SURVEY OF THE SOUTH CAROLINA SHRIMP BAITING FISHERY 1989

R. A. Low

South Carolina Wildlife and Marine Resources Department

Marine Resources Center

Charleston, South Carolina

Technical Report Number 73

January 1990

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

Mel Bell, Beth Hens, David Liao, Dale Theiling, Wayne Waltz, Betty Wenner, and David Whitaker contributed to the development of the project approach. Joe Carson and licensing personnel assisted with the distribution of the preseason questionnaire. Wyatt Coon and computer section personnel provided address labels and a list of permit holders by county of residence. Mark Brooker assisted with compilation of data from the preseason questionnaire, mailing of the postseason survey, and was the Charleston County creel clerk. Elease Smith contributed significantly as the Beaufort County creel clerk. Charlie Zemp was the administrative liaison in Beaufort. The many shrimpers who took the time to cooperate with the various survey efforts are sincerely appreciated. The survey was funded with proceeds from the sale of 1989 shrimp baiting permits.

ABSTRACT

Information on the 1989 shrimp baiting fishery was obtained through an on-site creel census and a postseason mailout survey. The creel census took place at heavily utilized public access points from early October through the end of the season (13 November) in Beaufort and Charleston Counties. A total of 348 interviews was obtained. The postseason questionnaire was mailed to 45% of the 6,644 permit holders. The return rate as of the end of the designated five-week response period was 34%. An additional 5% was received afterwards.

Compared to the 1988 season, there was a 21% increase in the number of permit holders, but only an 8% increase in those (N = 5,469) who actually shrimped. Overall participation (N = 17,171 individuals) declined about 3% and total effort (31,337 - 31,911 trips) was down about 10%. The overall average catch rate (26.5 quarts of whole shrimp per boat trip) was 19% higher and the total harvest (approximately 1.25 million pounds of whole shrimp) was up about 8%. This catch represented about 24% of the total white shrimp harvest, compared to 31.5% in 1988. The average catch per participant was about 10% more than in 1988. Most shrimping took place in Charleston and Beaufort Counties, with relatively less effort in the Charleston area than in 1988.

Shrimpers spent an estimated minimum of $756,000 for permits and expenses directly related to their trips, making the average cost of shrimp harvested about $0.60/pound. The catch was worth about $3.75 million.

The impact of Hurricane Hugo was most obvious from Wadmalaw Island north. Statewide, nearly 18% of the permit holders did not go shrimping, compared to 8% in the previous year. Most of the nonparticipation was among residents of Charleston County (29% did not go) and the Berkeley/Dorchester area (24% of these permit holders did not participate). Had it not been for the storm, it is projected that participation would have been 25% higher, effort 42% greater, and total catch about 1.77 million pounds. The total direct economic impact of the storm on the fishery was estimated at about $1.77 million.

Other than hurricane-related factors and weather, shrimpers reported few problems. About 29% of those who commented on management of the fishery felt no changes were necessary. The same percentage wanted a longer season. Many shrimpers felt that the season should have been extended due to the hurricane and thought that the Marine Resources Division should be granted the authority to make such in-season adjustments. The setting of the limit by boat rather than according to the number of permit holders in it was another major concern; shrimpers wanted to be allowed one limit per permit holder. In general, other comments were very similar to those made following the 1988 season.

ACKNOWLEDGEMENTS

Mel Bell, Beth Hens, David Liao, Dale Theiling, Wayne Waltz, Betty Wenner, and David Whitaker contributed to the development of the project approach. Joe Carson and licensing personnel assisted with the distribution of the preseason questionnaire. Wyatt Coon and computer section personnel provided address labels and a list of permit holders by county of residence. Mark Brooker assisted with compilation of data from the preseason questionnaire, mailing of the postseason survey, and was the Charleston County creel clerk. Elease Smith contributed significantly as the Beaufort County creel clerk. Charlie Zemp was the administrative liaison in Beaufort. The many shrimpers who took the time to cooperate with the various survey efforts are sincerely appreciated. The survey was funded with proceeds from the sale of 1989 shrimp baiting permits.

INTRODUCTION

The history of shrimp baiting in South Carolina was described by Theiling (1988). The first study of this fishery was done in 1987 and consisted of an on-site creel census of boating participants combined with a postseason mailout survey of registered boat owners (Theiling 1988). Public boat ramps in coastal counties were categorized according to suspected usage and were sampled during the creel census, with emphasis directed at the most heavily used sites. Usable interviews were obtained at 33 locations. The creel clerks spent an average of 25 hours (five to six nights) per week at the landings from 9 September until 9 December. A postcard mailout was made in mid-December to assess the use of boats. Owners of registered boats in the 12-20 ft category constituted the sampling universe and the questionnaire was sent to 12,000 individuals, stratified by residence (coastal counties, other counties). Results were used to estimate participation (6,406 boats and 21,735 persons) and catch (1.8 million pounds of whole shrimp) during mid-August through December, 1987.

The General Assembly passed the Shrimp Baiting Act in 1988, which established a 60-day season between 1 September and 15 November, limited the number of poles (ten) used to mark bait, placed a 48-quart (whole shrimp) limit per boat per day, and required at least one participant per boat to possess a permit and pole tags. This provided the means to directly survey the participants via a postseason mailout survey to all permit holders (5,509 individuals). Based on responses from 63% of this group, it was estimated that 17,749 participants made 35,609 boat trips and caught 1.16 million pounds of whole shrimp in the 1988 season (Waltz and Hens 1989).

In 1989, the fishery was surveyed using a combination of methods from the earlier efforts. One limitation of the 1988 survey was the lengthy recall period over which respondents were asked to estimate their catch rates. These estimates could not be independently corroborated because there was no on-site creel census. The accuracy of the 1987 mailout survey was limited because only a small part of the sampled population of registered boat owners consisted of shrimp baiters. The 1989 survey consisted of an on-site creel census combined with a postseason mailout to a subsample of permit holders and included questions that addressed socioeconomic aspects of the fishery in addition to participation, effort, and catch. Specific objectives were as follows:

1) estimate total effort in number of trips by permit holders
2) estimate total participation by permit holders and their assistants
3) estimate total catch of shrimp and retained fish bycatch
4) estimate total direct economic expenditures associated with trips
5) estimate the total ex-vessel equivalent value of the shrimp catch
6) develop a socioeconomic profile of permit holders

7) identify areas most heavily used by shrimp baiters

METHODS

The survey consisted of 1) an on-site creel census at heavily used public boat ramps and 2) a postseason mailout survey to a subsample of permit holders. The creel census was employed to obtain catch rate estimates during specific intervals, information on gear and areas fished, effort data, catch data (size of shrimp and retained fish bycatch), and socioeconomic information relevant to specific trips and areas. The mailout survey was used to determine the extent of participation by permit holders, obtain seasonal effort and catch estimates, and collect socioeconomic data regarding the permit holders. Some of the questions asked during each component were designed to be interlocking so as to cross-check information for potential bias.

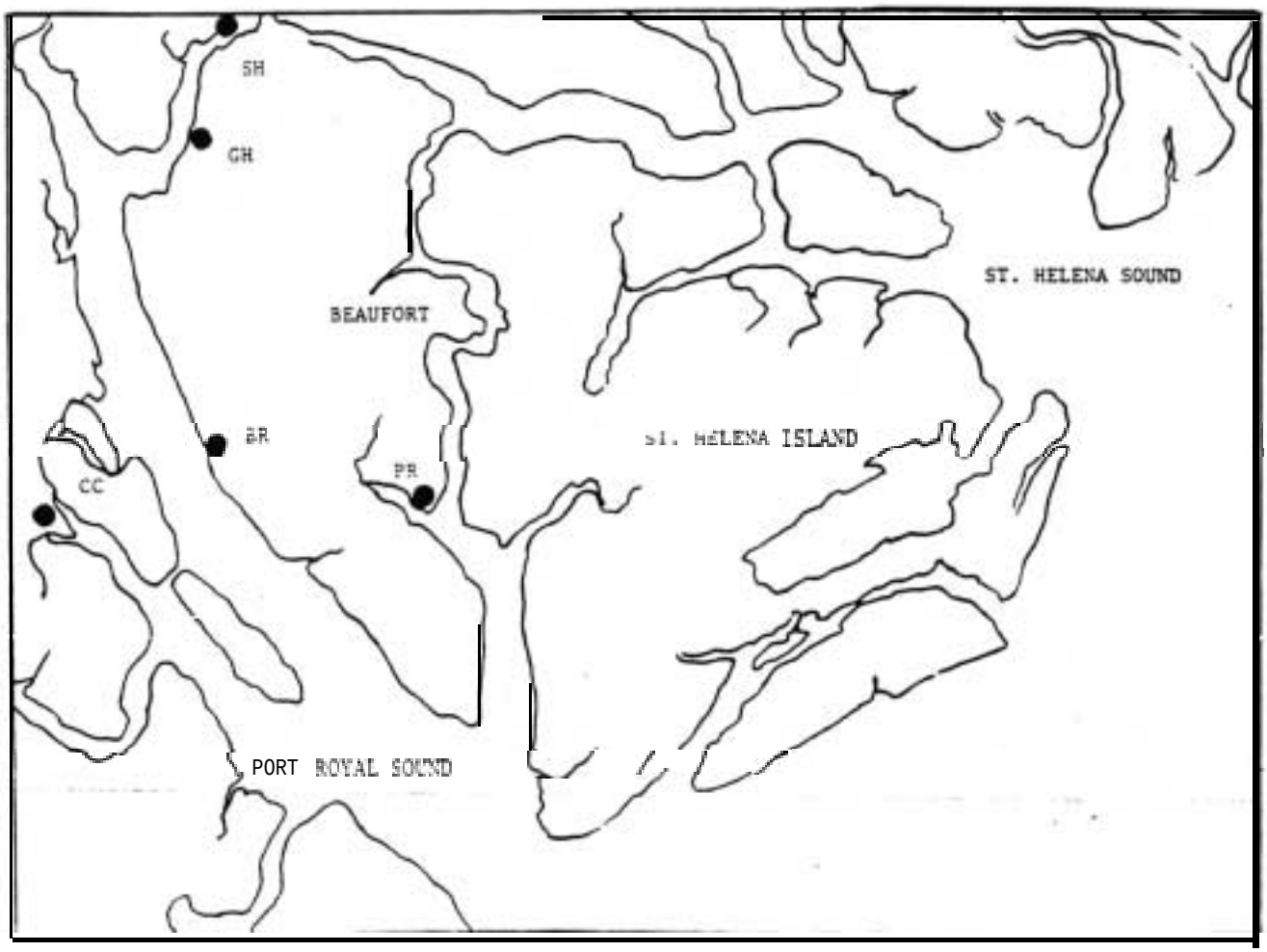
In the creel census, the survey area was divided into two components, Charleston and Beaufort Counties, with one creel clerk assigned to each. No field effort was allocated north of Charleston Harbor because of low interception rates experienced in the 1987 field survey and the impact of Hurricane Hugo, which was most severe north of Charleston. Six sites in each area were selected based on the average numbers of interviews per sampling night obtained during the 1987 survey, as well as geographic distribution. Creel clerks scheduled their nightly site visits as weather, tides, and personal considerations warranted, with a target level of five nights (20 hours exclusive of travel time) on-site each week. The initial schedule was designed so that each site would be visited an equal number of times during the ten-week season.

Because of Hurricane Hugo, which struck the Charleston area the night of 21 September, the original sampling schedule was substantially modified following the storm. After sampling during the first weekend of the season (which opened at 12:01 AM on 15 September), field work in the Charleston area did not resume until 9 October. This delay was caused by 1) poor communications between survey personnel due to disrupted phone service, 2) limited or no access to some sample sites (e.g. Remleys Point, which was commandeered for disaster assistance work, and Folly River, which was off limits to nonresidents of the immediate area), 3) a nighttime curfew in the Charleston area that extended into early October, and 4) very limited shrimping effort due to the curfew, blocked access points, poor water quality in many shrimping areas, lack of power in many residential areas, difficulty in local travel, and probable lack of interest by local residents impacted by the storm. Although the Beaufort area and south Charleston County received virtually no damage from the storm and shrimping there resumed immediately after it, field work in the Beaufort area did not begin until 6 October because of communication problems and personnel considerations. The creel census site list was further altered based on inseason observations of the distribution of shrimping effort. Actual field effort was distributed as indicated in Table 1 at the sites shown in Figs. 1 and 2.

The field survey instrument (Appendix 1a) solicited

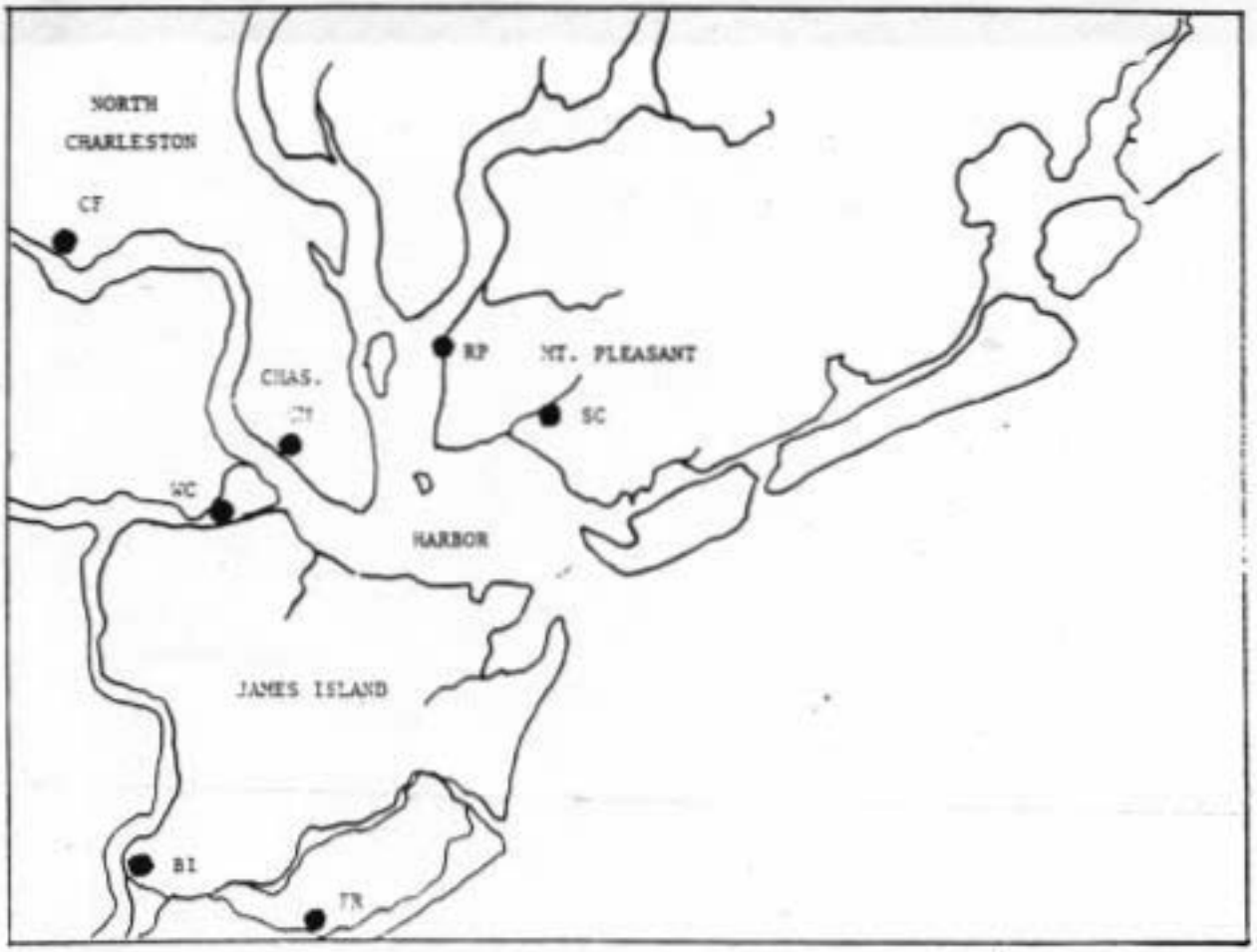
Table 1. Distribution of sampling effort during the creel census.

Month	Site	Number of visits	Number of interviews
		Charleston County	
September	Wappoo Cut	2	16
	Battery Island	1	0
	Folly River	1	0
	Remleys Point	1	0
October	Shem Creek	6	25
	Battery Island	6	8
	Wappoo Cut	10	14
	Remleys Point	6	11
	County Farm (Leeds Ave.)	4	0
	City Marina	2	2
November	Shem Creek	5	23
	County Farm	1	0
	City Marina	1	1
	Battery Island	4	13
	Wappoo Cut	4	8
	Folly River	3	6
	Remleys Point	2	4
		Beaufort County	
September	Gray's Hill	1	1
October	Gray's Hill	8	55
	Sheldon	3	22
	E.C. Glenn (Chechessee)	5	31
	Broad River	5	22
	Eddings Point	1	0
	Port Royal	6	4
	Lands End	2	3
November	Port Royal	2	5
	Gray's Hill	2	30
	Broad River	2	19
	Sheldon	1	0
	E.C. Glenn	2	25



SH - Sheldon
GH - Gray's Hill
BR- Broad River
cc- E.C. Glenn/Chechessee
PR- Port Royal

fig. Location of boat landings surveyed in Beaufort County. Not shown are Eddings Point and Lands End.



CF - County Farm
CM - City Marina
WC - Wappoo Cut
BI - Battery Island
FR - Folly River
RP - Remleys Point
SC - Shem Creek

Fig. 2. Locations of boat landings surveyed in Charleston County.

information directly related to the trip just completed by the participant(s). When feasible, the clerk asked the participants their estimate of what they had caught, then measured the interior dimensions of standard containers (coolers) and the depth of the contents. Contents were categorized as 1) whole shrimp, 2) headed shrimp, 3) with or without ice, and 4) culled or not culled. The latter referred to whether or not the shrimpers had saved all shrimp caught or selectively retained shrimp. For catches not retained in standard containers, the clerk visually estimated the volume (quarts) of the catch. The clerk also measured (total length from tip of rostrum spine to tip of telson) up to 15 randomly selected shrimp per catch on an opportunistic basis.

In evaluating the field catch data, all catches were converted to quarts of whole shrimp without ice, based on the dimensions recorded. One quart was considered equivalent to 57.75 cu. in. of whole shrimp without ice. Based on conversion data in Theiling (1988), a quart of headless shrimp was multiplied by 1.5 to obtain the volume of whole shrimp and a catch with ice was multiplied by 0.85 to convert it to the equivalent without ice. All catch data used for catch rate analysis were based on converted values (i.e., quarts of whole shrimp without ice).

A preseason questionnaire (Appendix 1b) was used to evaluate projected reaction of respondents to the socioeconomic questions planned for the postseason mailout, since this type of information had not been solicited in previous surveys and the degree of negation reaction (and its impact on return rates) was speculative. This questionnaire was provided at the Ft. Johnson license office for permit applicants who wished to voluntarily complete it. It was also sent to a subsample of shrimpers who applied by mail for their permits. In order to test the assumption that the use of quality materials improves response rate (Linsky 1975, Dillman 1978), part (N = 318) was sent in printed self-addressed envelopes and the remainder (N = 510) in rubber stamped envelope. Response rates were then used to project the probable range of response rates to the postseason questionnaire.

The final stage of the survey consisted of the postseason mailout (Appendix 1c), sent by first-class mail with printed, self-addressed envelopes to 45% (2,968) of the 6,644 permit holders immediately following closure (at midnight on 13 November) of the season. Based on the 1988 survey variances, the sample size needed to estimate mean effort with a 95% probability of being within +/- 5% of the true mean is about 1,000. Based on the responses to the preseason mailout (27.8% to the rubber-stamped component, 41.5% to the printed section, average 32.6% overall), this mailout would provide the target level of responses. The mailout was stratified by county of residence based on the percentages of 1988 permit holders in each category (82% to coastal residents - Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Hampton, Horry, Jasper Counties and 18% to noncoastal residents of other counties).

The postseason mailout was a one-step procedure, with no subsequent mailouts to address potential nonresponse bias. Based on results from the 1988 survey, it was considered that any fine-tuning based on follow-up mailouts was not worth the considerable

additional expense. The most important parameter being estimated was the number of boat trips made by each permit holder and the 1988 survey found no statistically significant difference between mailout groups in this value. The 1988 results did indicate statistically significant differences for mailout groups in the number of assistants per permit holder and the average season catch estimate, but the magnitude of the actual values (-9% for assistants, -6% for catch) was considered to be of little practical consequence given the potential amount of sampling error associated with the estimates.

RESULTS

Creel Census

Creel census logistics for the Charleston area were as follows for those sites where interviews were obtained:

Site	Number of interviews	Hours on-site	Interviews/hour
Shem Creek	48	21.5	2.2
Wappoo Cut	38	18.0	2.1
Remleys Point	15	9.5	1.6
Folly River	6	5.5	1.1
Battery Island	21	20.0	1.0
Chas City Marina	3	3.5	0.9

A total of 131 interviews was obtained during 78 hours of on-site sampling. Associated travel time was 21 hours, involving 818 miles. The total cost per interview was $6.60.

In the Beaufort area, the creel census logistics were:

Site	Number of interviews	Hours on-site	Interviews/hour
Chechessee	56	10.0	5.5
Gray's Hill	86	21.5	4.0
Sheldon	22	7.0	3.3
Broad River	41	15.5	2.7
Lands End	3	3.5	0.9
Port Royal	9	12.5	0.7

Total on-site hours were 73, with associated travel time of 48 hours and 2,291 miles. The total cost per interview was $6.14, with 217 interviews being obtained.

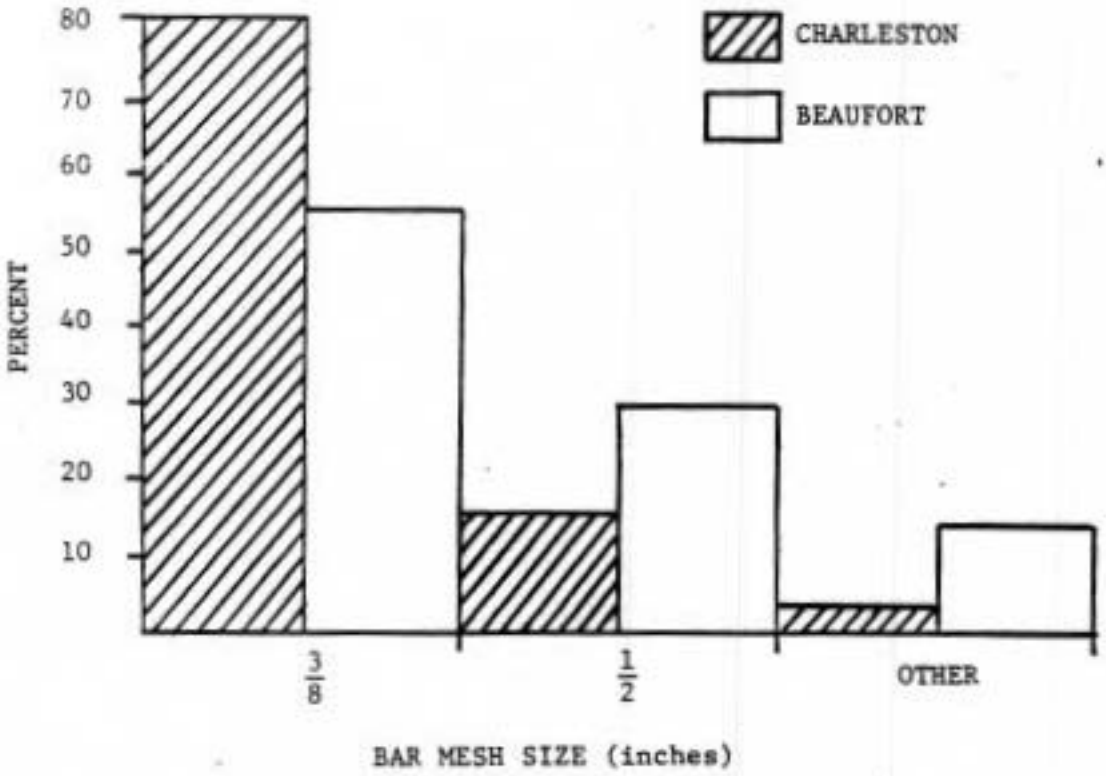
Residence of permit holders interviewed during the creel census is shown in Table 2. Of the total for both areas, 84% resided in coastal counties and 16% in noncoastal counties.

Most of the participants in both areas used six or seven-ft (length or radius) nets (Fig. 3). The percentage of shrimpers using smaller mesh (3/8 in.) nets was considerably larger in Charleston than in the Beaufort area. About 45% of the Beaufort shrimpers used 1/2 in. or larger mesh nets, compared to about 20% of the Charleston area fishermen (Fig. 3).

Most of the shrimpers in both areas landed their catches in

Table 2. Residence of permit holders interviewed in the creel census.

County of residence	Charleston area	Beaufort area	% of total
Aiken	-	6	1.7
Allendale	-	1	1
Bamberg	-	14	4.0
Barnwell	-	5	1.4
Beaufort	-	75	21.6
Berkeley	23	-	6.6
Calhoun	-	6	1.7
Charleston	100	2	29.4
Colleton	-	26	7.5
Dorchester	6	11	4.6
Edgefield	-	1	1
Hampton	-	26	7.5
Jasper	-	24	6.9
Kershaw	-	1	1
Lexington	1	4	1.4
Orangeburg	-	14	4.0
Sumter	1	-	1



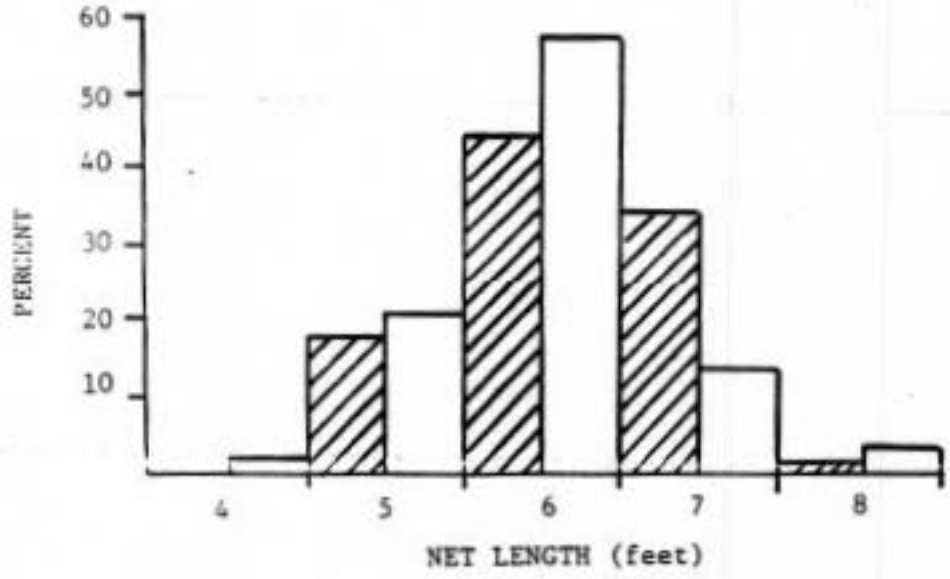


Fig. 3. Characteristics of nets used in the Charleston and Beaufort areas.

standard containers, e.g. 48-quart coolers. About 8% of the Charleston shrimpers and 19% of the Beaufort area fishermen used nonstandard containers. Nearly all shrimpers (93%) landed their catches whole and about 20% used ice. Only 4% culled their catches on the basis of shrimp size. The catch figures from the creel census are therefore based primarily on measured catches of whole, uniced, unculled shrimp. Distribution of catches for the entire sampling period is shown in Fig. 4.

The average catch rate in the Beaufort area (i.e., in locations adjacent to the landings shown in Fig. 1) was 24.8 quarts/trip (s.d=16.17). The average catch rate in the Charleston area (i.e., Fig. 2) was 30.3 quarts/trip (s.d. = 15.24). For both of these areas combined, the overall mean catch rate was 26.8 quarts/trip.

Catch rates were also determined according to the residence category of participants, since these were the basis of expansions used to estimate total catch. Charleston County residents (N=98) averaged 29.7 quarts/trip (s.d = 14.89). Shrimpers from Berkeley and Dorchester Counties (N=40) averaged 29.3 quarts/trip (s.d = 17.72). Those residing in the other coastal counties (N=151) reported a mean of 22.3 quarts/trip (s.d.=16.36), while noncoastal participants (N=54) averaged 34.3 quarts/trip (s.d.=14.20).

Examination of the effort data indicated that average catch increased with the amount of time shrimped, as shown below (data from both area combined):

Hours shrimped	Mean quarts/boat	Number of observations
1 - 1+	17.8	24
2 - 2+	25.4	96
3 - 3+	26.7	100
4 - 4+	27.2	70
5 - 5+	32.0	33
6 - 6+	34.7	16

The average Beaufort-area group shrimped somewhat longer (3.5 hours) than did the typical Charleston party (3.1 hours). When catch rates were calculated in quarts/boat-hour, average shrimping success was consistently greater throughout most of the season in the Charleston area (Fig. 5).

Combined catch data from both areas suggested that shrimpers using large (seven and eight-ft) nets were more successful than those using smaller nets, as shown below. The parameter compared is catch rate by gear in quarts of whole, uniced shrimp/boat-hour.

	Charleston		Beaufort		Total		
Net length	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	s.d.
5 ft	23	8.1	43	8.0	66	8.0	6.07
6 ft	57	9.6	124	7.6	181	8.2	5.73
7 & 8 ft	48	14.8	37	8.1	85	11.8	8.16

Shrimpers' estimates of their catch were compared to measured estimates calculated from the creel clerks' recorded container dimensions, as shown below. In both areas, the average estimated

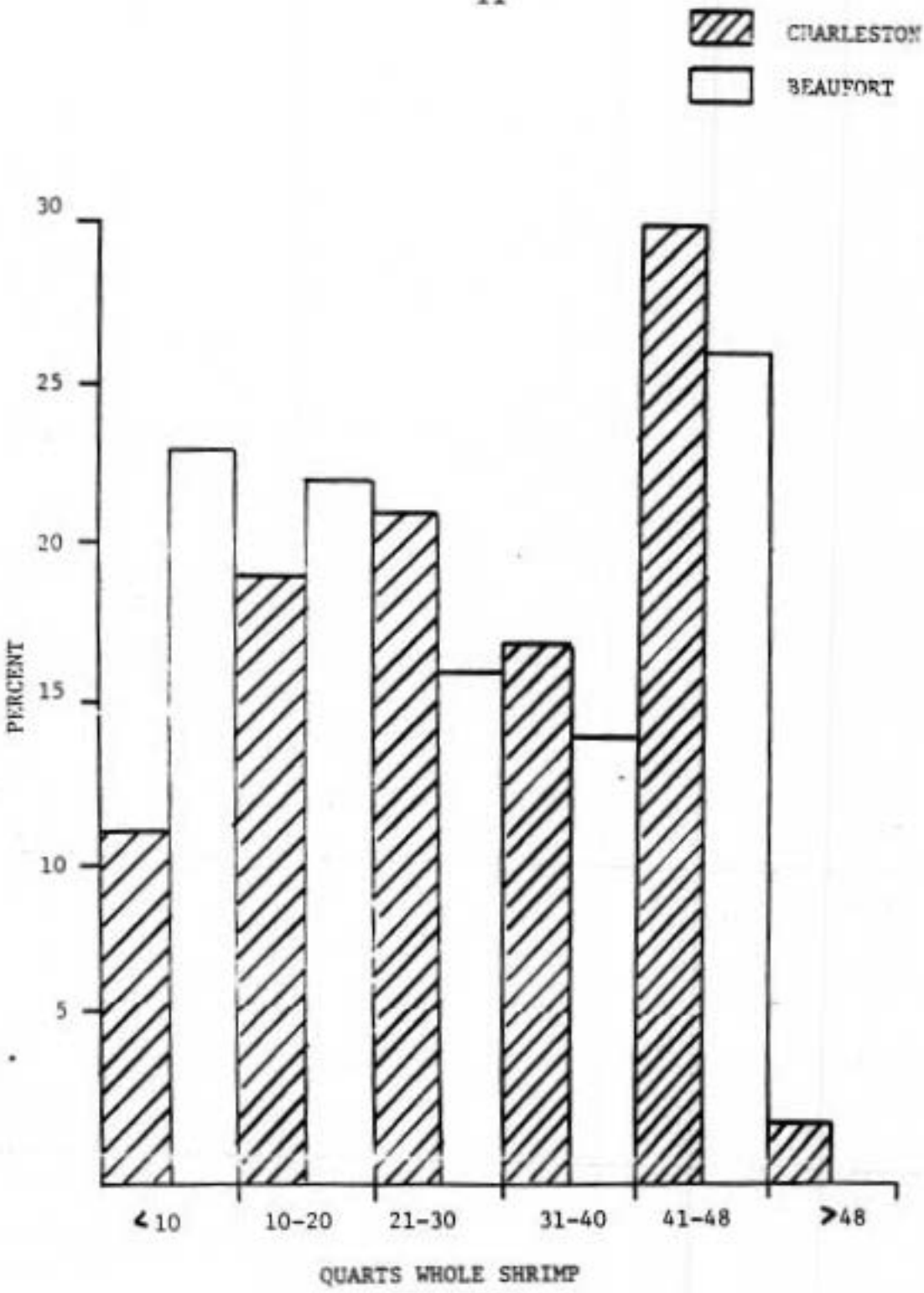


Fig. 4. Distribution of catch rates (quarts/boat-trip) in the Charleston and Beaufort areas.

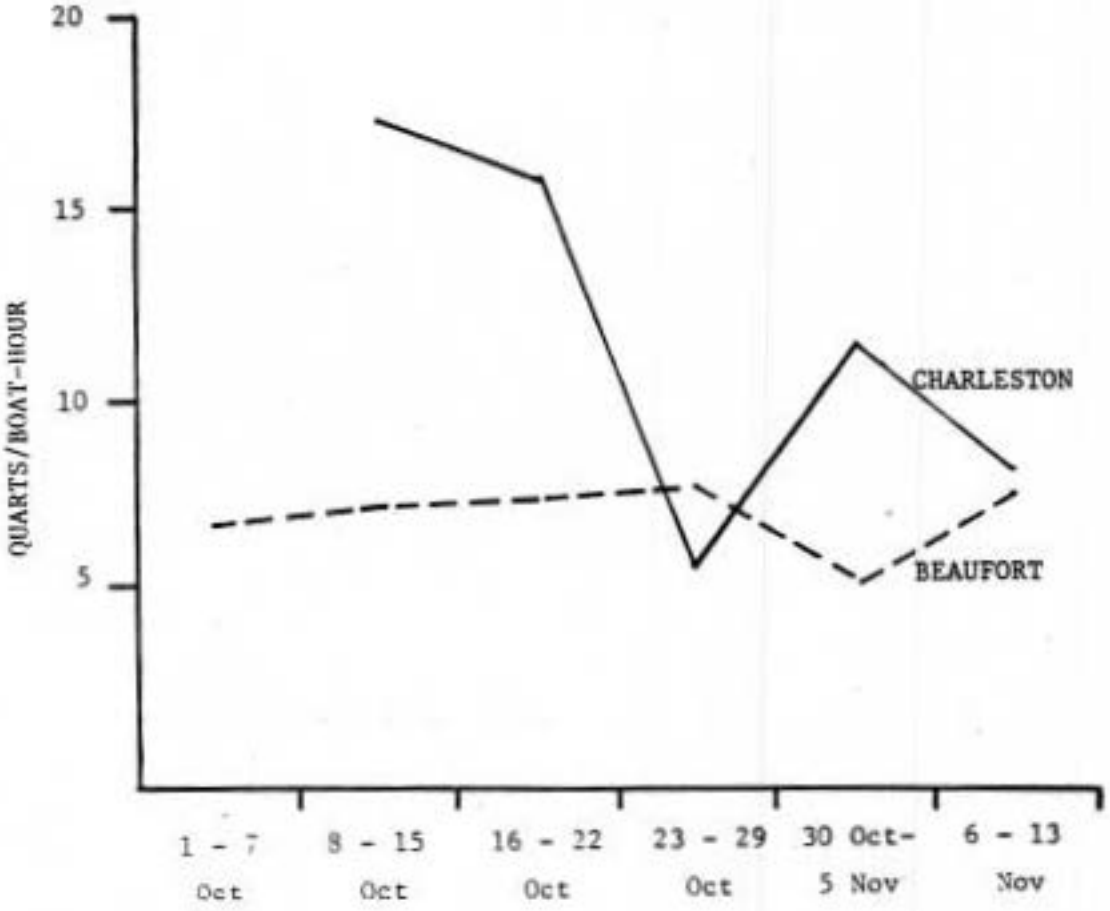


Fig. 5. Catch rates by area.

catch was slightly less than that estimated from volumetric dimensions (3.2% less in the Charleston area, 1.1% less in the Beaufort area, and 1.75% less overall).

	Charleston	Beaufort	Total
N	69	143	212
Mean (estimated)	27.9	30.7	29.8
s.d. (estimated)	16.02	16.93	16.65
Mean (measured)	28.9	31.0	30.3
s.d. (measured)	15.19	15.33	15.28

A paired t test indicated that there was no significant difference (t = 1.54) between the overall average estimated by shrimpers and that calculated volumetrically.

The shrimp caught in the Charleston area were consistently smaller than those taken by Beaufort shrimpers throughout the season (Fig. 6), although the difference became progressively smaller as the season progressed. This size difference may have been due in part to the greater usage of 3/8 in. mesh nets in the Charleston area.

Shrimpers in both areas retained very few fish taken as incidental bycatch, primarily due to small size and/or undesirability. The reported catch retained by area is listed below.

Charleston	Beaufort
8 spot	21 spot
3 flounders	9 mullet
2 kingfishes (whitings)	8 croaker
2 pinfish	6 flounders
1 bluefish	4 catfish
1 menhaden	2 kingfishes
	1 spadefish

In each area, the average permit holder was accompanied by one assistant on each trip. Participants shrimping in the Charleston area typically traveled a much shorter distance (13.2 miles) to the access point than did shrimpers in the Beaufort area (37.9 miles)(Fig. 7). The average shrimpers from Charleston County traveled 8.5 miles (s.d.=11.00), while those from Berkeley/Dorchester traveled 38.1 miles (s.d.=18.36). Participants from the other coastal counties estimated that their average one-way distance was 18.2 miles (s.d.=15.51). Noncoastal residents traveled an average of 87.9 miles (s.d.=27.44).

Although most shrimpers in both areas reported trip expenses in the $10-$25 range, a substantially greater percentage of those in the southern area spent more on their trips (Fig. 8). The average trip expense of fishermen in the Charleston area was $14.50, while that of shrimpers around Beaufort was $19.86. Charleston County residents spent an average of $13.70/trip (s.d.=6.19). Shrimpers from Berkeley/Dorchester averaged $18.95/trip (s.d.=11.34), while those from other coastal counties averaged $15.14/trip (s.d.=8.19). Non coastal participants had the highest expenses, estimated at $32.50/trip (s/d/=18.80).

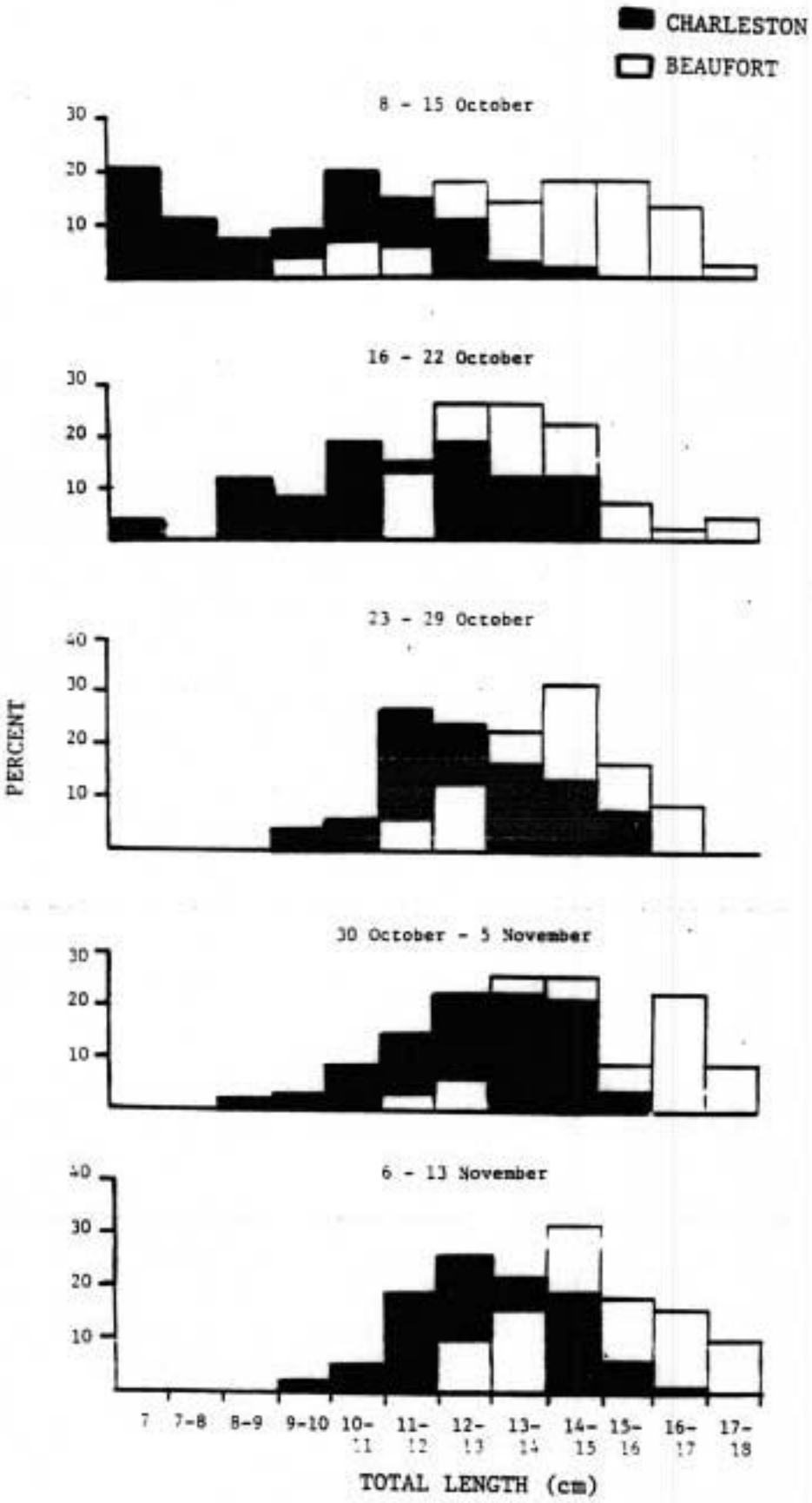


Fig. 6. Size distribution of shrimp by area during the season.

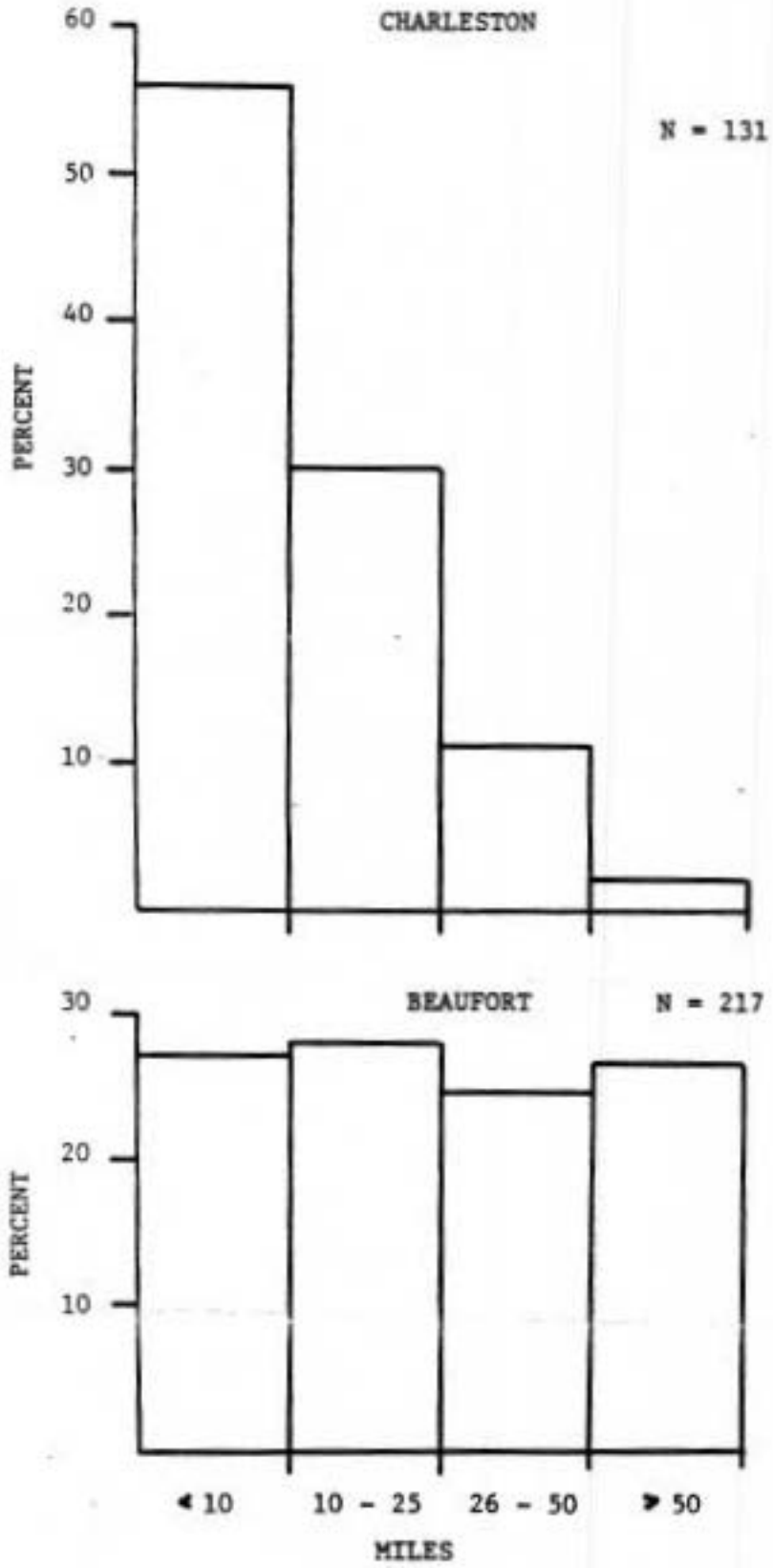


Fig. 7. Distance traveled (one-way) by shrimpers in the Charleston and Beaufort areas.

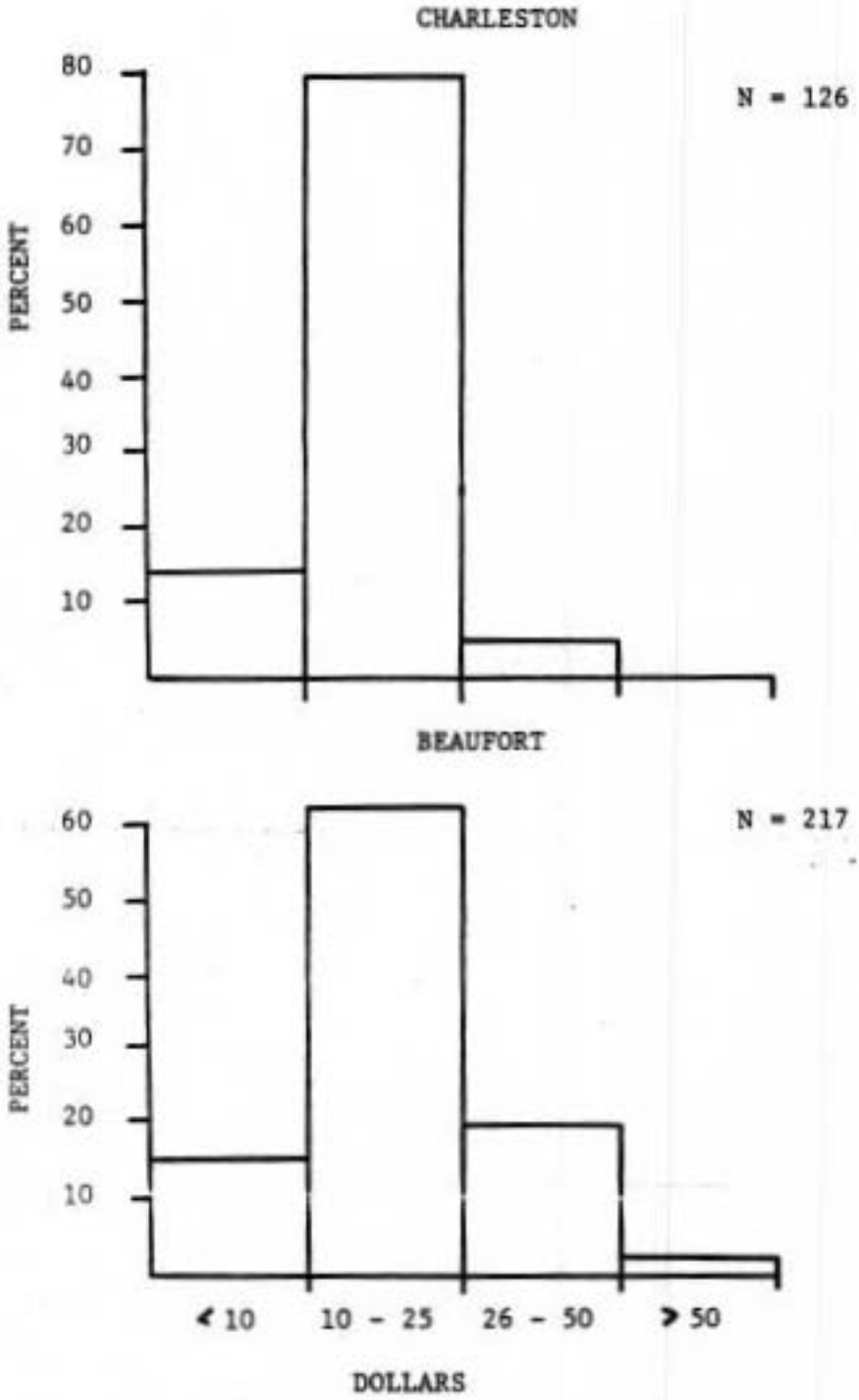


Fig. 8. Trip expenditures by shrimpers in the Charleston and Beaufort areas.

Preseason Questionnaire

A total of 451 were completed. Of these, 177 were from permit applicants at the license office. The response rate to the printed envelope mailout was 41.5%, while that to the rubber-stamped return address was 27.8%, for an overall average of 32.6%.

Postseason Mailout

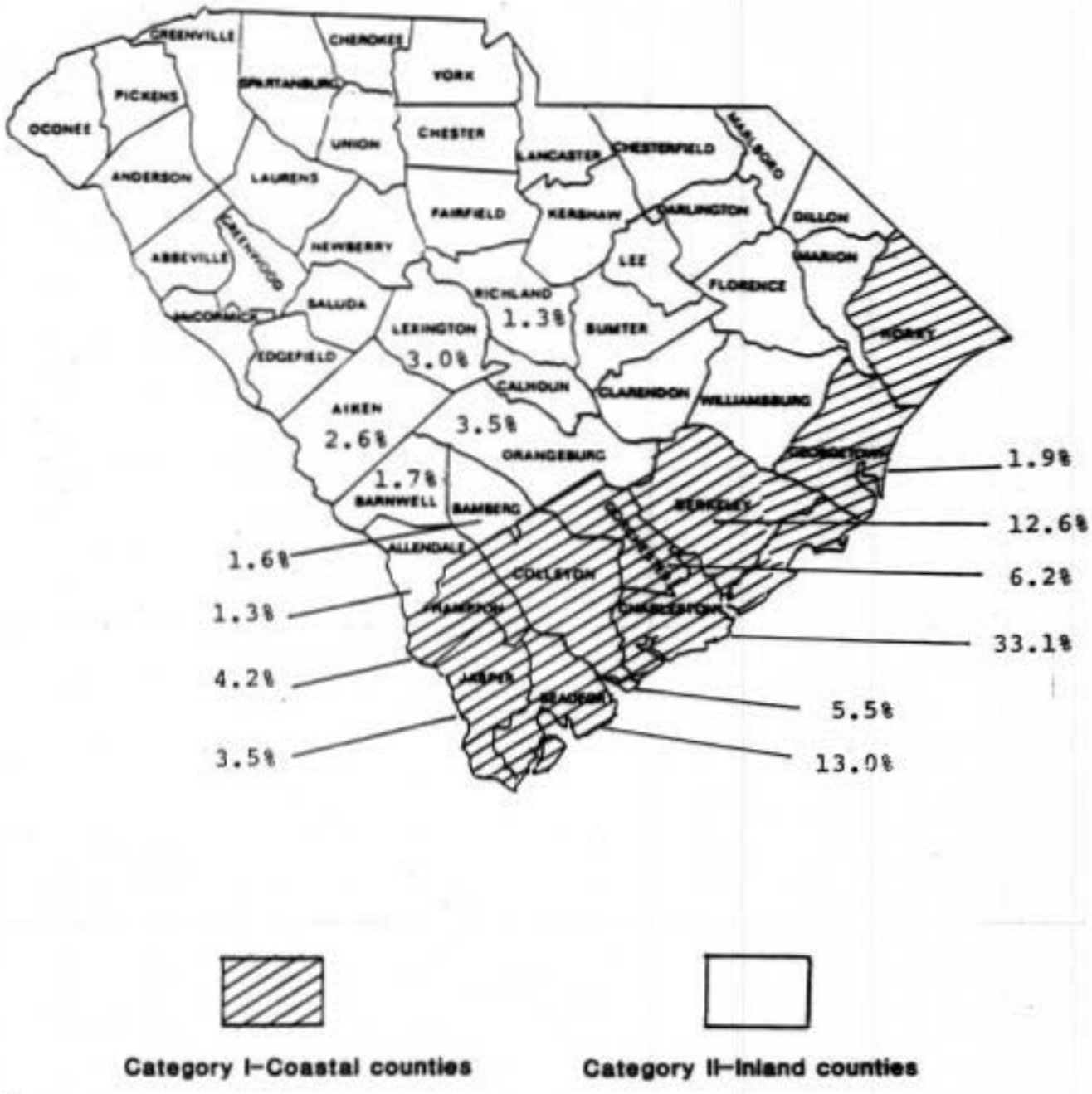
Only five counties (Fig. 9) accounted for more than 5% each of the 6,644 permit holders, with most of the remaining licensees living in adjacent counties. At the end of five weeks following conclusion of the season, the return period was terminated. This was the middle of the holiday season, few additional returns were anticipated, and the reply period had become extended beyond the limit of reasonably accurate recall. At this time, 1,009 responses had been received that could be identified by county of residence. Residence of permit holders and these respondents is shown in Table 3. Seven replies could not be categorized according to residence and are omitted from further discussion. After adjustment for nondeliverables (N=18), the overall return rate by the cutoff date was 34%. An additional 5% was received afterwards. Relative return rates of the 1,009 responses by area of residence are compared in Fig. 10.

The coastal area was divided into seven geographic components (Fig. 11). Of the 1,009 responses, the area most frequently fished could be ascertained from 836. Some individuals indicated several areas, so this total is slightly higher than the total number of respondents who shrimped. The relative distribution of activity, as measured by the percentage of respondents from each residence category who fished there, is shown in Table 4.

The most popular access points are listed in Table 5. With the exception of the private category, nine of the top ten were sampled during the creel census. "Private" includes numerous facilities, e.g. personal docks, marinas, and club or installation landings. An additional 36 sites (each with five or less observations) were identified, mostly in the Beaufort and St. Helena Sound areas.

The relative distribution of seasonal effort by category of residence is indicated in Fig. 12. About 29% of the permit holders residing in Charleston County reported making no trips during the season. For the Berkeley/Dorchester area, 24% of the residents made no trips. About 22% of the respondents from Georgetown and Horry Counties said that they did no shrimping. In the other coastal counties, as well as in the noncoastal counties, the reported no-trip rate was 7%. The average number of trips per month by residence category is summarized below. These averages are based only on the reported effort of those respondents who made at least one trip during the season.

Month	Charleston	Other coastal	Noncoastal	Total
September	1.5	1.9	1.2	1.6
October	1.2	2.9	2.2	2.2
November	1.6	3.3	1.4	1.9
Season	4.4	7.2	4.8	5.7



Category I–Coastal counties

Category II–Inland counties

Fig. 9. Area of residence of 1989 permit holders.

Table 3. Residence of 1989 permit holders and response rates to postseason questionnaire by county.

County	No. of permit holders	%	No. of respondents	%
Abbeville	23	<1	4	<1
Aiken	171	2.6	25	2.5
Allendale	87	1.3	16	1.6
Anderson	8	<1	2	<1
Bamberg	105	1.6	15	1.5
Barnwell	113	1.7	18	1.8
Beaufort	862	13.0	129	12.8
Berkeley	839	12.6	125	12.4
Calhoun	46	<1	9	<1
Charleston	2,202	33.1	370	36.7
Cherokee	3	<1	1	<1
Chester	2	<1	0	0
Chesterfield	1	<1	0	0
Clarendon	13	<1	3	<1
Colleton	367	5.5	49	4.9
Darlington	7	<1	2	<1
Dillon	4	<1	0	0
Dorchester	415	6.2	43	4.3
Edgefield	10	<1	1	<1
Fairfield	6	<1	3	<1
Florence	13	<1	3	<1
Georgetown	123	1.9	17	1.7
Greenville	18	<1	3	<1
Greenwood	17	<1	5	<1
Hampton	278	4.2	35	3.5
Horry	13	<1	1	<1
Jasper	232	3.5	20	2.0
Kershaw	9	<1	4	<1
Lancaster	2	<1	0	0
Laurens	10	<1	1	<1
Lee	0	0	0	0
Lexington	198	3.0	25	2.5
McCormick	2	<1	1	<1
Marion	7	<1	1	<1
Marlboro	0	0	0	0
Newberry	24	<1	6	<1
Oconee	7	<1	0	0
Orangeburg	232	3.5	42	4.2
Pickens	4	<1	2	<1
Richland	87	1.3	17	1.7
Saluda	5	<1	0	0
Spartanburg	16	<1	1	<1
Sumter	25	<1	2	<1
Union	9	<1	0	0
Williamsburg	18	<1	2	<1
York	11	<1	3	<1

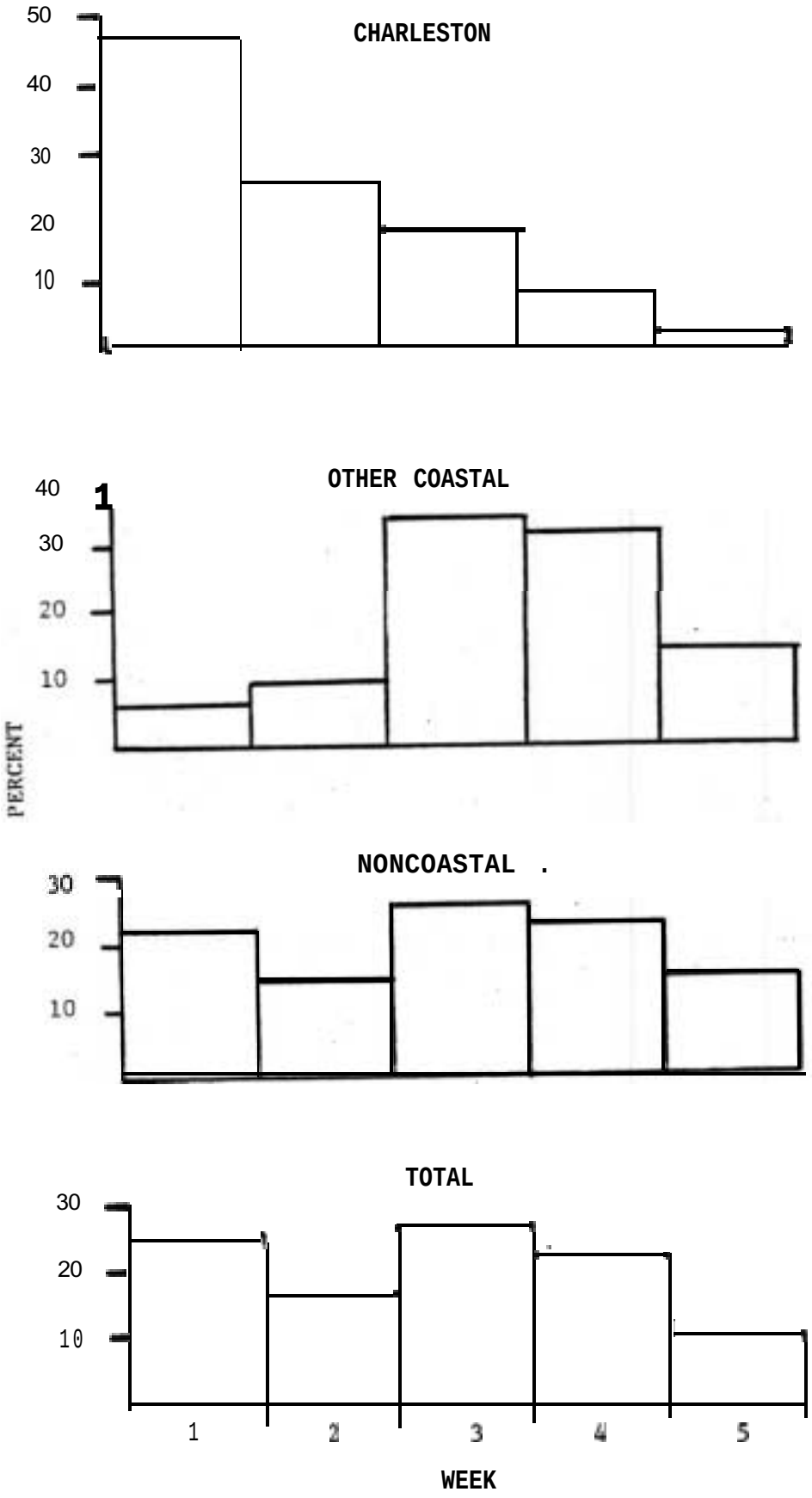


Fig. 10. Area return rates by week of response period.

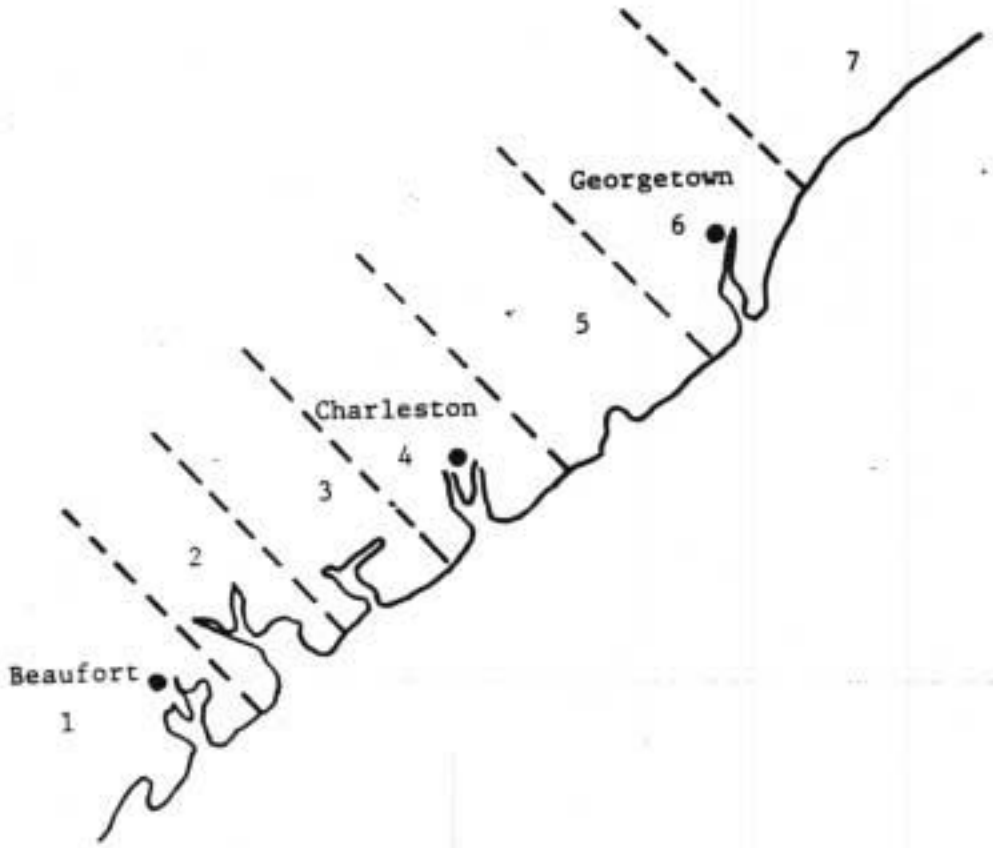


Fig. 11. Shrimp baiting areas.

Table 4. Distribution of shrimping effort.

Shrimping area	Residence category			Share of total effort
	Charleston Cty.	Other coastal counties	Noncoastal	
1 (Beaufort)	1%	50%	57%	37%
2 (St. Helena Sd.)	-	9%	11%	7%
3 (Edisto)	13%	5%	19%	11%
4 (Charleston)	85%	31%	9%	43%
5 (Bulls Bay)	1%	2%	2%	2%
6 (Winyah Bay)	-	3%	1%	1%
7 (Horry)	-	-	-	-

Table 5. Access points used by shrimp baiters, in descending order of reported frequency of use (= number of respondents identifying specific site).

Access point	Area of residence			
	Charleston Cty.	Other coastal	Noncoastal	Total
Remleys Point	69	61	11	141
Private	40	47	2	89
Gray's Hill	-	23	42	65
Shem Creek	38	8	2	48
Sheldon	1	25	19	45
Steamboat	4	9	26	39
Wappoo Cut	32	6	-	38
Folly River (Rd.)	27	6	3	36
Lemon Id.-Chechessee	-	29	6	35
Chas. City Marina	16	7	1	24
Broad River	-	16	3	19
Cherry Point	15	1	1	17
County Farm (Leeds)	11	2	1	14
Brighton Beach	-	4	10	14
Fields Point	-	10	4	14
Bennetts Point	-	9	3	12
Port Royal (Sands)	-	10	-	10
Dale	-	4	6	10
Battery Island	7	1	1	9
Station Creek	-	2	6	8
Waddell Center	-	3	5	8
Trask	-	4	4	8
Sam's Point	-	6	1	7
Bushy Park	-	6	1	7
McClellanville	-	6	1	7
Battery Creek	-	6	1	7
Riverland Terrace	6	-	-	6
Russ Point	-	1	5	6

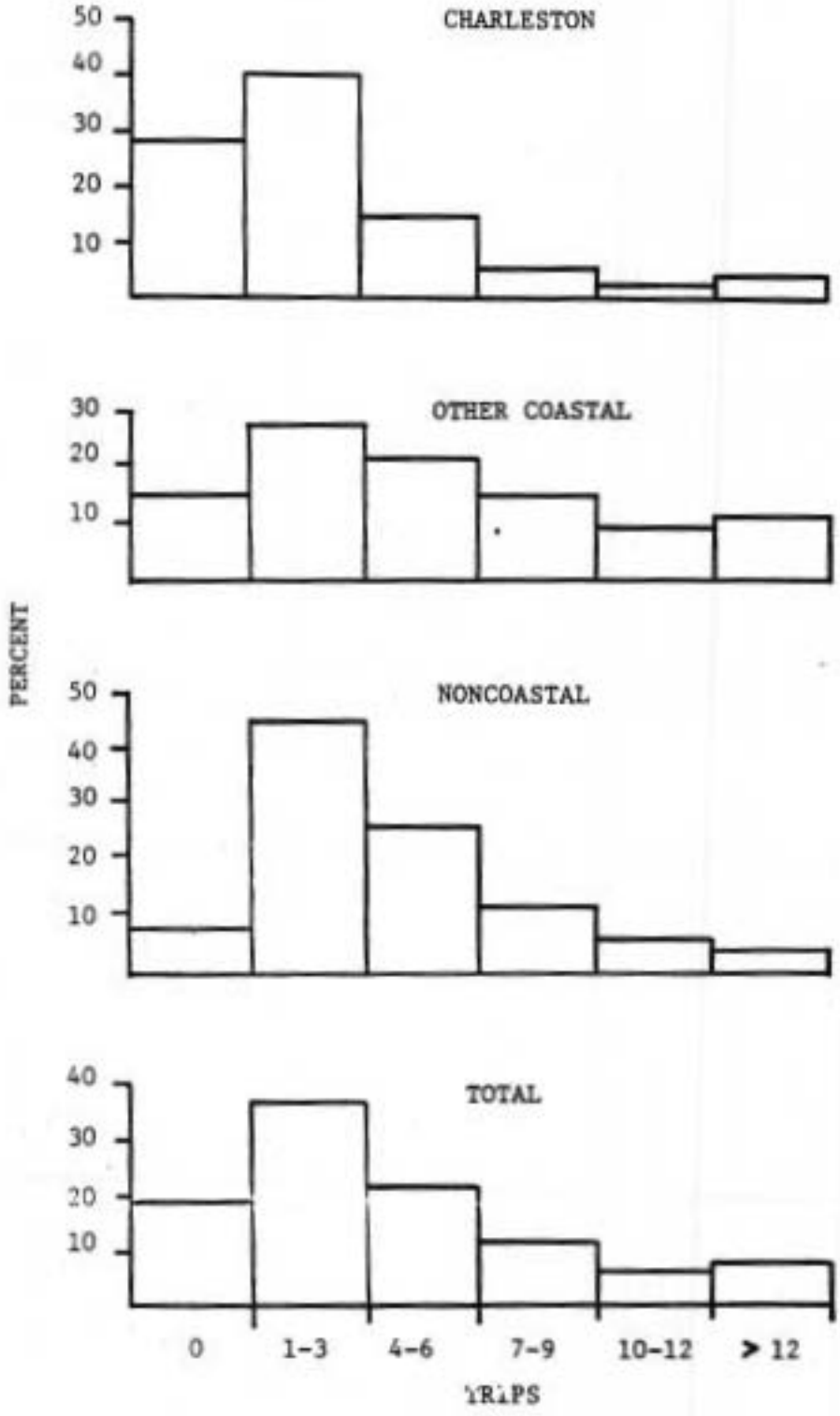


Fig. 12. Distribution of effort by area of residence.

Within the other coastal category, residents of Berkeley/Dorchester averaged 4.2 trips/season, while shrimpers from Georgetown and Horry Counties averaged 6.9. Residents of other coastal counties averaged 8.9 trips for the season. It should be noted that these estimates are categorically lower than those based on creel census interviews during the last week of the season, when shrimpers were probably making their final outing. Presumably, the explanation is that the end-of-the-season shrimpers were more avid participants than most and likely to have made more trips than the average participant. Residents of Charleston County reported an average of 2.053 assistants for the season. Permit holders from the other coastal counties indicated that an average of 2.148 people helped them during the season. The noncoastal respondents reported an average of 2.232 assistants.

Using this information, participation was estimated as shown in Appendix 1d. An estimated 5,469 active permit holders were assisted by 11,702 additional individuals, for a total of 17,171 participants.

Total seasonal effort was estimated by multiplying the number of participating permit holders in each residential category by the estimated average number of trips reported (on postseason mailout responses) for the season. Seasonal effort by residential category was therefore as follows:

Area of residence	Seasonal trips
Charleston County	6,890
Berkeley/Dorchester	4,015
Georgetown/Horry	731
Other coastal counties	14,409
Noncoastal counties	5,866

The estimated total effort calculated as the sum of these figures was 31,911 trips. Another estimate was obtained by multiplying the number of participating permit holders (5,469) by the estimated statewide average number of trips made (5.73, s.d.=5.39). This figure was 31,337 trips.

Relative shrimping success by residence category is shown in Fig. 13. Average seasonal catch rates (quarts of whole shrimp/boat-trip) were 25.77 for Charleston residents (s.d.=14.62), 26.05 for residents of other coastal counties (s.d.=13.85), and 27.56 for noncoastal residents (s.d.=13.80).
When considered on a geographic basis, the seasonal means for major areas were:

	Beaufort	St. Helena-Edisto	Charleston	Bulls-Winyah Bays
N	341	103	347	18
Mean	27.09	25.70	26.29	20.80
s.d.	13.47	13.95	14.56	-

The total seasonal catch can be estimated in several ways. The overall average catch rate from the creel census was 26.8 quarts/trip. This figure multiplied by the lower effort estimate gives a catch of 839,832 quarts. Converted into pounds (x 1.48), this is 1.243 million pounds. Using the higher effort estimate,

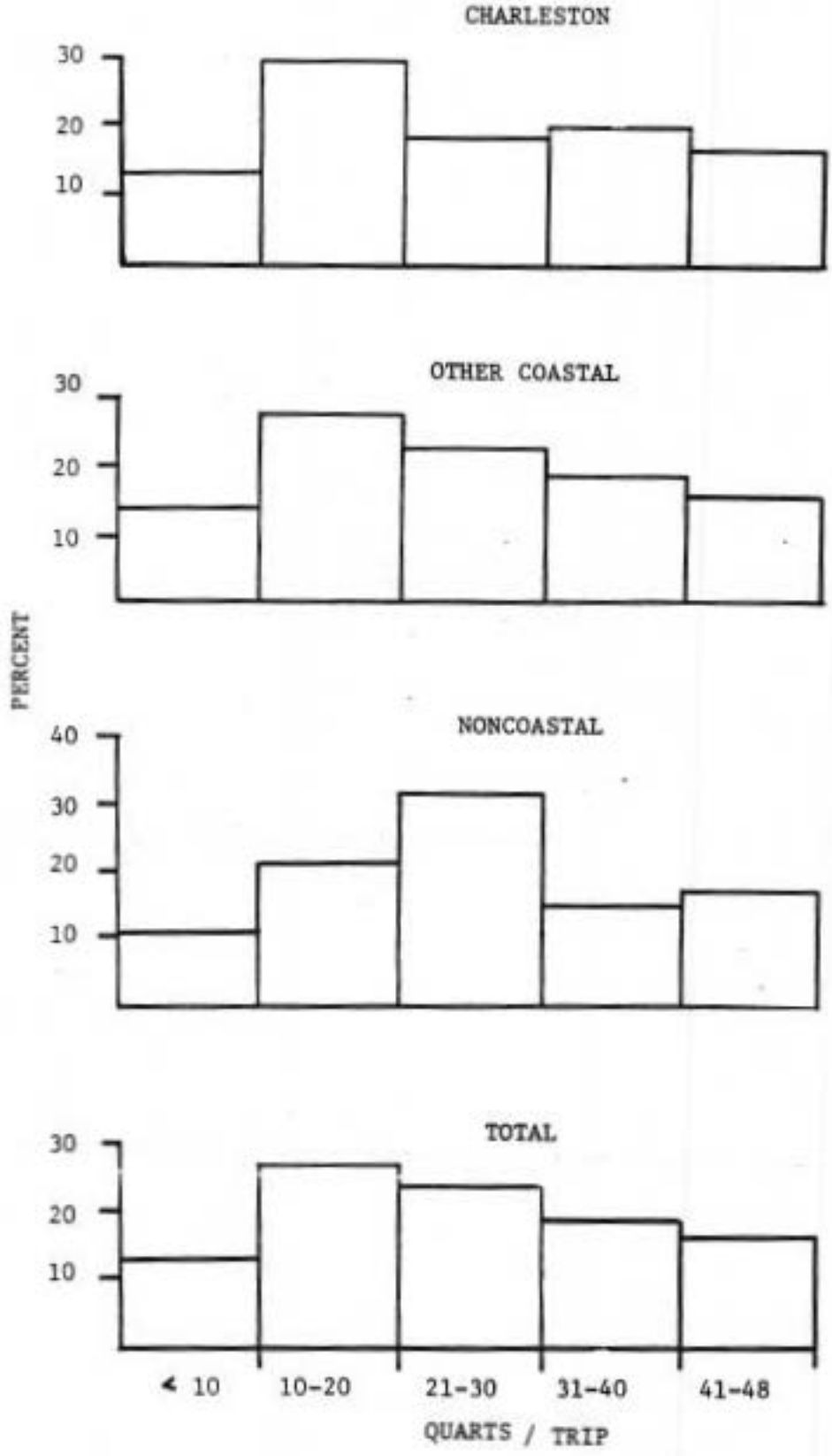


Fig. 13. Distribution of catch rates by area of residence.

the estimated catch is 1.266 million pounds. With the average catch rate from the postseason questionnaire (26.5 quarts/trip), the corresponding values are 1.229 and 1.252 million pounds.

A second approach is to use the measured catch rates by residence category from the creel census and expand them by the appropriate area effort estimates (Appendix 1e). The resultant total catch estimate is 1.274 million pounds. Using this method with the estimated catch rates from postseason questionnaire data produced an estimate of 1.241 million pounds (Appendix 1e).

Another alternative would be to estimate the number of trips made in each of the seven geographic areas and expand them by the appropriate catch rates. The problem here is that the numbers of trips by area aren't clearly definable, since respondents simply indicated where they did most of their shrimping. Relative participation by area can be estimated, but the breakdown of effort is less precise.

The six estimates of total catch ranged from 1.229-1.274 million pounds. The mean of these is 1.25 million pounds. Since there is no one "best" estimate, given statistical trade-offs, this average value has been used in subsequent calculations unless otherwise specified.

Slightly less than half of the participating respondent permit holders failed to catch at least one limit (48 quarts) during the season (Fig. 14). About 28% of the trips made by Charleston County residents produced a limit. Residents of other coastal counties also caught a limit on 28% of their trips, while noncoastal residents caught a limit on 31% of theirs. The overall average was a limit on 29% of all trips made. In terms of limits per participant (including permit holders and assistants) the following applied:

Area of residence	Season limits/permit holder	Limits/participant
Charleston County	1.2	0.40
Other coastal counties	2.0	0.65
Noncoastal counties	1.5	0.45
Total	1.6	0.52

Shrimpers retained very few fish taken as incidental bycatch. Based on expansion of the catch rates observed during the creel census by the maximum total number of trips, the following estimates pertain to the retained fish bycatch:

2,658	spot
826	mullet
826	flounders
734	croakers
367	kingfishes
826	miscellaneous
6,237	fish

About 14% more respondents indicated that they had completed a preseason questionnaire than could have actually done so (this may have resulted from confusion with the 1988 postseason survey). To prevent possible double counting, the following was based only

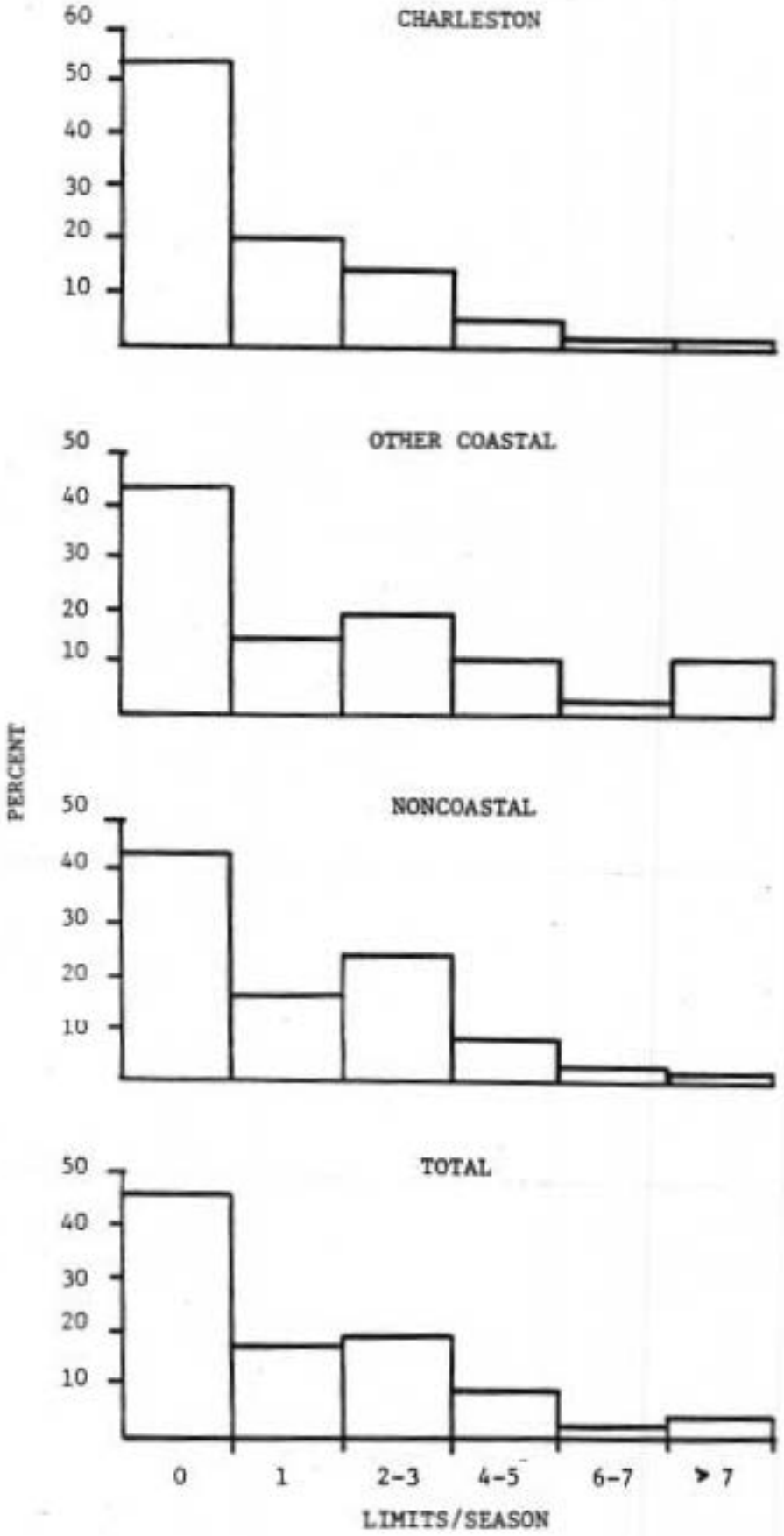


Fig. 14. Success by area of residence as measured in limits.

on responses to the postseason questionnaire. Relative categorical frequencies closely resembled those tabulated separately from the preseason survey. For brevity, results are summarized in Tables 6 and 7.

Statewide, 72% of the respondents indicated that they had shrimped over bait during the previous (1988) season, with the frequencies by area of residence being very similar. About 20% had done no other type of marine fishing during 1989 (Table 6), with the negative responses being highest in the noncoastal category. Rod-and-reel fishing was the most popular alternative activity, practiced by three-fourths of the respondents statewide. Crabbing was also popular, while participation in other activities was relatively limited.

Socioeconomic characteristics were very similar regardless of area of residence (Table 7). About 85% of the households consisted of 2-4 individuals. Statewide, 70% of the households had a gross annual income of less than $50,000, with the percentage being somewhat higher in the coastal counties (except Charleston). About 13% of the respondents statewide reported annual household incomes of less than $20,000, with the percentage again being slightly higher in the coastal counties (excluding Charleston). About 85% of the permit holders were actively employed, with professional/technical, tradesman/manufacturing, and managerial/proprietor occupations accounting for the vast majority.

Shrimpers reported very few incidents involving other participants, e.g. territorial disputes (Table 8). For the vast majority of those with a complaint, weather (particularly the hurricane) was the major problem. Crowding, both on the water and at access points, was the next most frequently mentioned difficulty. Limited access to Remleys Point,(the most heavily utilized site in the state) prevailed during much of the season and displaced shrimpers to smaller sites with limited parking, e.g. Shem Creek. Sale of shrimp was perceived by a significant number of shrimpers to be a common practice incompatible with the sport (and illegal).

Most of the respondents had something to say about management of the fishery (Table 9). A sizeable group (29%) felt that no changes were warranted. An equally sizeable group wanted a longer season. About 12% felt that the Marine Resources Division should have authority to adjust the season depending on conditions, e.g. size of the shrimp or weather. Nine percent suggested that the limit be set by permit holder rather than by boat. Several suggested that this apply to the number of poles as well. About 7% felt that more law enforcement was needed, particularly with regard to "hogs" exceeding the limit and sale of shrimp. Five percent wanted a larger limit and 5% wanted to be allowed to use more poles and/or space them farther apart. Other comments are addressed in the discussion.

The final aspect is the economics of the 1989 season. Shrimpers devoted a lot of travel to their sport. Based on the figures presented above, their round-trip mileage added up to slightly over 2.0 million miles (Appendix 1f). In addition to travel, shrimpers also spent a considerable sum in direct trip expenditures. The average trip cost its participants $18.50. In

Table 6. Fishing activities by area of residence. Values shown are percentages of positive responses in each category from the postseason questionnaire.

Type of activity	Charleston County	Other coastal	Noncoastal	Total
No other marine fishing	14	19	31	20
Rod and reel	77	81	62	76
Gigging (graining)	16	18	9	16
Gill netting	1	1	3	2
Crabbing	33	31	23	30
Shellfish gathering	14	14	9	14

Table 7. Socioeconomic characteristics of permit holders by area of residence. Values shown are percentages of positive responses in each category from the postseason questionnaire.

Category	Charleston County	Other coastal	Noncoastal	Total
Number in household				
1	9	5	5	6
2	32	33	35	33
3	24	27	23	25
4	27	25	28	26
4+	8	10	9	9
Gross household income				
< $10,000	3	2	2	2
$10,000 - $19,999	10	14	8	11
$20,000 - $29,999	16	18	18	17
$30,000 - $39,999	21	25	20	22
$40,000 - $49,999	17	16	17	17
$50,000 - $59,999	12	12	13	12
$60,000 - $69,999	10	7	10	9
> $70,000	11	7	11	9
Employment/occupation				
Unemployed	1	<1	<1	<1
Retired	13	13	14	13
Active military	1	2	0	1
Professional/technical	40	36	36	37
Managerial/proprietor	15	14	16	15
Agricultural	1	3	5	3
Clerical/sales	4	4	4	4
Tradesman/manufacturing	17	19	17	18
Other	7	8	8	7

Table 8. Problems and conflicts identified by respondents to the postseason questionnaire. Values shown are the number of responses.

Item	Charleston County	Other coastal	Noncoastal	Total
Weather, "Hugo"	196	141	51	388
Crowded access	7	23	12	42
Sale of shrimp	9	17	10	36
Limited access	15	9	0	24
Small shrimp	11	8	4	23
Dirty water	9	3	0	12
"Hogs"	2	4	2	8
Lack of information	3	0	5	8
Rude Law Enforcement	0	3	1	4

Table 9. Suggested changes in shrimp baiting laws. Values shown are the number of responses.

Change	Charleston	Other coastal	Noncoastal	Total
Number commenting	251	316	169	736
No change necessary	72	97	48	217
MRD assume authority to set flexible season	67	20	4	91
Longer season	69	86	62	217
Shorter season	1	1	0	2
Split seasons	5	2	0	7
Set limits by license instead of by boat	6	34	27	67
Larger limit	4	19	13	36
Smaller limit	3	3	0	6
More law enforcement	20	21	11	52
Earlier opening	5	18	5	28
Later opening	4	7	2	13
More poles and/or distance for poles	6	15	15	36
Less poles	2	1	0	3
Higher permit fee	2	1	0	3
Lower or no permit fee	6	2	1	9
Require license of all in boat	0	1	0	1
Require no license	3	1	0	4
Limit net to 7 ft or smaller	0	1	0	1
Minimum mesh regulation (½ inch)	0	5	2	7
Prohibit night baiting	0	1	1	2
Prohibit all baiting	2	4	1	7
Allow baiting from docks	4	6	1	11

1989, 6,644 permits were sold at $25 each. This sum ($166,100) added to the direct trip expenditures from Appendix 1f suggests that a minimum of $756,442 was spent on shrimp baiting. This does not include the cost of necessary related items such as cast nets, boat equipment, etc. On a statewide basis, this amounts to $113.85 for each permit holder (active or not) and $42.34 for every participant. In exchange for this investment, recreational shrimpers harvested an estimated 1.25 million pounds of whole shrimp, valued at approximately $3.75 million (at $3.00/pound). Thus, the estimated minimum return rate on their investment was nearly 5:1.

For the following calculations, a total harvest of 1.25 million pounds was also assumed. The statewide average cost of shrimp was $0.58/pound for participants, with the average participant receiving about 73 pounds (Appendix 1f). The approximate average pounds for each active permit holder was 168 for Charleston residents, 276 for residents of other coastal counties, and 196 for noncoastal permit holders making at least one trip. An average permit holder thus received an individual share of about 73 pounds, to be shared in a household averaging just over three people. This works out to about 24 pounds of whole shrimp per person, or slightly less than 16 pounds of heads-off shrimp per household member.

DISCUSSION

Survey Reliability

The residence breakdown of permit holders intercepted during the creel census (84% coastal, 16% noncoastal) was in reasonable agreement with that of the entire permit holder population (81% coastal, 19% noncoastal). Within the coastal category, there was over-representation from Beaufort, Hampton, and Jasper Counties, reflecting the fact that a substantial percentage of the permit holders from Charleston, Berkeley, and Dorchester Counties did not participate because of hurricane-related conditions. The county-by-county composition of the postseason survey responses very closely matched that of the entire permit holder population. This indicated that area-specific response rates were not affected by the hurricane and resultant lack of participation. Any figures based on data from the overall postseason survey responses should therefore be unbiased estimators of these parameters for the permit holder population.

The relatively good response rate (32.6%) to the preseason mailout survey indicated that inclusion of socioeconomic questions would not produce a strong negative reaction and detract from the overall effectiveness of the postseason survey. The postseason response rate (34% by the end of the fifth week) confirmed this assumption and generated the targeted number of responses. Further indication of the lack of adverse reaction to these personal-oriented questions was the fact that very few respondents refused to answer them or made derogatory comments regarding them.

The substantially higher rate (13.7%) of return to the printed, self addressed preseason questionnaire confirmed the

assumption that the use of quality materials enhances the response rate. The small additional cost is well worth the investment as so evaluated.

The fact that the creel census catch estimates were based primarily on volumetrically measured catches of whole, uniced, unculled shrimp contributed to minimal errors due to conversion calculations. Based on variances reported for the 1987 creel census data, a projected sample size of 550 interviews was targeted in order to obtain a mean with +/- 5% reliability. This sample size was not achieved due to hurricane-related factors and the actual sample size (348), combined with a high variance, resulted in a statewide mean catch rate estimator with a reliability of +/- 11% at the 95% level. When broken down on an area-specific basis (i.e., Charleston, Beaufort), the sample catch rate means had approximately +/- 20% reliability. Several weeks of activity also were not covered due to the hurricane.

The statewide mean catch rate (26.8 quarts/trip) estimated from the creel census data, however, was in excellent agreement with that estimated from postseason survey data (26.5 quarts/trip). Because of the larger sample size, the reliability of the latter figure was substantially greater (+/- 4%). The similarity of the two estimators probably is due to the lack of significant difference between shrimpers' estimates of what they had caught and what the actual catches were based on volumetric measurements, as noted in the results for the creel census.

The reliability of the statewide average trip estimator from postseason survey data was +/- 2.5% at the 95% level. There was less than 2% difference between the total effort estimate using this figure and that obtained from summation of area-specific effort. The difference between the area-specific catch rate estimators (25.77 to 27.56 quarts/trip) from postseason survey data was only 7%. Had there been a large difference, the range in statewide catch estimates (1.229 to 1.274 million pounds) derived by the various methods would probably have been substantially greater. As it was, there was less than a 4% difference between the high and low values.

The breakdown of effort and catch estimates involves a trade-off between statistical reliability (greater for the estimates based on statewide means) and detailed area-specific figures, but the overall close agreement between the totals suggests that the area-specific figures are also quite reliable. Since there is no clear-cut single "best" estimate of the total catch, the average of the six values calculated (1.25 million pounds) is a reasonable figure.

Comparison of 1988 and 1989 Seasons

The principal differences between the 1988 and 1989 seasons were attributable to the hurricane. These were reflected primarily in the percentage of permit holders who did not participate, the effort level of residents in affected counties, and the relative geographic distribution of effort.

In 1988, an estimated 8.2% of the overall number of permit holders did not shrimp. In 1989, the nonparticipation rate was 17.6% The nonparticipation rate by residents of counties least

affected by the hurricane (about 7%) was similar to the 1988 statewide rate. The most significant impact was in Charleston County (29% nonparticipation), Berkeley/Dorchester (24%), and Georgetown/Horry Counties (22%). These counties accounted for 54% of the total number of permit holders and therefore contributed most to the non-participation rate. The average number of assistants helping permit holders from these areas was also well below the 1988 average.

In 1988, the statewide average effort was 7.0 trips/permit holder. In 1989, the equivalent figure was 5.7. Residents of the hurricane-impacted coastal counties accounted for most of the decline, although average effort by noncoastal residents was also down slightly (4.8 vs 5.1 trips/permit holder) and this could also have been attributable to storm-related factors. In 1988, coastal residents averaged 7.4 trips, while in 1989 Charleston County residents made an average of 4.4 trips and those from Berkeley/Dorchester Counties only 4.2. Average effort by permit holders from other coastal counties not affected by the storm was somewhat above the 1988 average.

Conditions that contributed to reduced effort by residents of affected areas included polluted waters, lack of residential power, local curfews at night, restricted travel, and personal priorities.

In 1988, 59% of the effort took place in Charleston County (mostly around Charleston) and about 35% in Beaufort County. In 1989, somewhat more effort was targeted at areas south of Charleston (in relative terms). About 54% of the effort was expended between Edisto Island and Bulls Bay and 44% from Edisto Island south. In both years, there was very little effort (<2%) north of Bulls Bay.

The reallocation of effort appeared to be due primarily to hurricane related conditions rather than shortage of shrimp. Remleys Point in Mt. Pleasant is adjacent to some of the largest and most popular shrimping areas in the state and is the most heavily used access point (both in 1988 and 1989). Access via this site was restricted following the storm. Pollution in the Charleston area persisted into mid-October in some waters, e.g. the Ashley and Stono Rivers, and this contributed to a shift of effort. Publicized difficult travel conditions and nighttime curfews in the Charleston area also tended to divert potential participants from inland areas.

By the 9th of October, the Charleston curfew had been lifted, local residential power was largely restored, and some waters, particularly the northeastern part of the harbor, the Cooper River, and the Wando River had cleaned up. Effort increased progressively through the rest of the month and good catches of shrimp were reported. Creel census data indicated that the average catch rate in the Charleston area after the storm was consistently higher than that in the Beaufort area.

In addition to the hurricane, weather was a persistent problem during most of the 1989 season. Early October saw windy weather and large tidal fluctuations, the most extreme tides in a decade occurred in mid-month, and a northeaster prevailed during the last week. The final two weeks of the season were characterized by relatively good weather.

In spite of adversity, those shrimpers who persevered did relatively better in 1989 than in 1988. Statewide, the average catch per participant was about 10% higher. The average catch/trip increased by 19%. About 5% more shrimpers caught at least one limit during the season.

The 1989 season began at 12:01 AM on 15 September and ended at midnight on 13 November. After several days of unsettled weather, the hurricane made landfall at Charleston on 21 September. Although shrimping continued almost uninterrupted in the Beaufort area, there was very little effort from Charleston north until the second week of October. Thus, three weeks or about one-third of the season was lost north of Edisto Island. About 54% of the respondents indicated some problem during the season and over 70% of these specified hurricane-related factors. This raises the question of what the season could have been in the absence of the hurricane.

The storm's impact can be estimated by comparing the 1989 figures to projections based on 1988 rates of participation expanded by numbers of permit holders, catch rates, and economic data for the 1989 season (Appendix 1g). Based on permits sold in 1989, the assumed percentage (92%) of permit holders who would have shrimped, and the number of assistants per holder (2.5 in 1988), projected participation would have been around 21,500 individuals, or 25% more than the estimated 1989 participation. Their effort would have been about 45,200 trips or 42% more than the upper 1989 estimate. This would have produced a catch of approximately 1.77 million pounds (42% more than the estimated harvest). To obtain this catch, shrimpers would have spent about $968,000 in total direct expenses (trip costs + permit fees), or 28% more than was estimated. The increase in expenditure by Charleston County residents would have been 119%, while participants from Berkeley/Dorchester would have spent an additional 114%. There would have been little increase in the contribution from the nonaffected areas (1% from other coastal residents and 5% from noncoastal residents).

The direct economic loss in fishery-generated dollars attributed to the hurricane was estimated at approximately $212,000. The approximate ex-vessel value of the estimated catch loss to the recreational sector was $1.56 million. Thus, the total direct economic impact of the hurricane on the 1989 shrimp baiting fishery was estimated at about $1.77 million.

In 1988, the estimated recreational catch of white shrimp by shrimp baiters amounted to 31.5% of the estimated total (commercial plus recreational) reported harvest of this species. In 1989, based on a preliminary estimate of 2.55 million pounds (heads-off) landed by commercial fishermen, the shrimp baiting fishery accounted for about 24% of the total harvest.

Comments On Management

In general, responses were very similar to those received to the same questions in the 1988 survey. A somewhat higher percentage of 1989 respondents felt no changes were warranted, but nearly one-third of this user group continues to want a longer

season. Most apparently would prefer to see the season last later rather than start earlier, because the size of the shrimp tends to increase toward the end of the season. They contend that a longer season would alleviate the crowding problem in some heavily used areas by dispersing effort over a longer period. This would also provide more flexibility for individuals to re-schedule trips in the event of bad weather, etc. Some participants object to what they consider a pressure atmosphere associated with the present season.

Another categorical revision of interest to a significant number of shrimpers concerns the limit. Although relatively few supported a direct increase, many shrimpers felt that the limit should be set according to the number of permits per boat rather than at one limit per boat. In most other fisheries covered by a bag limit, the limit applies to the individual. The logic advanced by the shrimpers is that two permit holders in a boat should each be allowed a limit of shrimp, as is the case with other species.

Most of the other comments address relatively minor changes or were proposed by only a few individuals. Nearly all were also mentioned in responses to the 1988 survey. Waltz and Hens (1989) devoted substantial discussion to respondents' comments that is equally applicable to the 1989 survey responses and does not need to be repeated here.

Recommendations on Survey Methodology

The creel census is the most difficult component to implement properly, as well as the most expensive. Because of the large variances typically associated with the catch rates, large sample sizes are required for reasonable statistical reliability. It is questionable, given the results of this year's survey, whether such expense is warranted. As shown in this year's results, the participants' estimates of their catches when interviewed were very close to the catches as measured by the creel clerks. The average estimate based on postseason survey data was also very close to the estimates produced by the creel census on a statewide basis. It was also more reliable statistically because of the large sample size that produced it. Given the need for large sample sizes, it is less expensive to obtain them through a mailout survey. If the estimate so obtained in unbiased, as this year's results seem to indicate, then the need for an estimate from a creel census is questionable. If management interest is area-specific, then increasing the mailout survey to expand the sample sizes would be preferable to expanding the creel census coverage. The only data currently collected by the creel census that cannot be obtained from a postseason mailout are those relating to size of the shrimp and amount of bycatch. The significance of the bycatch is negligible, based on this year's results. The size distribution of the shrimp should be similar to that observed during the Crustacean Management Section's routine sampling of inshore areas.

Distribution of returns of the postseason questionnaire indicated that most responses from Charleston County residents will be received quickly (within two weeks), while those from other areas will peak in three-four weeks. After four-five weeks, the relative composition of the sample by area of residence has

stabilized and further waiting simply increases the sample size at the expense of recall-dependent accuracy.

Socioeconomic characteristics were very similar regardless of area of residence and are unlikely to change significantly within a short time frame. While the information obtained is useful in evaluating the impact of management measures on the constituency and their probable reactions to them, it is not the kind of information that needs to be routinely collected.

Based on the above considerations, the following recommendations for future surveys are made:

1. Use a postseason questionnaire as the principal suvey instrument for estimating catch, effort, and participation. This should be mailed immediately after the season closes, with a minimum response period of one month. Further extension of the response period should be governed by sample size requirements and recall-associated factors.
2. Collect socioeconomic data at three to five year intervals, using a relatively small mailout.

REFERENCES

Dillman, D.A. 1978. Mail and telephone surveys. John Wiley & Sons, N.Y. 325 p.

Linsky, A.S. 1975. Stimulating response to mailed questionnaires: a review. Public Opinion Quarterly 39(1):82-101.

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, 65 p.

Low, R.A. and C. W. Waltz. 1988. South Carolina marine recreational fishery statistics survey 1987. S.C. Mar. Res. Center Tech. Rep. 68, 58 p.

Theiling, D. 1988. Assessment of participation and resource impact of shrimp baiting in coastal South Carolina during 1987. S.C. Mar. Res. Center Tech. Rep. 69, 41 p.

Waltz, W. and B. Hens. 1989. Survey of the South Carolina shrimp baiting fishery, 1988. S.C. Mar. Res. Center Tech. Rep. 71, 43 p.

APPENDIX

FIELD INTERVIEW

Boat Landing_____ Interviewer_____ Date_____

Permit holder's residence (county)_____ Zip Code_____

How many trips have you made so far this season? _____

How many people assisted you in the boat on this trip? _____

Number of poles used _____

Net size: Radius (length) _____ Mesh_____

Location shrimped _____

Number of hours shrimped _____

How many miles did you travel from your residence to here? _____

How much do you think you spent directly on this trip (for car gas, boat gas, ice, bait, food/beverages, miscellaneous expenses)? _____

Fish caught and kept: (number/species)

___/_____ ___/_____ ___/_____ ___/_____

Estimated catch of shrimp: _____quarts

Container dimensions (if standard not used)

_____ Length _____Width _____ Depth

___ whole

___ headless

___ ice

___ without ice

___culled

___not culled

Appendix 1a. Creel census survey instrument.

The following questionnaire is part of a survey being conducted by the Marine Resources Division to evaluate the shrimp baiting fishery. It will be filed separately and cannot be traced to you individually. If you would like to participate by completing the following questions, your cooperation is sincerely appreciated.

YOUR RESPONSE IS VOLUNTARY AND IS NOT A PART OF THE PERMIT APPLICATION.

---

1. Did you have a shrimp baiting permit last year? _____YES ____NO

2. Did you do any other type of recreational salt water fishing this year? ____NO

___Rod & reel ___Gigging ___Gill netting ___Crabbing ___Shellfish gather:

3. What is your home's zip code? _____

4. How many people are there in your household (that reside with you)? _____

5. Please check the most appropriate blank describing your gross household income last year.

___less than $10,000 ___$30,000-$39,999 ___$60,000-$69,999

___$10,000-$19,999 ___$40,000-$49,999 ___more than $70,000: speci

___$20,000-$29,999 ___$50,000-$59,999 _____ to _____

6. Please check the most appropriate blank describing your occupational and employment status.

___Unemployed ___Professional/technical ___Clerical, sales

___Retired ___Managerial/proprietor ___Tradesman/manufacturing

___Military ___Farmer/farm manager ___Other (specify) _____

Appendix 1b. Preseason questionnaire.

South Carolina
Wildlife & Marine
Resources Department

EQUAL OPPORTUNITY AGENCY

James A. Timmerman, Jr., Ph.D.
Executive Director
Paul A. Sandifer, Ph.D.
Director of
Marine Resources Division

HELP US MANAGE YOUR RECREATIONAL SHRIMP BAITING FISHERY

In order for the Marine Resources Division to evaluate the effect of regulations and management strategies on the recreational shrimp fishery, we need to obtain detailed information on the people who participate as well as about the shrimp that they catch. You, the recreational shrimper, are the most reliable source of that information and we ask your help.

You have been selected from our baiting permit files to take part in this survey. Please contribute your part to the fair and effective management of this important recreational activity by filling out the questionnaire on the reverse side and mailing it in the self-addressed, prepaid envelope provided. Please answer honestly with your best estimates to the appropriate questions. Base your responses only on shrimping you did with your permit, tags, and poles. Respond even if you were unable to shrimp over bait during this season.

Thank you for your assistance.

S.C. Wildlife and Marine Resources Department

Appendix 1c. Postseason survey instrument (front this page, back following page).

1. Did you complete a pre-season questionnaire (either mailed to you or when applying for your permit)?

   _____YES _____NO

2. What is your home's zip code? _____ County_____

3. How many shrimp baiting trips have you made so far this season? If possible, indicate the number for each month to date.

   _____September _____October _____November _____Entire season

4. Where have you done most of your shrimping (which river, creek, etc.)?

   _____

5. Which boat launching point do you use most frequently? Please name if appropriate or provide a geographic reference point (example: Remleys Point, Mt. Pleasant)

   _____

6. How many different people have assisted you on your trips? _____

7. What was your average catch per trip? Please use only one blank.

   ____quarts whole ____quarts headless ____lbs whole ____lbs headless

8. How many times have you caught a limit (48 quarts whole shrimp)? _____

9. Did you shrimp over bait last year? _____YES _____NO

10. Have you done any other type of recreational saltwater fishing this year? ____NO

    ___Rod & Reel ___Gigging ___Gill netting ___Crabbing ___Shellfishing

11. How many people are there in your household (that reside with you)? _____

12. Please check the most appropriate blank describing your gross household income last year.

    ____less than $10,000 ____$30,000-$39,999 ____$60,000-$69,999
    ____$10,000-$19,999 ____$40,000-$49,999 ____more than $70,000:
    ____$20,000-$29,999 ____$50,000-$59,999 specify
    _____ to _____

13. Please check the most appropriate blank describing your occupational and employment status.

    ____Unemployed ____Professional/technical ____Clerical/sales
    ____Retired ____Managerial/proprietor ____Tradesman/manufacturing
    ____Military ____Farmer/farm worker ____Other _____

14. What problems or conflicts have you experienced while shrimping this season?

    _____

15. What changes should be made concerning the shrimp baiting fishery?

    _____

    _____

Appendix 1d. Estimation of participation.

Area of residence	No. of permit holders	- % making no trips	= Participating permit holders
Charleston County	2,202	28.9% (N = 636)	1,566
Berkeley/Dorchester	1,254	23.8% (N = 298)	956
Georgetown/Horry	136	22.2% (N = 30)	106
Other coastal counties	1,739	6.9% (N = 120)	1,619
Noncoastal counties	1,313	6.9% (N = 91)	1,222
Total			5,469

	No. of participating permit holders	x Average no. of assistants/permit holder	= Assistants	+ Holders	= Total
Charleston	1,566	2.053	3,215	1,566	4,781
Coastal	2,681	2.148	5,759	2,681	8,440
Noncoastal	1,222	2.232	2,728	1,222	3,950
Total			11,702		17,171

Appendix 1e. Estimation of catch by area of residence.

With measured catch rates from the creel census

Area of residence	Trips	x Catch/trip	= Quarts	x 1.48 = Pounds
Charleston County	6,890	29.7	204,633	302,857
Berkeley/Dorchester	4,015	29.3	117,640	174,107
Other coastal	13,140	22.3	337,622	499,681
Noncoastal counties	5,866	34.3	201,204	297,782
Total				1,274,427

With estimated catch rates from postseason questionnaire

Area of residence	Trips	x Catch/trip	= Quarts	x 1.48 = Pounds
Charleston County	6,890	25.77	177,555	262,781
Coastal	19,155	26.05	498,988	738,502
Noncoastal	5,866	27.56	161,667	239,267
Total				1,240,550

Appendix 1f. Estimation of mileage and trip expenditures.

Estimation of mileage (round trip) by residence category

Area of residence	Season trips	x	Average miles/trip	=	Total miles
Charleston County	6,890		17.0		117,130
Berkeley/Dorchester	4,015		76.2		305,943
Other coastal counties	15,140		36.4		551,096
Noncoastal counties	5,866		178.8		1,031,243
Total					2,005,412

Estimation of direct trip expenditures by residence category

Area of residence	Season trips	x	Average $/trip	=	Total expenditures
Charleston County	6,890		13.70		94,393
Berkeley/Dorchester	4,015		18.95		76,084
Other coastal counties	15,140		15.14		229,220
Noncoastal counties	5,866		32.50		190,645
Total					$ 590,342

Costs and benefits per participant

Area of residence	Permit fee	+	Trip cost	=	Total cost	Pounds	$/lb	lb/person
Charleston County	$39,150		$94,393		$133,543	262,781	0.51	55.0
Other coastal	$67,025		$305,304		$372,329	738,502	0.50	87.5
Noncoastal	$30,550		$190,645		$221,195	239,267	0.92	60.6

Appendix 1g. Hurricane-related projections.

Participation (by area of residence)

Area of residence	Registered permit holders	- no-shows	= Active holders
Charleston County	2,202	(8%) 176	2,026
Berkeley/Dorchester	1,254	(8%) 100	1,154
Georgetown/Horry	136	(8%) 11	125
Other coastal	1,739	(6.9%) 120	1,619
Noncoastal	1,313	(6.9%) 91	1,222
Total	6,644		6,146

The 8% figure is the percentage of no-shows statewide from 1988. The 6.9% figures are actual values in 1989.

Area of residence	Active holders	x Assistants	= Total participants
Charleston	2,026)		5,065
Berkeley/Dorechester	1,154)		2,885
Georgetown/Horry	125)	2.5	313
Other coastal	1,619)		4,048
Noncoastal	1,222)		3,055
Total	6,146	+	15,366 = 21,512

Effort

The percentage for other coastal is the actual 1989 value. Others are from the 1988 survey.

Area of residence	Active permits	x Average trips	= Total trips
Charleston County	2,026	7.44	15,073
Berkeley/Dorchester	1,154	7.44	8,586
Georgetown/Horry	125	7.44	930
Other coastal	1,619	8.90	14,409
Noncoastal	1,222	5.06	6,183
Total			45,181

Catch

45,181 trips x 26.5 quarts/trip = 1,197,297 quarts x 1.48 = 1.772 million pounds

(Appendix 1g. cont'd)

Expenditures

Area of residence	Trips	x	$/trip	=	Total trip expenditures
Charleston County	15,073		13.70		206,500
Berkeley/Dorchester	8,586		18.95		162,705
Other coastal	15,339		15.14		232,232
Noncoastal	6,183		32.50		200,948
Total					802,385
				+	166,100
					$ 968,485