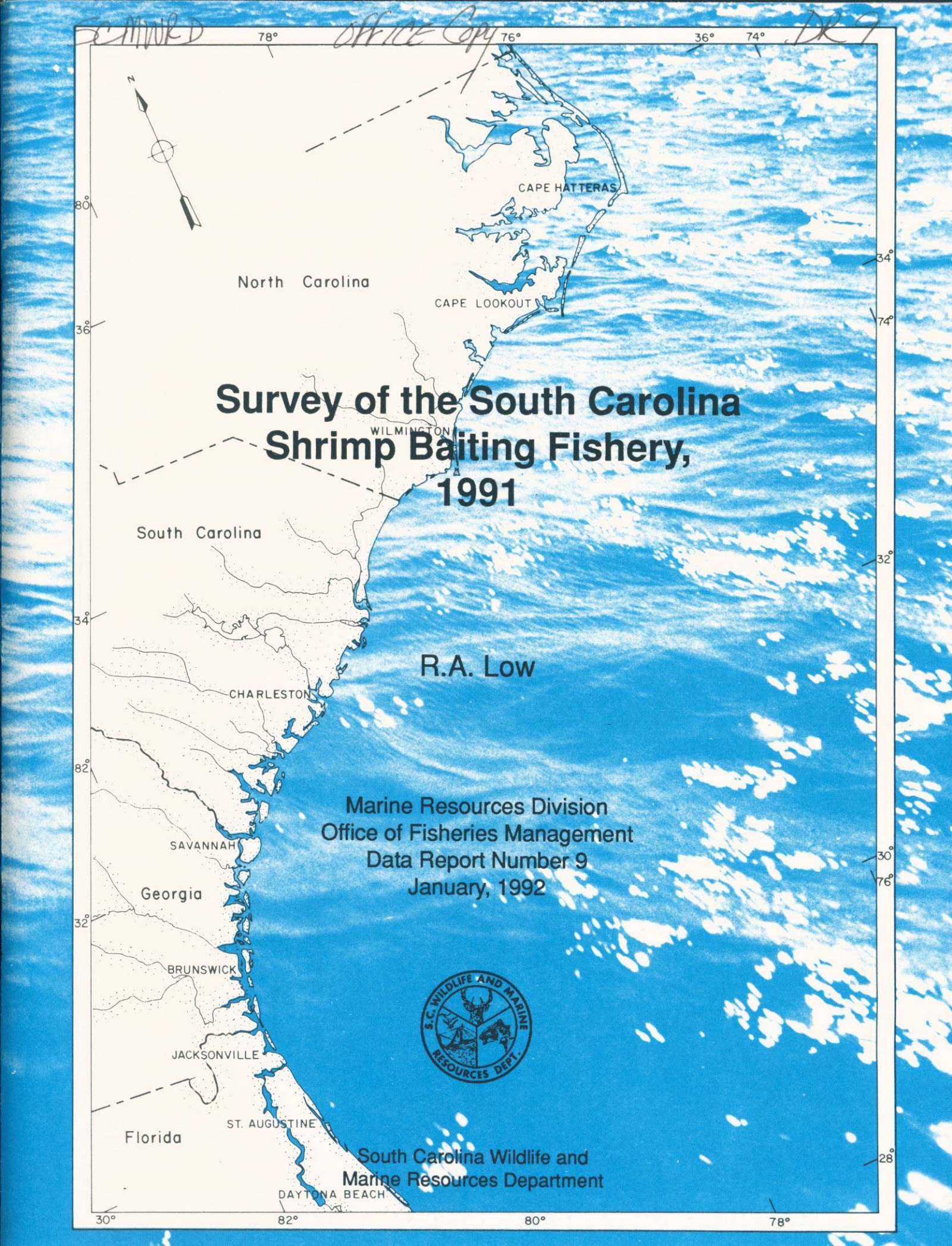

Survey of the South Carolina Shrimp Baiting Fishery, 1991

R.A. Low

Marine Resources Division
Office of Fisheries Management
Data Report Number 9
January, 1992

South Carolina Wildlife and
Marine Resources Department

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Charleston, South Carolina

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ABSTRACT

Information on the 1991 shrimp baiting fishery was obtained from a post season mailout survey sent to 25% of the 12,005 permit holders. The return rate at the end of the designated three-week response period was 37.5%. An estimated 10,724 permit holders and 24,097 assistants participated in the fishery, making 71,034 trips to catch 2.14 million pounds of whole shrimp. This exceeded the reported commercial catch during the same time frame by 11%. Permit holders made an average of 6.6 trips per individual. About 81% of the effort occurred during September/October and 19% in November. Residents of coastal counties (including Hampton, Berkeley, and Dorchester) represented 76% of the permit holders, expended 82% of the effort, and accounted for 79% of the catch. Charleston Harbor received a much lower percentage of effort than in recent seasons, with most of the displaced effort being directed at Bulls Bay. The statewide catch rate (21.3 quarts of whole shrimp per trip) was the lowest in five years as was the average seasonal share per participant (62 pounds of whole shrimp). The principal complaint registered by shrimpers was crowding. The poor condition of coastal access facilities also received prominent mention, particularly those in the Bulls Bay area. A majority of the respondents rated their season as less than satisfactory, although 89% expressed their intention to purchase a permit for the 1992 season.

ACKNOWLEDGEMENTS

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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 post season mailout survey of registered boat owners (Theiling 1988). In 1988, the General Assembly passed legislation establishing a 60-day season between 1 September and 15 November, a limit of ten poles to mark bait, a 48-quart (whole shrimp) limit per boat per day (regardless of the number of occupants and/or permit holders), and requiring at least one participant per boat to have a permit keyed to the pole tag numbers.

Licensing provided a means to directly survey the participants and a post season questionnaire was mailed to all permit holders (Waltz and Hens 1989). In 1989, the fishery was surveyed using a combination of methods from the earlier efforts. The 1989 survey consisted of an on-site creel census combined with a post season mailout to 45% of the permit holders and included questions that addressed socioeconomic aspects of the fishery in addition to participation, effort, and catch. Results from this study were described by Low (1990).

The survey of the 1990 fishery consisted of a mailout to 32% of the permit holder population, stratified by residence category. An abbreviated number of questions permitted the use of a postcard survey instrument. Permit holders were polled on several possible management options, compiled from previous survey responses (Low 1991).

The 1991 season began at noon on 13 September and ended at noon on 12 November. Information on the fishery was obtained by means of a post season mailout survey. Objectives were to 1) estimate total participation (i.e., the number of active permit holders and their assistants), 2) estimate total effort (i.e., the number of trips), 3) estimate total catch, 4) estimate effort and catch by major fishing areas, 5) update demographic and socioeconomic information, and 6) obtain constituency opinions on problems with the fishery and possible management options.

METHODS

The questionnaire (Appendix 1) was mailed first class with a pre-paid, self-addressed return envelope to approximately 25% (2,980) of the 12,005 permit holders (Appendix 2). Because of delayed receipt of the updated computerized list of permit holders, the mailout was not sent until 3 December, a longer than usual interval after the season closure.

Based on variances observed in previous surveys, the sample size needed to estimate average catch and effort with a 95% probability of being within + 5% of the true mean is about 1,000. Previous response rates within a reasonable recall period (30-45 days) have ranged from about 35-40%, therefore it was projected that the 25% sampling level would generate an adequate sample size. The

mailout was stratified by residence categories, based on the distribution of permit holders, as follows: 1) Charleston County, N = 890; 2) Beaufort, Jasper, Hampton, and Colleton Counties combined, N = 696; 3) Berkeley and Dorchester Counties combined, N = 534; 4) Aiken, Allendale, Bamberg, Barnwell, Orangeburg, Lexington, and Richland Counties combined (Aiken Group), N = 481; 5) Georgetown and Horry Counties combined, N = 169; and 6) other counties and nonresidents, N = 210. The selection program designated every fourth permit holder in each county's listing as a mailout recipient, thus the sample mailout was identical in residential composition to the total permit holder population.

The response period was terminated after three weeks. By this time, the target sample size had been obtained and its distribution was reasonably balanced in terms of response rates by residence category (i.e., the stratification of respondents was comparable to that of the total permit holder population). Because of the delayed mailout, it was thought that any benefit from extension of the response period (to achieve a larger sample size) would be largely negated by decreased recall ability.

RESULTS

The distribution of 1991 permit holders by area of residence (Fig. 1) was very similar to that in recent years (Table 1). One percent of the mailout was returned as nondeliverable. After adjustment for this factor, the response rate after three weeks was 37.5% (N = 1,106). An additional 134 responses (not included in the analysis) were received by 8 January, for a total return rate of 42% during a one-month period.

Participation

Statewide, 10.6% of the permit holders did not make at least one shrimp baiting trip using their tags and poles, based on expansions from the survey returns. Some apparently participated as assistants to other permit holders, however, the extent of such activity cannot be determined from the survey responses. Participation rates tended to be similar by residential category (Table 2). The estimated number of active permit holders was obtained by multiplying the number of permits issued in each residential category by the percentage of active respondents. Assistants were the numbers of different individuals who joined the permit holders on their trips (conceivably, some individuals were counted by more than one permit holder, but there was no way to determine this). The average number of assistants per permit holder reported for each residential category was multiplied by the estimated number of active permit holders to obtain the estimated number of assistants. The total numbers of participants by residential category equalled the sum of the active permit holders and assistants.

Respondents were asked to estimate the number of trips they made in each month and most did so. Based on these data, about two-thirds of the active permit holders made at least one trip in September. Over three-fourths participated during October, while

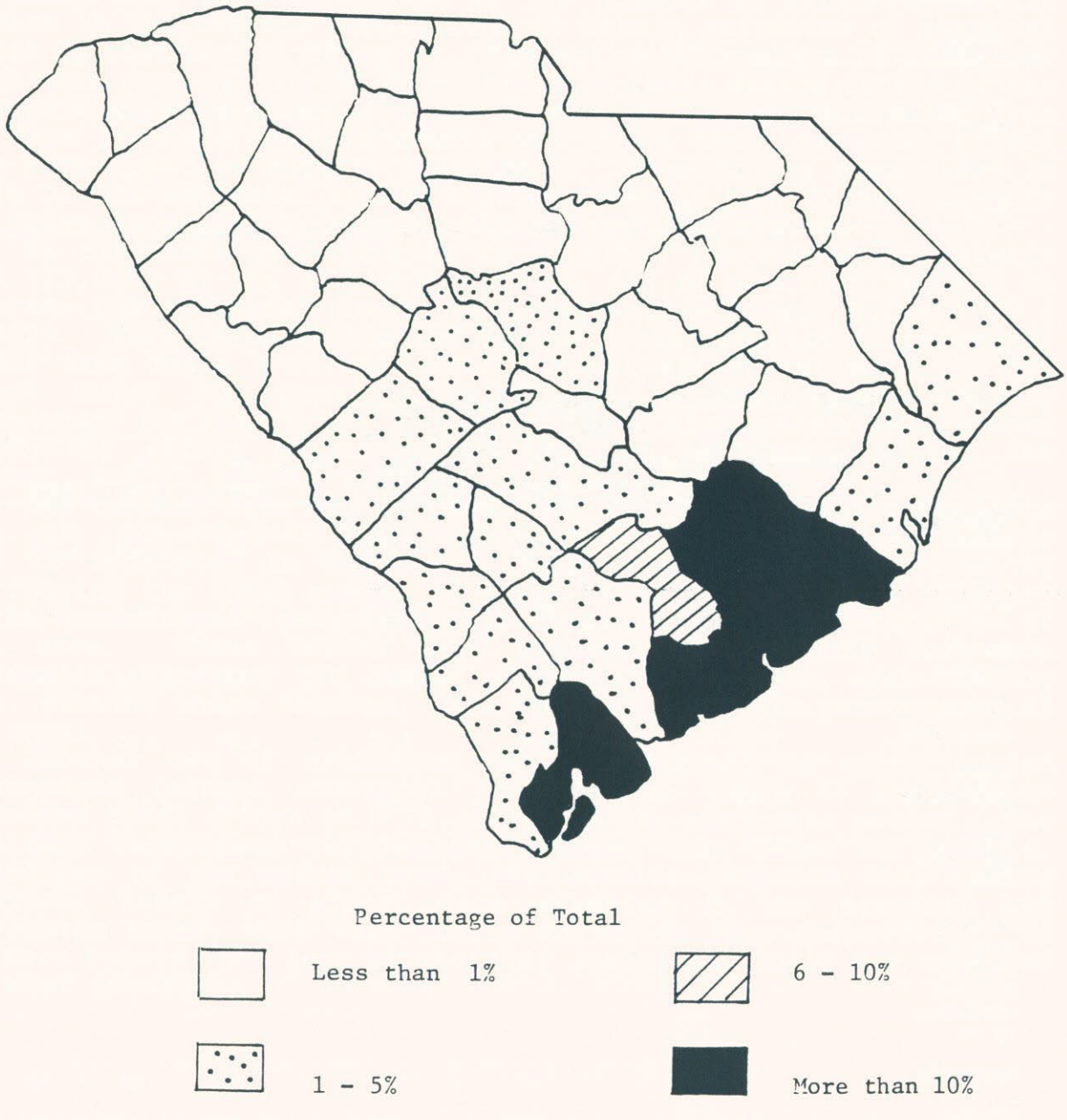

Fig. 1. Distribution of 1991 shrimp baiting permit holders by county of residence.

Table 1. Distribution of permit holders by area of residence and 1991 response rates.

Counties	N	1991 Percentage	1990 Percentage	1989 Percentage	1991 Percentage response
Charleston	3,562	29.7	33.7	33.1	36.3
Beaufort, Jasper, Hampton, and Colleton	2,794	23.3	23.0	26.2	36.8
Berkeley, Dorchester	2,139	17.8	18.6	18.8	34.3
Georgetown, Horry	681	5.7	3.9	1.9	31.1
Other	2,829	23.5	20.8	20.0	43.7
Total	12,005				37.5

Table 2. Estimated participation by residential category

	Charleston County	Beaufort/Jasper/ Hampton/Colleton	Berkeley/ Dorchester	Georgetown/ Horry	Aiken, etc.	Other	Total
Permits issued	3,562	2,794	2,139	681	1,809	1,020	12,005
Percent active	87.5	89.4	90.0	90.4	92.3	88.0	89.4
Number active	3,117	2,498	1,925	616	1,670	898	10,724
Avg. no. of assistants	2.22	2.24	2.44	1.85	2.16	2.38	2.24
Number of assistants	6,920	5,596	4,697	1,140	3,607	2,137	24,097
Total participants	10,037	8,094	6,622	1,756	5,277	3,035	34,821
Percent of active permit holders shrimping by mo.							
September	71	62	67	66	59	56	64
October	78	83	74	81	76	80	78
November	54	48	53	45	42	36	48

just under half went in November. Rates of participation by month tended to be roughly equivalent in all residential categories except in November, when there was relatively less activity by inland residents.

Effort

The average number of season trips per active permit holder was obtained by summing the number of trips in each residential category and dividing this figure by the number of active permit holders. The means were then multiplied by the numbers of estimated active holders in the overall populations to obtain estimates of seasonal effort by residential category. The estimated numbers of trips per month were then calculated by multiplying these season totals by the appropriate percentages of trips in each month, as determined from the data provided by respondents who broke their seasonal effort down into complete monthly components. Results are summarized in Table 3. The estimated effort figures shown in the "Total" category are those generated by summing the categorical figures.

An alternate procedure is to multiply the number of permits sold (12,005) by the active percentage (89.4) shown in Table 2 to generate the estimated number of total active permit holders (N = 10,732). This value multiplied by the pooled average trips/permit holder from Table 3 (6.56) gives a total effort estimate (70,402 trips) which can then be multiplied by the pooled monthly percentages (in the "Total" column of Table 3) to obtain another set of monthly effort estimates (25,345 for September, 31,681 for October, and 13,376 for November).

The coastal area was divided into six geographical components (Fig. 2). The relative distribution of estimated effort by fishing area is indicated in Table 4. These figures were obtained by multiplying the total number of trips in each residential category by the percentages (geographically reported) of effort targeted at each area. These values were derived by compiling for each residential category the number of trips reported in each fishing area, summing these figures, then determining their percentages of the total.

Another set of estimates can be obtained by using pooled percentages (almost identical to those in Table 4) applied to estimated total effort (N = 70,402) from the alternate method. The resultant values are very slightly lower than those in Table 4. Regardless of the method used, the results indicate that nearly identical levels of effort were expended in the Beaufort and Charleston areas, with very little shrimping near Georgetown. Of the more remote (and less accessible) locations, Bulls Bay received the most pressure.

Table 3. Estimated effort (number of trips) by residential category.

	Charleston County	Beaufort/Jasper/ Hampton/Colleton	Berkeley/ Dorchester	Georgetown/ Horry	Aiken, etc.	Other	Total
Avg. trips per active permit holder	7.25	7.74	6.90	5.34	4.90	4.84	6.56
Percent of total trips by month:							
September	41	32	33	38	33	33	36
October	40	49	45	46	46	48	45
November	19	19	22	16	21	19	19
Estimated trips per month:							
September	9,265	6,187	4,383	1,250	2,700	1,434	25,219
October	9,039	9,474	5,977	1,513	3,764	2,086	31,853
November	4,294	3,674	2,923	526	1,719	826	13,962
Estimated season trips	22,598	19,335	13,283	3,289	8,183	4,346	71,034
Percent of total effort							
1991	32	27	19	5	12	6	
1990	38	26	18	4		--13--	

BF - BEAUFORT (including Calibogue and Port Royal Sounds, Broad River)

SH - ST. HELENA SOUND (including Coosaw, Combahee, and Ashepoo Rivers)

WE - WADMALAW/EDISTO ISLAND (including N. and S. Edisto Rivers)

CH - CHARLESTON HARBOR (including Kiawah, Stono, Folly, Ashley, Cooper and Wando Rivers)

BB - BULLS BAY (including McClellanville area)

GH - GEORGETOWN (including Santee and Winyah Bays and Horry County intracoastal waterway)

Fig. 2 Shrimp baiting areas.

Table 4. Estimated effort (number of trips) by fishing area.

Residential category	Fishing Area BF	SH	WE	CH	BB	GH
Charleston County	57	11	2,865	15,390	4,011	264
Beaufort/ Jasper/ Hampton/ Colleton Counties	17,125	1,903	171	103	23	11
Berkeley/ Dorchester Counties	778	247	877	8,069	3,077	235
Georgetown/ Horry Counties	13	0	0	13	2,298	964
Aiken Group	5,399	851	984	594	239	115
Other Counties	1,287	508	579	272	1,299	402
Total	24,659	3,520	5,476	24,441	10,947	1,991
Percent of total 1991	35	5	8	34	15	3
1990	31	6	7	49	3	4

The distribution of statewide seasonal effort is shown in Table 5. About 58% of the respondents reported making five or less trips during the 1991 season, compared to 44% in 1990. The percentage of respondents making more than ten trips (13%) was appreciably less than that in 1990 (21%).

Catch Rates

With the exception of Bulls Bay, catch rates in areas north of the N. Edisto river were substantially lower than those in the southern part of the state (Table 6). Residents in the southern coastal area and inland counties fared better than those from the Tri-County area (Charleston, Berkeley, Dorchester) and northern coastal region. Compared to past seasons, there were few limit catches reported and the majority of the state's shrimpers averaged less than half a limit per outing (Table 7).

Because the residential stratification of the respondent population closely paralleled that of the total active permit holder population, an unbiased estimate of the average statewide seasonal catch rate can also be obtained directly by dividing the sum of reported seasonal catches by the total reported number of trips (ratio of average value). This provides a seasonal CPUE estimator of 20.0 quarts of whole shrimp per trip. A similar approach is to average the individual seasonal catch rates for the entire sample (i.e., an average of ratios estimator); this produces a value of 21.26 quarts per trip. The latter statistic is usually preferred because the resultant value is unweighted by the distribution of effort and normality assumptions are usually better met (Rothschild and Yong 1970).

Results of the 1989 survey (Low 1990) indicated that several factors may influence catch rates. One is net length. Combined data from both areas of major shrimping activity (Beaufort and Charleston) suggested that shrimpers using larger nets were more successful. The 1991 survey data (from all areas) supported that interpretation, as indicated below:

	1989		1991	
Net length	N	$\bar{x}$ catch/hr	N	$\bar{x}$ catch/trip
5 ft	66	8.0	199	17.2
6 ft	181	8.2	568	21.9
7 & 8 ft	85	11.8	163	24.1

In 1989, about 45% of the shrimpers in the Beaufort area used 1/2 in. or larger mesh nets, compared to about 20% of the Charleston area participants. In 1991, the percentages of shrimpers using larger (>1/2 in.) mesh were substantially higher. About 47% of the Tri-County area participants (most of whom shrimped in the Charleston area) used the bigger mesh, while 61% of the Beaufort/Jasper/Hampton/Colleton residents used 1/2 in. mesh. Statewide usage in 1991 was divided equally (49% in each category)

Table 5. Distribution of statewide seasonal effort.

Residential category	Trips per individual per season <5	6-10	11-15	16-20	>20
Charleston County	54%	31%	9%	2%	1%
Beaufort/Jasper/ Hampton/Colleton Counties	51%	31%	7%	5%	5%
Berkeley/Dor-chester Counties	51%	35%	11%	1%	1%
Georgetown/Horry Counties	62%	29%	9%	0	0
Aiken Group	72%	22%	4%	1%	1%
Other Counties	68%	28%	3%	0	1%
Total statewide	58%	30%	8%	2%	3%

Table 6. Catch rates (quarts of whole shrimp per trip) by residential category and fishing area.

Residential category	Fishing area BF	SH	WE	CH	BB	GH	Total
Charleston County	20.0	-	28.5	13.7	19.6	12.5	17.0
Beaufort/Jasper/ Hampton/Colleton Counties	23.4	17.4	24.5	-	-	-	24.1
Berkeley/Dor-chester Counties	31.2	30.0	23.8	13.9	27.2	-	19.4
Georgetown/Horry Counties	-	-	-	-	21.3	7.4	18.2
Aiken Group	26.0	30.5	17.2	18.8	29.6	-	24.6
Other Counties	27.8	31.2	15.1	29.2	21.2	-	25.7
Total State	24.4	25.0	24.2	14.1	22.5	10.5	20.8
Number of observations	287	36	56	226	65	15	685

Table 7. Distribution of average seasonal catch rates (quarts of whole shrimp per trip), in percentages of respondents.

Residential category	Catch Rate <10	10-20	21-30	31-40	41-48
Charleston County	28%	41%	22%	6%	3%
Beaufort/Jasper/ Hampton/Colleton Counties	17%	32%	23%	15%	13%
Berkeley/Dorchester Counties	27%	33%	25%	7%	8%
Georgetown/Horry Counties	30%	26%	34%	6%	4%
Aiken Group	17%	24%	32%	16%	11%
Other Counties	15%	33%	22%	9%	21%
Total State	22%	33%	25%	10%	9%
Cumulative %	22%	55%	80%	90%	100%

between 3/8 and 1/2 in., with the average catch rate (quarts per trip) being 10% greater with the 1/2 in. mesh.

Experience frequently influences fishing success although the relationship is difficult to quantify (Cato and Prochaska 1977). In most situations, it probably is not asymptotic but rather increases to a certain point and then levels off (i.e., the fisherman does not appreciably increase his proficiency beyond a given level simply by continued participation). Although the technique has been practiced in South Carolina (particularly the Beaufort area) since at least the early 1980's, it was not widely popular until 1986. Thus, relatively few shrimpers would be expected to have five or more years of baiting experience. This was confirmed by the survey results, which also suggested that experience is a factor in shrimp baiting success, though not an overriding one.

	Years of baiting experience				
	0-1	2	3	4	5
Number of respondents	249	215	244	128	176
Percentage of total	25%	21%	24%	13%	17%
Average catch per trip	17.8	18.6	20.5	21.6	21.3

Catch

The total statewide catch was estimated in several ways. Because of the similar residential composition of the total permit holder population and the respondent group, one unbiased estimate can be obtained directly by multiplying the estimated total number of trips by the average of ratios CPUE estimator. Using the higher value for estimated trips (N = 71,034), this produces a catch estimate of 1,510,183 quarts of whole shrimp. With the lower effort estimate (N = 70,402 trips), the figure is 1,496,747 quarts. Various combinations of these trip figures and other statewide CPUE indices generate catch estimates of 1,408,040 quarts, 1,464,362 quarts, 1,420,680 quarts, and 1,477,507 quarts.

Another approach is to multiply the estimated number of trips in each fishing area by the average catch rate for that area, as summarized below using data from Tables 4 and 6:

Fishing area	Trips	Catch rate	Catch (whole quarts)
BF	24,659	24.4	601,680
SH	3,520	25.0	88,000
WE	5,476	24.2	132,519
CH	24,441	14.1	344,618
BB	10,947	22.5	246,308
GH	1,991	10.5	20,906

The sum from this approach is 1,434,031 quarts.

Another method is to multiply the number of active permit holders in each residential category by the average number of trips per permit holder to obtain the effort estimates, then multiply

these by the mean catch rate for each category. These results, using data from Tables 3 and 6, are as follows:

Residential category	Trips	Catch rate	Catch (whole quarts)
Charleston County	22,598	17.0	384,170
Beaufort/Jasper/ Hampton/Colleton Counties	19,335	24.1	465,962
Berkeley/Dorchester Counties	13,283	19.4	257,681
Georgetown/Horry Counties	3,289	18.2	59,868
Aiken Group	8,183	24.6	201,302
Other Counties	4,346	25.7	111,700

The sum of the catches by residential category is 1,480,683 quarts.

Within each residential category, the catch rate reported by each respondent can be multiplied by the number of trips reported to obtain that individual's season catch or the estimate the respondent provided can be used. The average seasonal catch can then be calculated and multiplied by the number of active permit holders in that residential category. This procedure, using the season catch estimates provided by the respondents, produces the following results:

Residential category	Average catch	Active permits	Catch
Charleston County	117.0	3,117	364,689
Beaufort/Jasper/ Hampton/Colleton Counties	175.9	2,498	439,398
Berkeley/Dorchester Counties	124.7	1,925	240,048
Georgetown/Horry Counties	94.5	616	58,212
Aiken Group	119.9	1,670	200,233
Other Counties	112.1	898	100,666

The total catch estimate from this procedure is 1,403,246 whole quarts.

Finally, the estimated catches by residential category in each

fishing area can be added up. Using data from Tables 4 and 6 (estimated effort in each cell and catch rate), the area cell catches can be generated; the statewide area values were substituted for missing CPUE observations in the residential categories. These figures are summarized in Table 8.

The following listing summarizes the range of estimates (in quarts of whole shrimp) for the various residential categories and fishing areas:

Residential category	Fishing area
Charleston County...364,689-384,170	BF...601,680-602,609
Beaufort, Jasper, Hampton, Colleton Counties.....439,398-465,962	SH...82,603-88,000 WE...132,384-132,519 CH...343,746-344,618
Berkeley, Dorchester Counties.....240,048-257,681	BB...246,308-246,388 GH...18,477-20,906
Georgetown, Horry Counties.....56,581-59,868	
Aiken Group.....200,233-202,704	
Other Counties.....100,074-111,700	

A total of 14 estimates of total catch can be derived using these procedures, ranging from 1,401,023 quarts of whole shrimp to 1,510,183 quarts. In pounds of whole shrimp (x 1.48), the range is 2.074 - 2.235 million pounds (1.348 - 1.453 million pounds heads-off). Each estimation procedure has advantages and disadvantages depending on the application and there is no obviously superior method. The average of the 14 values is probably a reasonable proxy. This was 1,447,498 quarts of whole shrimp, equivalent to approximately 2.142 million pounds of whole shrimp and 1.392 million pounds heads-off.

The distribution of reported season catch per active permit holder is shown in Table 9. Based on the above estimate of total catch, the average active permit holder caught 140 quarts (200 pounds) of whole shrimp. Assuming that this was evenly divided between the permit holders and assistants, the typical participant in the 1991 fishery obtained 41.5 quarts (61.5 pounds) of whole shrimp or about 40 pounds of heads-off product.

Table 8. Estimated catches by residential category and fishing area.

Residential category	Fishing area BF	SH	WE	CH	BB	GH	Total
Charleston County	1,140	275	81,653	210,843	78,616	3,300	375,827
Beaufort/Jasper/ Hampton/Colleton Counties	400,725	33,112	4,190	1,452	518	116	440,113
Berkeley and Dorchester Counties	24,274	7,410	20,873	112,159	83,694	2,468	250,878
Georgetown and Horry Counties	317	0	0	183	48,947	7,134	56,581
Aiken Group	140,374	25,956	16,925	11,167	7,074	1,208	202,704
Other Counties	35,779	15,850	8,743	7,942	27,539	4,221	100,074
Total	602,609	82,603	132,384	343,746	246,388	18,447	1,426,177
Percent of Total	42	6	9	24	17	1	

Table 9. Distribution of season catches by residential category.

Residential category	Catch (quarts of whole shrimp) <99	100-199	200-299	300-399	400-499	>500
Charleston County	58%	25%	11%	2%	3%	2%
Beaufort/ Jasper/ Hampton/ Colleton Counties	45%	21%	18%	7%	4%	5%
Berkeley/ Dorchester Counties	53%	23%	15%	7%	1%	1%
Georgetown/ Horry Counties	59%	28%	11%	2%	0	0
Aiken Group	58%	23%	14%	2%	1%	1%
Other Counties	61%	24%	9%	4%	1%	1%
Total state	54%	24%	14%	4%	2%	2%
Cumulative %	54%	78%	92%	96%	98%	100%

Constituency Opinions

Respondents were asked to rate the season as poor, fair, satisfactory, good, or excellent. Results are summarized in Table 10. Not surprisingly, appraisals generally reflected the distribution of catch rates. Tri-County participants were the least pleased, with about three-fourths giving the season less than satisfactory ratings. Overall, 60% of all respondents were in this category.

As has been the practice in recent surveys, respondents were asked to identify problems they encountered during the season. As usual, a wide variety of responses was received, but most could be assigned to several general classifications. Table 11 summarizes the problem areas most frequently cited.

Most frequently mentioned was crowding, both at access points and on the water. This appeared to be a universal complaint regardless of area although Bulls Bay was often specifically identified. Limited launching areas and the poor condition of many of these facilities were related problems exacerbated by the crowding. Again, the Bulls Bay area (Moore's and Buck Hall landings) was particularly singled out for criticism.

The principal resource-related problem identified was the small size of the shrimp, particularly in Charleston Harbor and Winyah Bay. Scarcity of shrimp was also a prominent complaint of shrimpers using these areas.

Weather caused problems for many shrimpers, especially those coming from inland without adequate knowledge of current tide and wind conditions. Northeast winds were prevalent during the season and produced choppy conditions on outgoing tides in exposed areas such as Charleston Harbor. Since many shrimpers use small boats, this caused both discomfort and concern.

Illegal sales apparently continued to be widespread, judging from the comments received. Although many respondents recognized the difficulty in preventing this practice, they felt more could be done to control it. The activity apparently is widely held in disfavor by most legitimate shrimpers.

Considering the crowding, there were relatively few complaints about the conduct of other shrimpers and/or boaters. Few respondents referred to conflicts over territory, harassment, and other personal interactions. The most frequently mentioned specific problems were boaters operating without lights, irresponsibly, and drunk. Some Beaufort area shrimpers complained about large numbers of nonresidents (from Georgia) although only ten non-resident permits were issued.

Compared to previous surveys, there were relatively few comments on management received (Table 12). From this it can be implied that most of the constituency is generally satisfied with the current arrangement; a sizeable group expressed this sentiment directly. Those permit holders who did respond generally addressed the same aspects as in previous years. The most popular change is a longer season, an option that has consistently had strong support. Changes in the limit also received considerable comment, with the most frequently mentioned one being to set the limit per permit holder rather than per boat. Some shrimpers supported a lower trip

Table 10. Respondents' rating of the 1991 season, in percentage of replies in each category.

Residential category	Poor	Fair	Satisfactory	Good	Excellent
Charleston County	44%	27%	15%	10%	4%
Beaufort/Jasper/ Hampton/Colleton Counties	29%	20%	23%	22%	6%
Berkeley/Dorchester Counties	50%	25%	13%	8%	4%
Georgetown/Horry Counties	34%	28%	15%	21%	2%
Aiken Group	22%	26%	24%	22%	5%
Other Counties	22%	20%	26%	24%	8%
Total state	35%	25%	19%	16%	5%

Table 11. Problems cited by respondents, in number of replies per category.

	Chas. Cty.	Beaufort Group	Berkeley/ Dorchester	Georgetown/ Horry	Aiken Group	Other
Crowding	30	38	24	8	23	10
Small shrimp	53	15	40	3	9	3
Few shrimp	43	13	24	8	7	4
Weather	17	18	23	8	17	12
Poor/limited access facilities	22	3	16	7	11	7
Illegal sales	20	21	8	3	9	3
Other shrimpers and boaters	10	5	6	1	1	3
Nonresidents	-	8	-	-	3	1
Vandalism/theft	3	1	3	-	4	-
Game hogs	3	3	-	-	-	-

Table 12. Comments on management, in number of replies per category.

	Chas. Cty.	Beaufort Group	Berkeley/ Dorchester	Georgetown/ Horry	Aiken Group	Other
None/no response	134	88	63	26	105	38
No changes	28	33	19	6	18	5
Longer season	31	20	20	4	18	7
Limit changes	11	26	15	4	26	11
More/improved law enforcement	25	18	17	2	20	4
Flexible season dates	21	7	19	3	3	2

limit if a longer season was in effect, while others simply wanted a higher limit to justify their efforts.

A sizeable number of respondents expressed a need for more and/or improved enforcement of existing regulations, although comments about enforcement efforts they had witnessed were generally favorable. Three concerns were typically addressed: 1) illegal sales, 2) limit excesses, and 3) boat operation (e.g. no lights, high speeds, drunk operators). One specific need often referred to was for more on-the-water patrols.

The final main area of comment dealt with the season opening and closing dates, with a roughly equal split between those favoring an earlier opening and those supporting a later one. Many shrimpers appear to be unaware of the statutory limitations on MRD's flexibility in setting these dates. There also were many opinions expressed of a more or less unique nature that could not be readily categorized. Some of these are referred to in the Discussion.

DISCUSSION

Survey Reliability

The sample size (N = 983) used to estimate the most important parameter, mean catch per trip, provided a value within - 4% of the true mean (95% confidence level) for the variance observed. Since the residential composition of the respondent population was comparable to that of the total permit holder population, the CPUE estimator obtained by averaging the figures provided by the sample group (average of ratios statistic) should be an unbiased index. This index multiplied by the estimated total number of trips should therefore generate a reasonably reliable estimate of the total statewide catch. The resultant value is slightly over 1.5 million quarts of whole shrimp (depending on the effort estimate used). The catch estimate determined by averaging the various estimates derived was 3.5% less than this, within the general statistical margin of error associated with the sample size. The averaged estimate therefore appears to be a reasonable figure for the total catch given the trade-offs associated with the various estimation procedures.

The survey approach of course assumes that the CPUE estimates provided by the respondents accurately represented their actual catch rates. Results from the 1989 creel census showed no significant difference between shrimpers' estimates of what they had caught and the actual catches (as measured volumetrically by the creel clerks). It must also be assumed that the respondents' recall of their catch rates was reasonably accurate. It appears that most shrimpers have rather accurate estimates of their catches (due to splitting up the catch with assistants, packaging for freezing, etc.) and the recall period allocated for the survey was sufficiently short to permit reasonably reliable recall of the number of trips made.

Season Comparisons

The 1991 shrimp season was highly unusual from its inception.

Due to a large overwintering population and a mild winter, the spring spawning (roe) stock was the largest in 15 years. An excellent spawn and favorable postlarval survival conditions led to highly optimistic assessments of the probable abundance of fall white shrimp. MRD sampling in inner estuarine areas confirmed the presence of very high densities of juvenile shrimp in most areas during early summer, with an average size similar to that in 1990.

State rainfall during July was extremely heavy with associated high discharge rates from the rivers into estuarine nursery areas. This influx of fresh water lowered salinities well below normal, particularly in areas receiving discharge from rivers with upstate drainages. The lowered salinities appeared to reduce the growth rate of the juveniles as well as stimulate early outmigration from the nursery areas. Shrimp first moved into the rivers and open estuarine areas, where they were more vulnerable to predation, then seaward into coastal trawling areas. August trawl landings, normally less than 200,000 pounds (heads-off), were about 1.05 million pounds, composed of substantially smaller than average shrimp. Landings during August and September (when trawl catches also exceeded one million pounds) averaged 49 count (heads-off) compared to 34 count in 1990.

The impact on the shrimp baiting fishery was obvious. First, much of the stock that would normally have been available to the recreational shrimpers in estuarine areas had moved into the ocean (and been caught) prior to the opening of the shrimp baiting season. An earlier opening (the law allows the season to open as soon as 1 September) would have partially alleviated this situation but was rejected because of the very small size of the shrimp in Charleston Harbor and other popular areas. MRD decided that the wastage of large quantities of very small shrimp would negate any advantage of an earlier opening. The season was therefore delayed until almost the statutory deadline.

Small and few shrimp were leading complaints of respondents who shrimped in the Charleston Harbor and Winyah/Santee Bay areas. Both are fed by large rivers with extensive upstate watersheds and experienced abnormally low salinities for weeks prior to the season. By the time it opened, a substantial portion of the population in the estuaries had moved out and the remaining shrimp were small. For example, on opening weekend catches seen in the Charleston Harbor area consisted mostly of 70 count or smaller shrimp. Continuation of this situation tended to reduce effort in the Charleston and Georgetown areas and many shrimpers from the Tri-County area and Georgetown County eventually shifted their effort elsewhere, notable to Bulls Bay. This accounted for the substantial reduction in the percentage of total effort in the Charleston Harbor area and the increase in Bulls Bay effort (Table 4).

During the last two weeks of September, larger shrimp were reported in the Wadmalaw Island/Edisto Beach area and some effort was also diverted there. Reports of decent catches and larger shrimp attracted large numbers of shrimpers to Bulls Bay, where success apparently was good until mid-October. Bulls Bay has no major tributary rivers and received little fresh water inflow, which probably accounted for the relative abundance and large size of shrimp there.

Estuaries in the southern part of the state, particularly Calibogue Sound, received relatively lower amounts of river discharge and the salinities were higher. Shrimp were somewhat larger and more abundant, as reflected in the higher catch rates in the Beaufort and St. Helena Sound fishing areas (Table 6). Most Beaufort/Jasper/Hampton/Colleton County residents shrimped primarily in these areas (Table 4), which largely accounted for their higher catch rates. Inland residents, particularly those from the counties in the Aiken Group, also expended the majority of their effort south of the Charleston area, which also contributed to their relatively high success. Results of the 1989 survey indicated that average catch per trip increased with the number of hours shrimped. Residents of inland counties made fewer trips (Table 3) and (presumably) shrimped more hours per trip to improve their catches, so this factor also would have contributed to their success regardless of the area shrimped.

Table 13 summarizes performance parameters for the 1991 season vs those of previous years. The increase in permits sold was 24%, compared to 46% in the previous year although the percentage of active users declined (presumably due in part to reports of poor shrimping). The average number of assistants accompanying permit holders also declined, resulting in a level of total participation nearly the same as in 1990. The average number of trips per permit holder was down in all residential categories (from 4% in the inland counties to 39% in Georgetown/Horry Counties). Seasonal effort per permit holder decreased by 16% in Charleston County and 13% in the Beaufort Group, the two principal sources of permit holders. This offset the increase in permit holders so that total effort in 1991 was nearly identical to that in 1990.

The statewide average catch rate was the lowest reported during the five seasons surveyed, with the unusual climatic conditions and consequent early outmigration of shrimp primarily responsible. The average yield per participant was also the lowest to date. The overall catch by shrimp baiters was appreciable in spite of the reduced size and availability of shrimp, particularly when compared to commercial (mainly trawl) landings during comparable periods. In 1990, the baiting catch (from 7 September - 6 November) was about 20% greater than the September/October commercial landings. During 1991, the catch by baiters was approximately 11% more than the commercial landings for the same period. (Commercial landings were calculated as the sum of landings submitted via weekly reports for 15 September - 15 November, the dealer reported landings for October, and half of the dealer reported landings in September and November).

Problems and Options

The substantial increase in participation in recent years has severely taxed the capacity of the largely marginal access facilities in popular areas as well as produced increased congestion on the water. This will probably continue to be a major complaint of participants in this increasingly popular recreational activity; 89% of the 1991 respondents indicated that they would purchase a permit for the 1992 season vs only 5% who said they would not. If

Table 13. Season comparisons of participation, effort, and catch parameters.

	1987	1988	1989	1990	1991
Permits	NA	5,509	6,644	9,703	12,005
% active permits	NA	92	82	94	89
Assistants/permit holder	NA	2.50	2.14	2.79	2.24
Participants	21,735	17,749	17,171	34,662	34,821
Season trips/ permit holder	NA	6.99	5.73	7.78	6.56
Effort (trips)	40,101	35,609	31,624	71,153	71,034
Quarts/trip (whole shrimp)	28.5	22.1	26.5	25.6	21.3
Million pounds (whole shrimp)	1.80	1.16	1.25	2.75	2.14
Pounds/participant	83	65	73	79	62
Percent of total fall harvest	29	32	24	46	29

this percentage of 1991's permit holders does obtain licenses and an additional 20% is accounted for by newcomers, the 1992 permit holder population would be at least 12,820.

Illegal sale is another major problem. The unenforceability of the present law is widely recognized and an incentive for those who would profit from the fishery. Peer pressure may eventually curtail it somewhat, but most buyers of the illicit product probably either don't know its source or don't care. More restrictive commercial licensing is likely to have relatively little impact. Either the individuals will obtain the required license and continue to "launder" shrimp illegally caught or they will simply ignore the license (as many now do) and continue doing business as usual. Very few respondents had commercial licenses; seven reported having a trawler captain's license, two a land and sell license, and two were primary wholesale dealers. Some respondents indicated that holders of commercial licenses should not be issued a baiting permit (would the same logic apply to the marine recreational fishing stamp?). Since only one percent of the respondents held such licenses, it seems that this measure would accomplish little to reduce illegal sales and could easily be judged discriminatory.

Conservation and efficient utilization of the resource are principal concerns of MRD. Commercial shrimpers have complained about the potential wastage (of small unusable shrimp) associated with widespread use of small mesh cast nets in estuarine areas, particularly the more inland portions where small shrimp predominate. This is a relevant issue considering the increasing spatial competition in lower estuarine areas due to greater participation and the resultant tendency to move inland to less crowded waters (particularly where coastal access facilities are overtaxed).

Recent studies by the Georgia Coastal Resources Division (Woodward 1989) and MRD (Whitaker et al. 1991) have demonstrated that the average size of shrimp caught by cast nets increases progressively with mesh size. In the MRD study, 3/8 in. and 1/2 in. mesh nets retained virtually identical numbers of usable shrimp, but the wastage rate of small shrimp was much higher (54%) with the smaller mesh than with the 1/2 in.(25%). MRD's Crustacean Management Program (CMP) therefore recommended that a minimum mesh regulation of 1/2 in. be adopted (Whitaker et al. 1991). While the 1991 survey indicated greater usage of larger mesh nets than in 1989, almost half of the shrimp baiters still used the 3/8 in. mesh. It would therefore be appropriate to specify some future date at least two years in advance (e.g. 1 September, 1994) as the cut-off for use of nets with less than 1/2 in. mesh in this fishery.

A suggested CMP alternative was the restriction of use of 3/8 in. mesh to nets 5 ft or less in length. Practically no shrimpers reported using 4 ft nets (regardless of mesh size) while only about 12% used 5 ft nets with 3/8 in. mesh. The potential conservation value of such a regulation is therefore limited.

The other major concern associated with shrimp baiting is resource allocation. There has been growing concern over the increasing recreational shrimp harvest and much controversy about how, and how much, to control it. It is obvious from the results of this and previous surveys that very few recreational participants

support the complete prohibition of the practice, yet many have expressed a desire to have some changes in its management.

Many shrimpers want a longer season, not so much to increase their harvest but to allow more flexibility in scheduling their trips and minimize crowding. Although numerous respondents theorized that a longer season would spread out effort and alleviate the growing crowding problem, the impact of such a change is difficult to project. Their argument assumes that there would be little or no increase in overall effort (simply a temporal redistribution of it), which may not be realistic. The obvious counterargument is that the longer opportunity to harvest shrimp would not only further increase the recreational harvest (at the expense of the commercial sector) but also proportionally contribute to additional illegal sales.

Many recreational shrimpers have stated a preference for having the limit set per permit holder rather than per boat. The current provision, while inconsistent with most other South Carolina bag limits for shellfish and fish (which are set on a per-individual basis), is not unique. The 1991 Louisiana state legislature enacted a possession limit of 50 pounds per boat per day for recreational cast netters. A simple modification of South Carolina's law to allow the daily harvest of the present limit (48 quarts of whole shrimp) per person or permit holder would likely also increase the recreational harvest assuming no change in season duration. (Some shrimpers have suggested a lower daily limit in exchange for a longer season.) In order to maintain the status quo between recreational and commercial landings, the personal bag limit would have to be appreciably lower, probably no more than 24 quarts. Florida, for example, recently adopted a recreational daily limit of one 5-gallon pail of whole shrimp (roughly 30 pounds) per person.

One option that would tend to restrict recreational harvest without imposing any additional restrictions on gear, season length, or bag limits would be to impose a higher fee for the use of more effective gear. Both the 1989 and 1991 survey results indicated that catch rates were higher with larger nets. The same bill passed by the 1991 Louisiana legislature that set the bag limit (for cast nets less than 6 ft long) also required a $25 commercial license for nets over 6 ft. Thus, there is some basis for restructuring the South Carolina law to continue the $25 fee for nets 6 ft or less and have a higher fee for larger nets. About 17% of the 1991 respondents used nets longer than 6 ft; they accounted for about 20% of the catch. Survey data indicated that the average catch rate for nets larger than 6 ft was higher than that for smaller nets. There would therefore be some equitability to such a provision since the individuals using the larger nets have the capability to catch more shrimp and appear to do so.

For many years, the informal objective of the state's shrimp management has been to maximize the gross economic value of the commercial landings. This policy was adopted when recreational harvest (attributable mainly to seining and cast netting, but not over bait) apparently accounted for only about 10% of the annual trawl landings (Cupka and McKenzie 1974). Traditionally, the management objective has been addressed by trying to maximize 1) the amount of shrimp available in coastal trawling areas and 2) their

size. The first condition has been handled through openings and closures intended to protect pre-spawning and spawning stocks and maximize spawning productivity. The second has been dealt with by curtailing harvest of small shrimp through area closures and/or seasonal openings and closures.

The state's shrimp fishery has evolved into something quite different from that when this policy was formulated. With the development of the baiting technique, the expanding recreational sector now has the demonstrated capability to harvest a substantial portion of the fall white shrimp crop, historically the most important source of annual landings. Because the recreational fishery operates nearly exclusively in estuarine areas (mostly closed to trawling), it often harvests shrimp somewhat below the size they would attain for commercial exploitation. The existence of a large recreational fishery therefore obviously is not compatible with the objective of maximizing gross economic commercial yield.

A more contemporary management goal, and that specified in federal fishery management plans, is to target optimal yield. Loosely translated, this means exploiting the resource so as to provide the maximum overall benefit to society. South Carolina's version of this is the overall principle of managing resource utilization in the best interests of the state's citizens, one of the implied missions of MRD. This includes not only tangible quantities, such as ex-vessel value of commercial landings and economic expenditures by recreational shrimpers, but various social benefits that are difficult to measure. These include the satisfaction derived from pursuing a local traditional occupation (commercial shrimping) and the entertainment value of an enjoyable leisure activity (recreational shrimping).

Some respondents have questioned the inclusion of questions about household size, family income brackets, perceived worth of a shrimp baiting trip, etc. in the 1989 and 1991 surveys. What, they ask, does this have to do with management of the fishery?

In order to adequately evaluate the total socioeconomic impact of recreational shrimping and devise a management strategy compatible with contemporary conditions in the shrimp fishery, MRD must have such information in addition to catch and effort data. This is the rationale for the demographic and socioeconomic information solicited. MRD staff are using the information provided and that obtained from the commercial sector to prepare a comprehensive economic evaluation of the entire shrimp fishery that will be the subject of a forthcoming report. Policy-making entities (e.g. the South Carolina Wildlife and Marine Resources Commission) and legislative bodies will then have the information base to factually address allocation priorities for South Carolina's most valuable living marine resource.

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APPENDIX 1. The 1991 survey 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

ATTENTION SHRIMP BAITING PERMIT HOLDERS

Because of the increasing popularity of recreational shrimp baiting, the Marine Resources Division must have accurate and unbiased data to manage the shrimp fishery fairly and effectively. Please answer the following questions honestly with your best estimates. Base your responses only on shrimping you did with your permit, tags, and poles. The return envelope requires no postage. Please complete and return this form even if you did no shrimping.

Thank you for your cooperation.

---

1. What county do you live in? _____ Zip code_____

2. How many trips did you make this season using your permit and gear?

___September ___October ___November ___All season ___Didn't go

3. Please indicate the number of trips you made in <u>each</u> of the following areas:

___BEAUFORT (incl. Calibogue & Pt. Royal Sds., Broad R.)

___CHARLESTON (incl. harbor, Wando, Cooper, Ashley, Folly, Stono, & Kiawah R.)

___ST. HELENA SD. (incl. Coosaw, Combahee, Morgan, Ashepoo R.)

___BULLS BAY (incl. McClellanville)

___WADMALAW/EDISTO ID. (incl. N. & S. Edisto R.)

___GEORGETOWN (incl. Santee & Winyah Bays & Horry County waters)

4. How many <u>different</u> people assisted you on your trips? _____

5. What was your average catch per trip? (quarts whole shrimp)____

6. What was your total catch for the season? (quarts whole shrimp)_____

7. What mesh size did you use most often?
____3/8 in.____1/2 in. ____larger

8. What length net did you use most often?
____4 ft. ____5 ft. ____6 ft. ____7 ft. ____8 ft.

(OVER)

P. O. Box 12559 ☐ Charleston, South Carolina 29412 ☐ Telephone: 803 — 795-6350

9. How many miles (one-way) did you travel from home to landing on an average trip ? _____

10. How much did you spend directly on an average trip (for gas, bait, ice, food, travel, and related expenses)? _____

11. How many people shared the cost of an average trip? _____

12. What is the maximum you would be willing to pay for your average trip in total costs rather than give up the shrimp baiting trip?
_____

13. How many people live in your household (including yourself)? ____

14. Please check the most appropriate blank describing your gross household income in 1990.

___less than $10,000 ___$30,000 to $39,999 ___$60,000 to $69,999
__$10,000 to $19,999 ___$40,000 to $49,999___ $70,000 or more
__$20,000 to $29,999 ___$50,000 to $59,999

15. Please check your appropriate age category.

____less than 21 ____30-39 ____50-59 ____70 or over
____21-29 ____40-49 ____60-69

16. How many years have you engaged in shrimp baiting? _____

17. What problems or conflicts did you experience this season?
_____

_____

_____

18. How would you rate your overall shrimp baiting experience this season?

____Poor ____Fair ____Satisfactory ____Good ____Excellent

19. Do you intend to obtain a shrimp baiting permit next year?
_____YES _____NO

20. Do you currently have any of the following licenses?
___Trawler Captain ___Land and Sell ___Primary Wholesale Dealer

21. What comments, criticisms, suggestions, etc. do you have regarding this fishery and its management?
_____

_____

_____

APPENDIX 2. Number of 1991 shrimp baiting permits issued by county of residence.

County	Number of permits	County	Number of permits
Abbeville	58	Hampton	443
Aiken	344	Horry	142
Allendale	126	Jasper	351
Anderson	40	Kershaw	27
Bamberg	177	Lancaster	7
Barnwell	202	Laurens	21
Beaufort	1,413	Lee	3
Berkeley	1,392	Lexington	383
Calhoun	82	McCormick	2
Charleston	3,562	Marion	8
Cherokee	3	Marlboro	3
Chester	11	Newberry	34
Chesterfield	5	Oconee	16
Clarendon	43	Orangeburg	440
Colleton	587	Pickens	9
Darlington	32	Richland	263
Dillon	15	Saluda	14
Dorchester	747	Spartenburg	32
Edgefield	28	Sumter	67
Fairfield	23	Union	12
Florence	69	Williamsburg	94
Georgetown	539	York	31
Greenville	66	Nonresident	10
Greenwood	29