually identical in each district in 1987. The composition of red drum catches showed no substantial differences from that observed in 1985, after allowances are made for the size limit. The modal length for seatrout (14-15") was the same in both districts in 1987 and comparable to that observed statewide in 1985.

Apparent changes in the various parameters used here to evaluate relative fishing success can be graphically summarized as follows; the direction of the vectors indicates the direction of change in the specific parameter value in 1987 from previous years:

Parameter	Southern District
% contrib. preferred species (i.e., red drum, spotted seatrout, and flounders)	↓
% unsuccessful trips (i.e., those with no catch)	↔
Catch rate (fish/trip) for all species combined	↑
Catch rate (fish/hour fished) for all species combined	↑
Catch rate of red drum (fish/trip)	↓
Catch rate of spotted seatrout (fish/trip)	↑
Length dist. red drum	↔
Length dist. spotted seatrout	↔

Parameter	Central District
% contrib. preferred species (i.e., red drum, spotted seatrout, and flounders)	↔
% unsuccessful trips (i.e., those with no catch)	↑
Catch rate (fish/trip) for all species combined	↑
Catch rate (fish/hour fished) for all species combined	↑
Catch rate of red drum (fish/trip)	↑
Catch rate of spotted seatrout (fish/trip)	↓
Length dist. red drum	↔
Length dist. spotted seatrout	↔

In each district, there have been no significant changes in three parameters. In the southern district, two parameters have shown a downward trend, compared to one in the central district. The most important parameters are probably 1) percentage of trips with no catch, 2) catch rate of red drum, and 3) catch rate of spotted seatrout. For the first (no catch), the increase shown for the central district reflects a rather small percentage increase. Opposite trends by district are reflected for the other two.

In conclusion, the differences in catch rates between areas indicated in these results could reflect differences in fishing pressure (greater in the Charleston and Port Royal-Beaufort metropolitan areas) as much, or more, than any other factor. Annual variability in abundance of red drum and spotted seatrout is well-known, although the specific biological mechanisms have yet to be quantified. One would expect abundance to therefore vary similarly (i.e., up or down) from area to area, but this may not be reflected in catch rates due to the above-mentioned differential effort factor. In any event, there is no obvious relationship between the cessation of trawling in closed areas with fishing success in proximal tributaries that can be identified from these data.

LITERATURE CITED

- Bearden, C., R. Low, R. Rhodes, R. Van Dolah, C. Wenner, E. Wenner, and D. Whitaker. 1985. A review and analysis of commercial shrimp trawling in the sounds and bays of South Carolina. S.C. Mar. Res. Ctr., Tech. Rept. 61.
- Low, R.A., W. Waltz, R. Martore, and C.J. Moore. 1986. South Carolina marine recreational fishery surveys, 1985 and 1986. S.C. Mar. Res. Ctr., Tech. Rept. 65.

APPENDIX II

Status Report on Recreational Fishing Success in the Charleston Harbor Area

This report contains a brief summary of results from interviews of private boat anglers obtained during the 1987 cooperative NMFS/SC Marine Recreational Fishery Statistics Survey (MRFSS) and supplemental Division sampling. The sampling period extended from July through December.

Methods

Private boat fishermen were interviewed at boat launching facilities as they returned from their fishing trips. About 60% of the interviews were scheduled for weekends and 40% for weekdays. Nearly all interviews were obtained between the hours of 1000 and 1800

and none were collected at night.

The standard 1987 MRFSS Finfish Intercept Questionnaire was the survey instrument for most interviews. An abbreviated Division sampling form was used during some of the supplemental Division interviews. Regardless of the questionnaire employed, the creel clerks asked anglers to specify the general area in which they had done most of their fishing. With few exceptions, the indicated locations corresponded to the immediate area of the launching facility (e.g. fishermen interviewed at Remleys Point nearly always had fished in either the Wando or Cooper Rivers or that portion of the harbor near the Cooper River bridges). The geographic areas and their principal interview sites are indicated in Figure II-1. Data were pooled for these fairly extensive areas in order to obtain minimally satisfactory sample sizes, while still maintaining some logical basis for separation by river system.

Catches include all fish reported landed, including those released or otherwise unavailable for inspection by the creel clerks. Catch rate (CPUE) data, measured in numbers of fish per angler-trip, include released fish and those that were discarded. All-species estimates are based on all trips and total catches. CPUE estimates for red drum and spotted seatrout are based only on data for trips in which the species was either targeted or reported caught. Data included here pertain only to trips made in the inshore waters included in the geographic categories indicated; they do not include trips to coastal waters, e.g. the Charleston jetties or the Morris or Capers Island surf.

Results

Table II-1 summarizes the distribution of sampling observations and relative distribution of fishing effort. Relative fishing success by geographic area is shown in Table II-2.

Table II-3 lists the species preferences, equivalent to target species. Species composition of the actual catches (including fish reported released or discarded) is shown in Table II-4.

There were too few fish of priority species measured in the various areas to permit meaningful comparisons of length composition of the catches. For the entire Charleston area, the average size of both red drum and spotted seatrout was slightly smaller than that of fish caught elsewhere.

Discussion

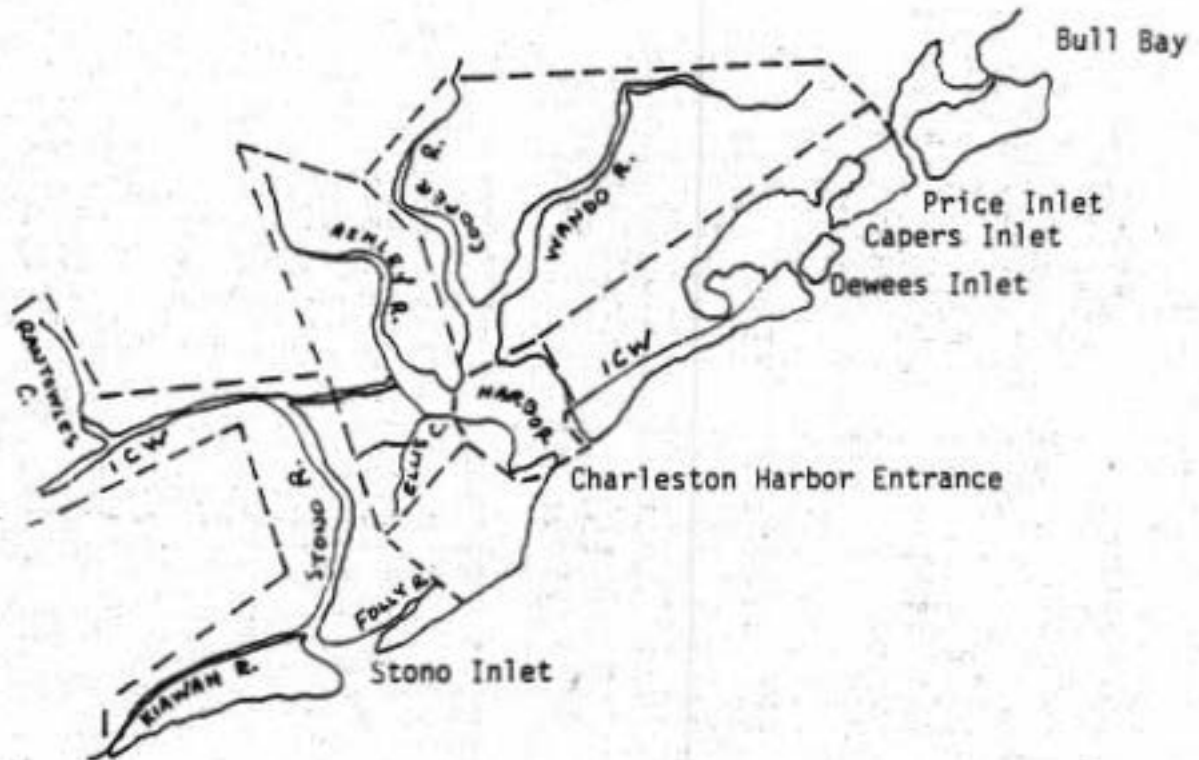
Sample sizes are rather small in most of the areas and the variances associated with catch rates are uniformly very large, so no rigorous statistical analysis was performed. It should be intuitively obvious that the results should be interpreted with caution and that any apparently significant statistical differences may have little practical meaning under these circumstances. The main value of

these findings is descriptive.

The percentages of anglers who specified no preference (i.e., targeted "any") were higher in the more southwestern areas (33% in the harbor, 35% in the Ashley River area, and 36% west of the Ashley). The percentages of anglers reporting no fish caught were also highest in these areas. This suggests that the level of expertise among the general angling population here may be somewhat lower than that of fishermen who fish in the Cooper and Wando Rivers and the rest of the East Cooper areas. The relative fishing success for priority species in the various areas also indicates that this is probably the case. An alternative explanation is that a larger portion of the angling population who fishes west of the Ashley prefers general bottom fishing, whereas fishermen in the East Cooper area are more oriented toward selective angling for popular sport species.

In terms of percent composition of the total catch, red drum were considerably more important in the East Cooper areas than west of the Ashley, while spotted seatrout were better represented in catches from the latter areas. Catch rates for both of these priority species were substantially higher in the Wando and Cooper Rivers than in any other area.

When viewed in the overall sense (i.e., with catch rates of priority species, overall fishing success, relative contribution of priority species, and species diversity), the Ashley River appears to be the least productive area for local fishermen. The highest failure rate was reported there and the species diversity of the reported catch was substantially less. The overall catch rate (i.e., for all species combined) was considerably lower (about 46% of that in the next lowest area) than elsewhere. The fishing success for red drum appears to be much lower in the Ashley River than anywhere else.



Dewees/Capers
ICW

Wild Dunes

Wando/
Cooper R.

Paradise Island
Remleys Point

Harbor

City Marina

Ashley R./
Ellis Creek

Wappoo Cut
County Farm

Folly/
Stono R. ICW

Folly River
Battery Island
Limehouse
Bulow Ldg.

Fig. II-1. Geographic areas and principal launching sites. Boundaries are indicated by the dashed lines.

Table II-1. Numbers of interviews and relative effort by fishing area, July-December 1987.

	Dewees/ ICW	Wando/ Cooper	Harbor	Ashley/ Ellis	Folly/ Stono
Interviews	58	114	28	33	51
Anglers	95	126	30	46	69
Total hours of fishing	340.5	593.5	101.0	156.5	255.5
Average trips/ angler during previous two months	6.5	6.1	6.0	10.0	8.0

Table II-2. Catch rates of private boat fishermen by geographic area. CPUE data are in numbers of fish per angler-trip and have been calculated as average-of-ratios statistics.

	Dewees/ ICW	Wando/ Cooper	Harbor	Ashley/ Ellis	Folly/ Stono
Percent of anglers reporting no fish caught	13%	17%	40%	50%	34%
All-species CPUE	3.5	7.6	3.5	1.6	4.0
Red Drum CPUE	2.1	5.0	2.2 ^a	0.9 ^a	1.8
Spotted Seatrout CPUE	1.0	3.8	1.2 ^a	3.2 ^a	1.6

^a Based on < 20 observations

Table II-3. Species preferences (i.e., target species) of private boat fishermen by fishing area, July-December 1987.

	Deweese/ ICW	Wando/ Cooper	Harbor	Ashley/ Ellis	Folly/ Stono
Red Drum	31	Spotted Seatrout	58	Any	10
Any	24	Red Drum	41	Spotted Seatrout	19
Spotted Seatrout	21	Any	25	Any	16
Flounders	10	Flounders	1	Red Drum	11
Spot	5		Seatrout		
Sharks	3		Black Sea Bass		
Kingfishes	1		Sharks		
			Bluefish		
			Flounders		
					Sheepshead
					2

Table II-4. Total catch of private boat fishermen by fishing area, July-December 1987. Numbers of released fish are shown in parentheses.

	Deweese/ ICW	Wando/ Cooper	Harbor	Ashley/ Ellis	Folly/ Stono
Red Drum	99(47)	Red Drum	380(45)	Red Drum	33(8)
Sharks	61(48)	Spotted Seatrout	335(106)	Croaker	13(3)
Catfish	28 (8)	Pinfish	83 (55)	Spotted	64(7)
Kingfishes	27 (0)	Croaker	28 (22)	Red Drum	14(0)
Croaker	24 (6)	Spot	23 (15)	Catfish	5(2)
Pinfish	23 (6)	Catfish	19 (19)	Jack	
Spotted Seatrout	21 (0)	Flounders	11 (4)	Crevalle	2(2)
Spot	20 (5)	Black Drum	9 (0)	Flounders	1(0)
Flounders	19 (0)	Jack Crevalle	8 (8)	Silver Perch	1(1)
Sheepshead	3 (0)	Rock Sea Bass	3 (0)	Total	87(12)
Weakfish	2 (0)	Toadfish	3 (3)		
Black Sea Bass	2 (1)	Silver Perch	3 (1)		
Bluefish	1 (1)	Rays	2 (2)		
Pigfish	1 (0)	Bluefish	1 (0)		
Spadefish	1 (0)	Pigfish	1 (0)		
Mullet	1 (1)	Sheepshead	1 (0)		
Total	333(123)	Total	910(280)		
				Total	106(32)
					Spot
					52(0)
					Spotted
					Seatrout
					46(17)
					Red Drum
					38(4)
					Pinfish
					32(17)
					Catfish
					24(24)
					Jack
					Crevalle
					24(24)
					Silver
					Perch
					11(0)
					Weakfish
					8(0)
					Kingfishes
					8(0)
					Croaker
					7(2)
					Flounders
					5(2)
					Sharks
					4(4)
					Sheepshead
					3(0)
					Eels
					2(1)
					Toadfish
					2(2)
					Black Drum
					2(0)
					Rays
					1(1)
					Rock Sea
					Bass
					1(0)
					Total
					270(98)