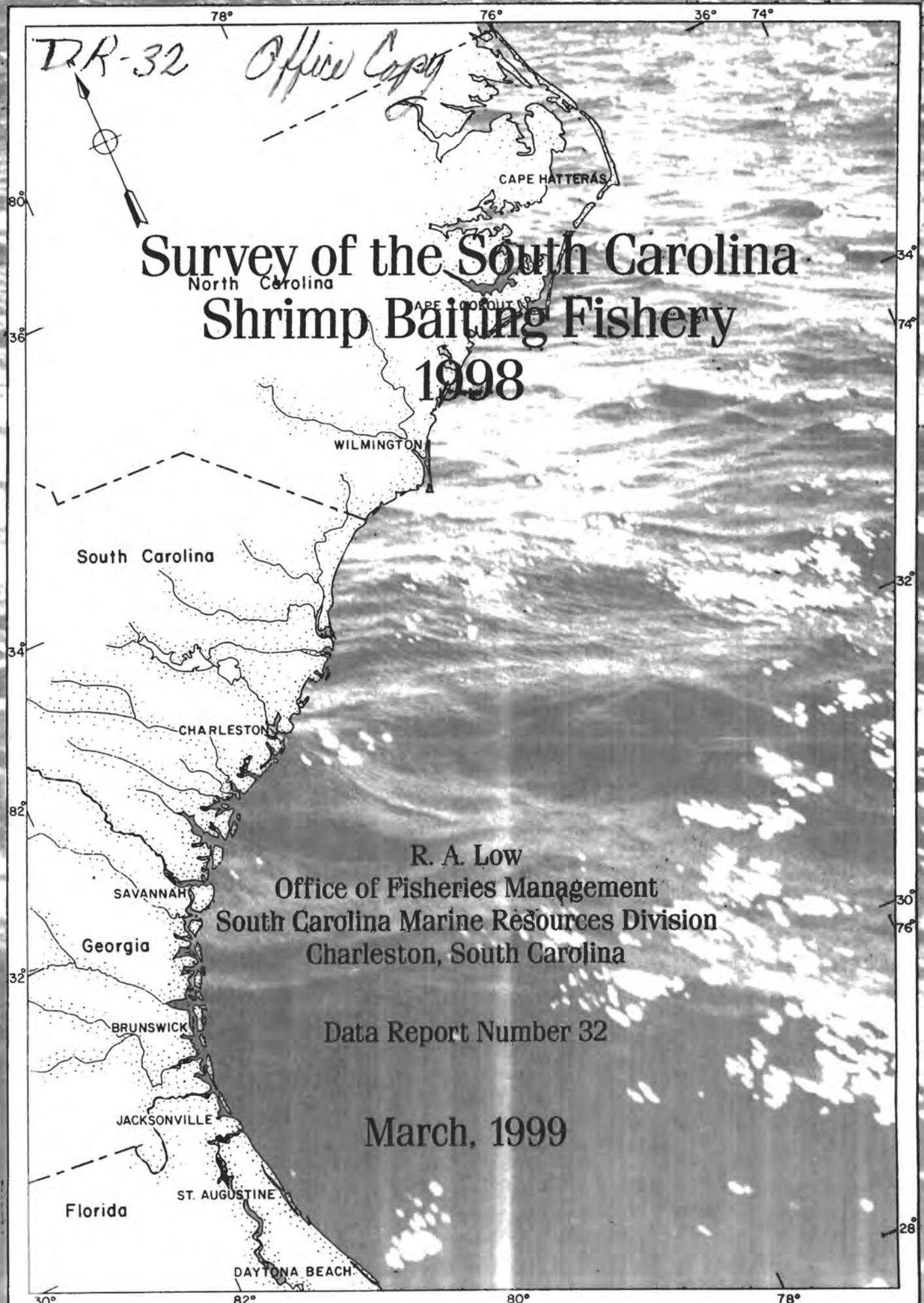


DR-32

Office Copy

Survey of the South Carolina Shrimp Baiting Fishery 1998



R. A. Low
 Office of Fisheries Management
 South Carolina Marine Resources Division
 Charleston, South Carolina

Data Report Number 32

March, 1999

TABLE OF CONTENTS

	Page
LIST OF TABLES	ii
LIST OF FIGURES	ii
ACKNOWLEDGMENTS	iii
INTRODUCTION	1
METHODS	1
RESULTS	1
Participation	5
Effort	5
Catch Rates	5
Catch	10
DISCUSSION	13
REFERENCES	23

LIST OF TABLES

	Page
1. Distribution of permit holder populations, in percentages of permit holders by county	3
2. Distribution of permit holders and sample population . .	4
3. Estimated participation by residential category	6
4. Estimated number of trips by residential category. . . .	7
5. Distribution of season effort in percentages of respondents by residential category	7
6. Estimated number of trips by shrimping area.	7
7. CPUE (quarts of whole shrimp/trip) by residential category	9
8. CPUE (quarts of whole shrimp/trip) by shrimping area . .	9
9. Distribution of season catches (quarts of whole shrimp) in percentages of respondents by residential category. .	12
10. Estimated shrimp baiting catches and reported commercial landings (all gears) by area, in thousands of pounds of whole shrimp	12
11. Season comparisons of participation, effort, and catch parameters	14

LIST OF FIGURES

1. Survey questionnaire	2
2. Shrimp baiting areas	8
3. Number of shrimp baiting permits sold, 1988-1998	15
4. Annual incremental growth in permit sales.	15
5. Number of shrimp baiting trips, 1987-1998.	16
6. Area CPUEs in 1998 compared to 1990-1997 averages. . . .	16
7. Annual shrimp baiting catch, 1987-1998	17

ACKNOWLEDGMENTS

Mary Jo Clise and the Computer Services Section provided computer listings of permit holders and mailing labels. Printing of survey materials was done in the SCDNR Print Shop in Columbia under the supervision of B. R. Hook. Joe Moran of the Fisheries Statistics Section provided information on commercial landings. The survey was funded with proceeds from sales of 1998 shrimp baiting permits at a cost of approximately \$1,500.

The South Carolina Department of Natural Resources prohibits discrimination on the basis of race, color, sex, national origin, handicap, or age. Direct all inquiries to the Office of Personnel, P.O. Box 167, Columbia, SC 29202.

INTRODUCTION

Theiling (1988) described the history of shrimp baiting in South Carolina. Surveys have been conducted annually since 1987, using various approaches to address several objectives and issues (Theiling 1988, Waltz and Hens 1989, Liao 1993, Low 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997 and 1998). These studies have obtained statistics on participation, effort, and catch for each season, in addition to information on demographics of participants and constituency opinions on management options, user group conflicts, and economic issues.

Data for the 1998 fishery were obtained from a postseason mailout survey. The objectives were to estimate 1) total participation (i.,e., the numbers of active permit holders and their assistants), 2) total effort in numbers of trips, 3) total catch, 4) effort and catch by shrimping area, and 5) obtain an evaluation of how the shrimp baiters perceive the management of the fishery.

METHODS

The survey was nearly identical to those of the previous four years. The survey package consisted of an introductory statement and a self-addressed business reply postcard questionnaire (Fig. 1). The package was sent by first class mail to 4,000 permit holders out of a total population of 17,497. The sample was randomly selected and stratified in direct proportion to the percentage of permit holders residing in each county. All nonresident permit holders (N=27) received a questionnaire. A three-week return period was specified in order to minimize problems associated with recall and responses received after that were not included in the analysis.

RESULTS

The effective mailout (after subtraction of nondeliverables) was 3,948 with a return rate of 43% (N = 1,701) by the cutoff date (December 10). Residence of 13 respondents was unknown and their responses were not included in the evaluation. The survey results were therefore based on 1,688 replies or 9.6% of the total population of permit holders. Distributions of the total permit holder populations in the last three years by county of residence compared to that in the first year of permit sales are shown in Table 1. The distributions of the 1998 permit holder population and sample are provided in Table 2. As has been generally the case, the return rates from noncoastal residents were slightly higher, but the overall distribution of the sample group was comparable to that of the total population.

Table 1. Distributions of permit holder populations, in percentages of permit holders by county.

County	1988	1996	1997	1998
Abbeville	0.1	0.3	0.3	0.3
Aiken	2.0	3.7	3.7	3.8
Allendale	1.2	0.8	0.9	0.8
Anderson	0.2	0.4	0.5	0.5
Bamberg	1.5	1.3	1.3	1.3
Barnwell	1.3	1.8	2.0	1.9
Beaufort	10.3	10.1	9.7	9.8
Berkeley	9.4	9.7	9.7	9.3
Calhoun	0.4	0.8	0.9	1.0
Charleston	41.2	25.7	25.6	23.5
Cherokee	<0.1	<0.1	<0.1	<0.1
Chester	<0.1	0.2	0.2	0.2
Chesterfield	<0.1	<0.1	<0.1	<0.1
Clarendon	0.1	0.5	0.5	0.6
Colleton	5.0	4.8	4.9	4.8
Darlington	0.1	0.7	0.6	0.6
Dillon	0	0.2	0.2	0.2
Dorchester	6.9	5.5	5.4	5.1
Edgefield	<0.1	0.3	0.3	0.4
Fairfield	0.1	0.2	0.2	0.3
Florence	0.2	1.4	1.5	1.8
Georgetown	2.4	5.8	5.6	5.7
Greenville	0.2	0.8	0.8	0.9
Greenwood	0.1	0.5	0.6	0.6
Hampton	4.0	2.9	2.8	2.7
Horry	0.3	2.4	2.4	2.9
Jasper	3.4	1.9	1.9	1.8
Kershaw	0.1	0.5	0.6	0.6
Lancaster	0	0.1	0.2	0.2
Laurens	0.1	0.3	0.2	0.4
Lee	0	<0.1	<0.1	<0.1
Lexington	2.5	5.0	5.3	5.7
McCormick	<0.1	<0.1	<0.1	<0.1
Marion	0.1	0.2	0.2	0.2
Marlboro	<0.1	<0.1	<0.1	<0.1
Newberry	0.2	0.5	0.5	0.5
Oconee	<0.1	0.2	0.2	0.2
Orangeburg	4.0	3.6	3.6	3.8
Pickens	<0.1	0.2	0.3	0.3
Richland	1.4	3.0	3.0	3.1
Saluda	<0.1	0.3	0.3	0.3
Spartanburg	0.1	0.5	0.5	0.7
Sumter	0.3	1.0	0.9	1.0
Union	0.1	<0.1	<0.1	<0.1
Williamsburg	0.4	0.8	0.8	0.9
York	0.1	0.5	0.5	0.5

Table 2. Distribution of permit holders and sample population.

Residence category	Total population		Sample population	
	N	%	N	%
North Coast				
Georgetown	994	5.7	97	5.7
Horry	510	2.9	45	2.7
Total	1504	8.6	142	8.4
Central Coast				
Berkeley	1621	9.3	146	8.6
Charleston	4110	23.5	426	25.2
Dorchester	887	5.1	83	4.9
Total	6618	37.8	655	38.8
South Coast				
Beaufort	1721	9.8	157	9.3
Colleton	842	4.8	73	4.3
Hampton	472	2.7	33	2.0
Jasper	317	1.8	27	1.6
Total	3352	19.2	290	17.2
Central Inland				
Aiken	670	3.8	74	4.4
Allendale	146	0.8	15	0.9
Bamberg	220	1.3	20	1.2
Barnwell	332	1.9	26	1.5
Lexington	995	5.7	88	5.2
Orangeburg	667	3.8	63	3.7
Richland	539	3.1	56	3.3
Total	3569	20.4	342	20.3
Other	2454	14.0	259	15.3
Total	17497		1688	

Participation

About 12.9% of the respondents indicated that they had made no trips using their gear tags. The estimated numbers of active permit holders (Table 3) were obtained by multiplying the number of permits issued in each residence category by the percentage of positive responses received per area. Assistants were the numbers of different individuals who accompanied the permit holders. Although some individuals probably were counted by more than one individual, the extent of such duplication was assumed to be negligible. The average numbers of assistants per permit holder in each residence category were multiplied by the estimated numbers of active permit holders to obtain the estimated total numbers of assistants. The total numbers of participants equalled the sums of the active permit holders and their assistants.

Effort

The average numbers of season trips per active permit holder were obtained by summing the numbers of trips reported in each residence category and dividing these figures by the numbers of respondents who reported trips. These means were then multiplied by the numbers of estimated active permit holders in the overall populations to obtain estimates of seasonal effort by residence category (Table 4). The estimated numbers of trips per month were calculated by multiplying these season totals by the appropriate percentages of trips in each month. These were determined from the data provided by respondents who broke their seasonal effort down into complete monthly components. The estimated effort figures in the **Total** column were generated by adding these categorical figures. The distribution of seasonal effort by residential category is shown in Table 5.

The coastal area was divided into six geographical components (Fig. 2). The relative distribution of estimated effort in each area is indicated in Table 6. These figures were obtained by multiplying the total numbers of trips in each residence category by the percentages of effort reported in each area. Percentages were determined by summing all trips reported by area within each residence category, then dividing by the numbers associated with each area.

Catch Rates

Average seasonal catch rates are listed in Table 7. These were obtained by adding the reported catch per unit of effort (CPUE, in quarts of whole shrimp/trip) in each category and dividing by the numbers of observations. The CPUEs in Table 8 were calculated by summing the season CPUEs for each area and dividing these figures by the corresponding numbers of observations. Only the data from respondents who limited their activity to one area were included, since there was no way to separate catch and effort

Table 3. Estimated participation by residential category.

	North coast	Central coast	South coast	Central inland	Other	Total
Permits issued	1504	6618	3352	3569	2454	17497
% active permits	81.7	87.0	87.2	88.9	88.0	87.1
Number active	1229	5758	2923	3173	2160	15243
Aver. assistants	2.35	2.20	2.31	2.40	2.44	2.31
Total assistants	2888	12668	6752	7615	5270	35193
Participants	4117	18426	9675	10788	7430	50436
Percent of total	8.2	36.5	19.2	21.4	14.7	

Table 4. Estimated numbers of trips by residential category.

	North coast	Central coast	South coast	Central inland	Other	Total
Aver. trips/permit	6.22	6.30	7.40	5.16	4.89	6.03
% by month						
September	41	35	35	35	37	36
October	46	47	49	48	50	48
November	13	18	16	17	13	16
Estimated trips/month						
September	3134	12696	7571	5731	3908	33040
October	3516	17049	10598	7859	5281	44303
November	994	6530	3461	2783	1373	15141
Total	7644	36275	21630	16373	10562	92484
Percent of total	8.3	39.2	23.4	17.7	11.4	

Table 5. Distribution of seasonal effort in percentages of respondents by residential category.

Residential category	Trips/individual/season				
	1-4	5-10	11-15	16-20	>20
North Coast	42	50	3	3	4
Central Coast	46	39	8	5	3
South Coast	39	44	7	6	4
Central Inland	54	39	5	1	< 1
Other	59	33	5	2	1
Statewide	48	40	6	3	2

Table 6. Estimated number of trips by shrimping area.

Residence category	Beaufort	St. Helena	Wadmalaw/Edisto	Charleston	Bulls Bay	Georgetown
North Coast	0	11	0	57	5841	1735
Central Coast	444	412	5336	21355	8580	148
South Coast	16827	3880	802	36	36	49
Central Inland	8425	3133	2058	1506	1240	11
Other	2561	2286	1005	631	3281	798
Total	28257	9722	9201	23585	18978	2741
% of total	30.6	10.5	9.9	25.5	20.5	3.0

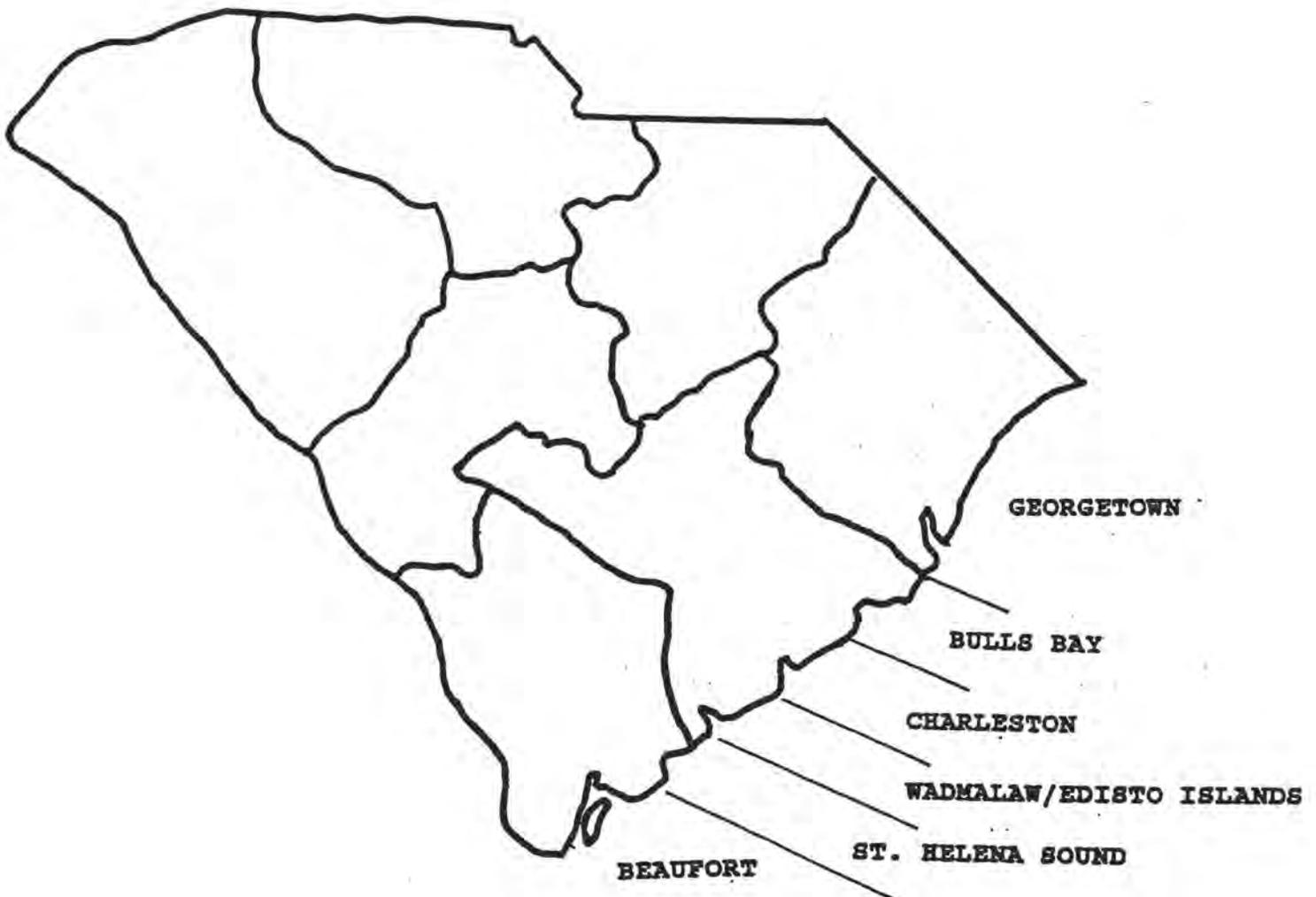


Fig. 2. Shrimp baiting areas.

BEAUFORT-from the Savannah River to the south end of St. Helena Island; including the Beaufort River

ST. HELENA SOUND- from the south end of St. Helena Island to the South Edisto River and southern end of Edisto Island

WADMALAW/EDISTO ISLANDS- from the South Edisto River to the Stono River (Edisto, Wadmalaw, Seabrook, Kiawah, Johns Islands)

CHARLESTON- from the Stono River to the north end of the Isle of Palms

BULLS BAY- from the north end of the Isle of Palms to the southern boundary of Georgetown County (near the Santee River)

GEORGETOWN- Georgetown and Horry Counties, including Winyah Bay

Table 7. CPUE (quarts of whole shrimp/trip) by residential category.

Residential category	1992	1993	1994	CPUE 1995	1996	1997	1998
North Coast	15.0	26.5	17.9	29.0	13.3	25.4	21.4
Central Coast	24.3	22.3	21.7	27.0	18.7	23.3	19.2
South Coast	26.3	24.0	12.1	28.9	14.8	28.7	23.8
Central Inland	30.3	24.0	16.7	32.3	16.7	29.2	25.3
Other	25.2	24.4	19.9	29.0	16.3	28.5	20.9

Table 8. CPUE (quarts of whole shrimp/trip) by shrimping area.

Area	1998 obs.	1992	1993	1994	1995	1996	1997	1998
Beaufort	310	28.7	22.2	13.2	30.6	15.5	30.7	25.7
St. Helena	113	29.7	23.8	16.4	27.7	18.8	26.2	21.5
Wad./Edisto	102	30.0	22.5	16.1	25.6	17.1	22.4	21.5
Charleston	258	23.4	20.4	21.6	26.1	18.2	23.7	17.7
Bulls Bay	220	20.3	26.4	23.1	28.7	15.2	25.2	19.6
Georgetown	28	14.4	26.9	13.2	19.9	9.6	23.3	21.5

by area for respondents who shrimped in more than one area.

Because the residential stratification of the sample population was similar to that of the total permit holder population, an unbiased estimate of the average statewide CPUE can be obtained by calculating the mean of the CPUEs reported by the respondents. This value was 21.7 quarts of whole shrimp/trip.

Catch

The average season catches (quarts of whole shrimp) reported by respondents were as follows for various residence categories:

North Coast	Central Coast	South Coast	Central Inland	Other
116.3	111.6	150.6	126.9	105.7

There are numerous ways to estimate the total catch, depending on the interest in its relative components. One estimate can be derived from the average catch data above by multiplying them by the appropriate numbers of active shrimpers. This method produced the following estimates:

Residence category	Estimated catch (quarts)
North Coast	142,933
Central Coast	642,593
South Coast	440,204
Central Inland	402,654
Other	228,312
Total	1,856,696

The simplest CPUE-based method is to multiply the statewide average CPUE (21.7 quarts/trip) by the estimated total number of trips (92,484). This figure is 2,006,903 quarts.

Catches by residence category were also estimated by multiplying the estimated effort for each by the appropriate CPUE:

Residence category	Trips	CPUE	Catch (quarts)
North Coast	7,644	21.4	163,582
Central Coast	36,275	19.2	696,480
South Coast	21,630	23.8	514,794
Central Inland	16,373	25.3	414,237
Other	10,562	20.9	220,746
Total			2,009,839

In most cases, this produced slightly higher values than the method using average season catch.

Catches by shrimping area were obtained by multiplying the estimated effort in each by the corresponding average CPUE:

Shrimping area	Trips	CPUE	Catch (quarts)
Beaufort	28,257	25.7	726,205
St. Helena	9,722	21.5	209,023
Wadmalaw/Edisto	9,201	21.5	197,822
Charleston	23,585	17.7	417,455
Bulls Bay	18,978	19.6	371,969
Georgetown	2,741	21.5	58,932
Total	92,484		1,981,406

There are trade-offs in probable accuracy and lack of bias associated with each approach and an intermediate value is a reasonable overall estimate. The average of the four estimates shown above is **1,963,711 quarts**. The conversion factor from quarts to pounds (whole weight) is 1.48. The weight equivalent of heads-on shrimp is **2,906,292 pounds**. The conversion factor to heads-off weight is 0.649, giving an estimate of **1,886,184 pounds heads-off**.

The distribution of season catches by residential category is shown in Table 9. The statewide average catch per active permit holder, based on reported season catches, was 120.9 quarts (179 pounds) of whole shrimp. Assuming that this was evenly divided between the permit holders and their assistants, the typical participant obtained about 58 pounds of whole shrimp.

The relative distribution of the fall white shrimp harvest is perceived by some parties as an allocation issue. Since 1992, a monitoring system for commercial landings has been in place that permits comparison of recreational and commercial landings for comparable area/time units. The baiting areas and corresponding commercial statistical zones are as follows:

Baiting area	Commercial zone
Beaufort (rivers, sound)	Hilton Head to Bay Point
St. Helena Sound	Bay Point to South Edisto River
Wadmalaw/Edisto Islands	South Edisto River to Stono Inlet
Charleston (rivers, harbor)	Stono Inlet to Dewees Inlet
Bulls Bay	Dewees Inlet to Cape Romain
Georgetown (rivers, bay)	Cape Romain to N.C. line, Winyah and Santee Bays

The comparison of baiting and commercial landings is shown in Table 10. In-season commercial landings were defined as those during week 2 of September through week 2 of November. Total commercial landings included those from week one of August through the closure of the 1998 season. Combined total recreational and commercial landings are the baiting catch plus the total commercial landings as so defined.

Table 9. Distribution of season catches (quarts of whole shrimp) in percentages of respondents by residential category.

Residential category	Catch/permit holder					
	<99	100-199	200-299	300-399	400-499	>500
North Coast	52	27	16	3	< 1	< 1
Central Coast	62	22	8	4	1	3
South Coast	45	26	16	8	3	2
Central Inland	51	30	10	4	2	3
Other	58	26	11	4	1	< 1
Statewide	55	25	11	5	2	2

Table 10. Estimated shrimp baiting catches and reported commercial landings (all gears) by area, in thousands of pounds of whole shrimp.

Area	Baiting	Commercial		Percent baiting	
		In-season	Total	In-season	Total
Beaufort	1,075	99	161	92	87
St. Helena	309	648	1,300	32	19
Wad./Edisto	293	317	461	48	39
Charleston	618	281	427	69	59
Bulls Bay	551	577	867	49	39
Georgetown	87	570	952	13	8
Total	2,933	2,492	4,168	54	41

DISCUSSION

Documentation of seasonal statistics began in 1987. Table 11 summarizes the data for each year's fishery. The trend in number of permits sold annually is shown in Fig. 3. The incremental annual growth in permit sales was the largest since that occurring in 1993 (Fig. 4) with predictions of an abundant fall shrimp population a probable contributing factor. The principal difference in the distribution of the current permit holder population vs the original one is that Charleston County residents now account for an appreciably lower percentage (23.5% in 1998 vs 41.2% in 1988). Although permit sales have increased 31% since 1994, the relative (percentage) distribution of the permit holders by county has remained virtually unchanged since then.

Climatic conditions favored the fishery. August was unusually dry. This would normally curtail shrimp outmigration into the ocean. The statewide commercial trawl landings during August and the first week of September totalled 971,000 pounds (heads-on) of white shrimp, however, well above the average. The weather throughout September was also dry and abnormally hot. During the first four weeks of the season, anecdotal information indicated that shrimping was exceptionally good with limit catches common. Individual size of the shrimp varied considerably with catches frequently containing large numbers of small shrimp.

During the second week of October, strong northeast winds occurred with heavy rains and big tides. This storm was soon followed by a cold front with additional rain and high winds. Although the weather thereafter was conducive to shrimping, shrimp remained scarce in most areas until the end of the season and catches declined greatly. Although these factors probably contributed to reduced effort later in the season, the overall number of trips made was barely short of last year's record level (Fig. 5).

Historically, the highest average catch rate has occurred in the Beaufort area and this was the only location in which shrimping during the 1998 season was relatively good (Fig. 6). Seasonal success in the Georgetown area (mainly Winyah Bay) has been more variable than anywhere else, but also was above average in 1998. Catch distribution by shrimping area during 1998 was generally comparable to that in recent years with the Charleston harbor's share a little lower than usual. The statewide season catch was relatively large in spite of the late-season scarcity of shrimp, due to the high level of effort (Fig. 7).

Several issues have continually been associated with this fishery. No biological problems such as overexploitation have been verified and conservation of the shrimp resource does not appear to be a major concern at the present time. Some environmentalists have suggested that baiting adds excessive nutrients to the ecosystem. Studies by the Marine Resources Division have

Table 11. Season comparisons of participation, effort, and catch parameters.

	1987	1988	1989	1990	1991	1992
Permits issued	NA	5509	6644	9703	12005	11571
% active permits	NA	92	82	94	89	87
Assts./permit	NA	2.50	2.14	2.79	2.24	2.15
Participants	21735	17749	17171	34662	34821	31812
Trips/permit holder	NA	7.0	5.7	7.8	6.6	6.1
Total trips	40101	35609	31624	71153	71034	62459
Average qts./trip	28.5	22.1	26.5	25.6	21.3	25.4
Million lbs heads-on	1.80	1.16	1.25	2.75	2.14	2.35
Lbs/participant	83	65	73	79	62	74
	1993	1994	1995	1996	1997	1998
Permits issued	12984	13366	13919	14156	15488	17497
% active permits	91	86	89	85	91	87
Assts./permit	2.43	2.32	2.39	2.25	2.44	2.31
Participants	40620	38081	41971	38932	48544	50436
Trips/permit holder	6.8	6.0	6.5	5.7	6.6	6.0
Total trips	80709	70429	81632	68927	94154	92484
Average qts./trip	23.5	18.5	28.9	16.9	26.4	21.7
Million lbs heads-on	2.72	1.91	3.40	1.73	3.63	2.91
Lbs/participant	67	50	81	44	72	58

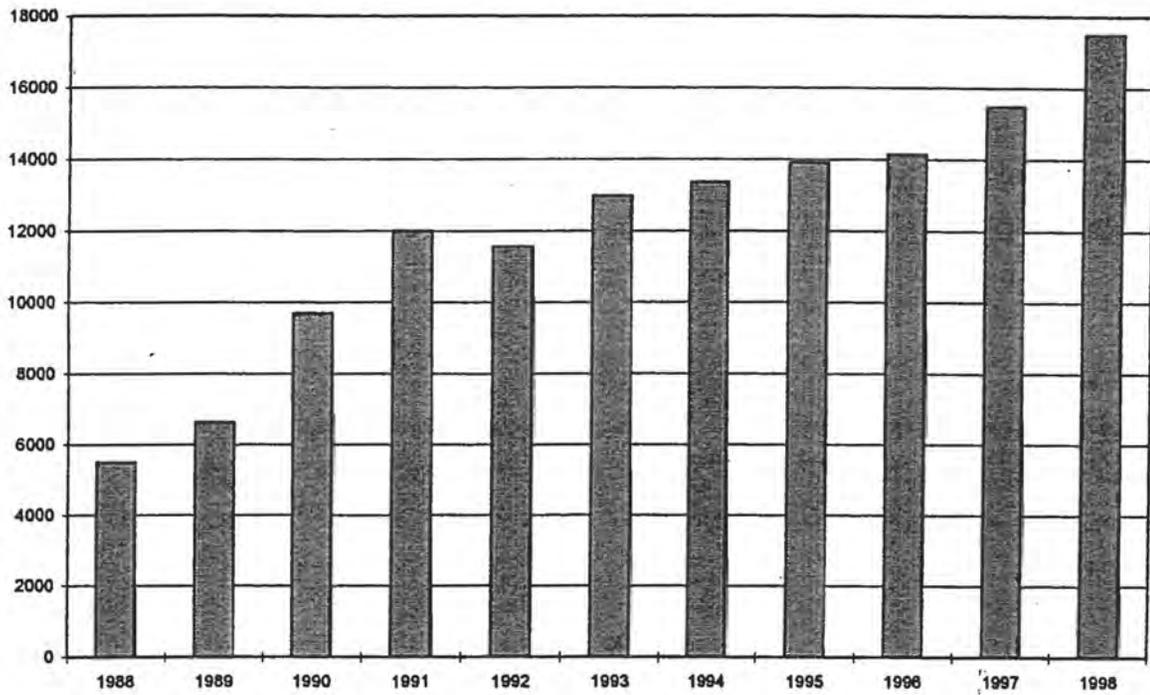


Fig. 3. Number of shrimp baiting permits sold, 1988-1998.

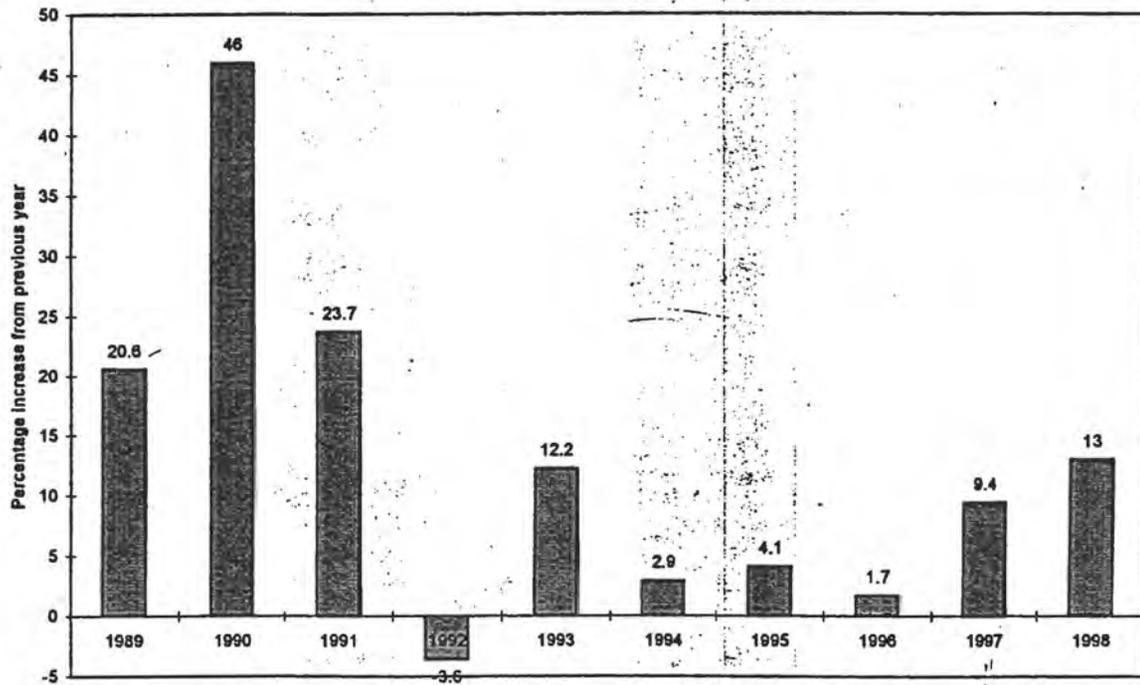


Fig. 4. Annual incremental growth in permit sales.

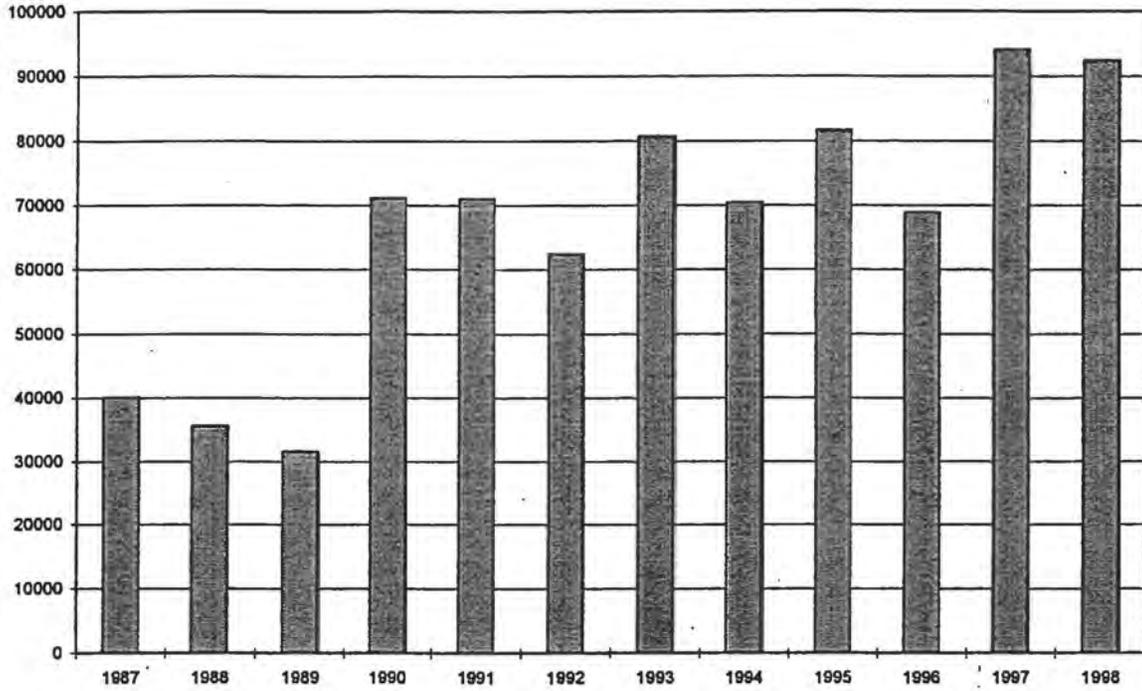


Fig. 5. Number of shrimp baiting trips, 1987-1998.

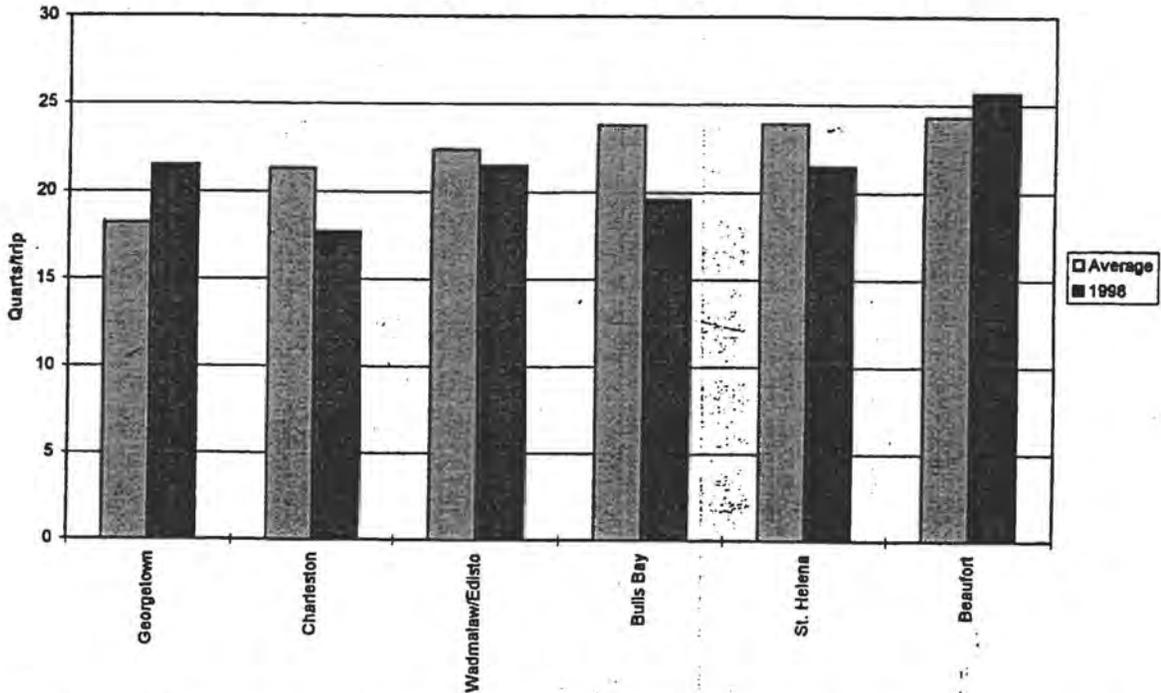


Fig. 6. Area CPUEs in 1998 compared to 1990-1997 averages.

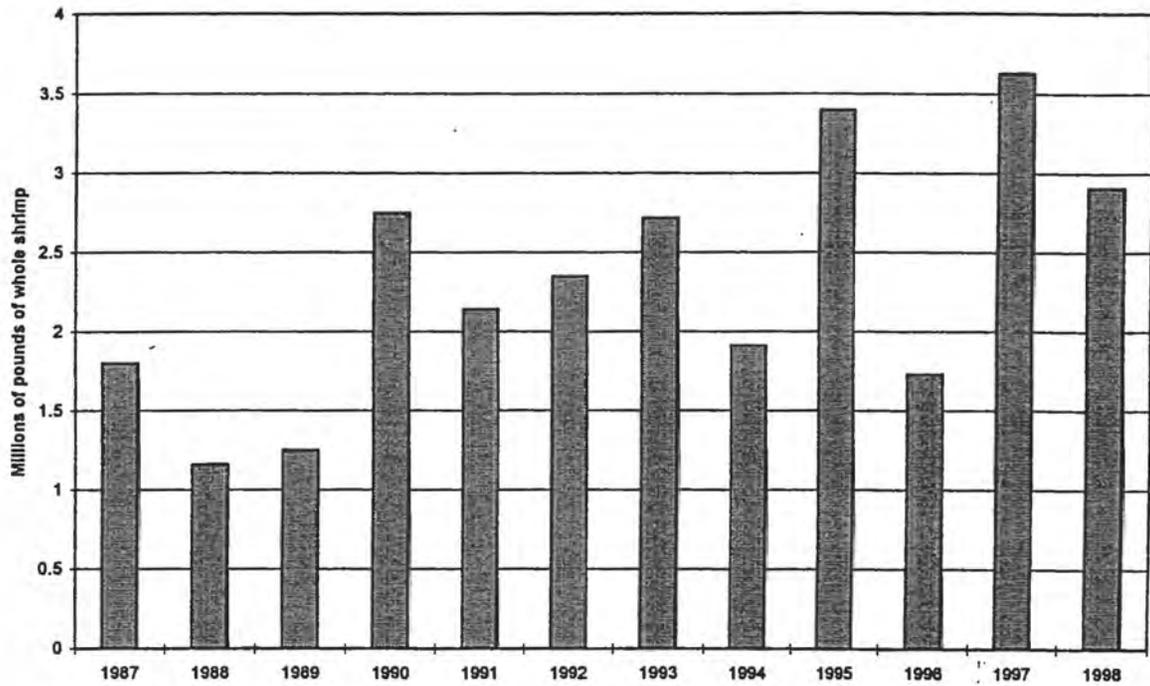


Fig. 7. Annual shrimp baiting catch, 1987-1998.

indicated that the fishery is a negligible source compared to natural input, e.g. from river discharge, runoff from agricultural areas, etc.

As the number of permits sold has continued to increase, the capacity of the estuaries in terms of accommodating shrimpers has been questioned. Crowding has become more noticeable in popular areas and access facilities have been overburdened during periods of peak usage. The problem has perhaps been most publicized in the McClellanville area with limited public access to popular Bulls Bay.

The crowding problem has been addressed in several surveys. The 1990 shrimp baiting questionnaire offered two options for comment. One source of conflict is the poles, which impede navigation and cause arguments over spacing. A measure eliminating poles and requiring use of an anchored boat would allow more boats per area and obviate problems of lost poles and tag replacement. The other option directly addressed at reducing crowding was limitation of the number of permits issued per area with selection by lottery (similar to the restriction of access to some game management areas). Another option that indirectly addressed the crowding problem was a longer season, which could disperse effort over a longer period (assuming no compensatory increase associated with the additional time).

The percentages of 1,261 respondents to the 1990 survey supporting these proposals were as follows by residential category:

	No poles/anchored boat	Permit lottery	Longer season
North Coast	3	< 1	53
Central Coast			
Charleston Cty.	4	5	44
Berkeley/Dorchester	5	3	48
South Coast	7	2	31
Other counties	2	2	53
Statewide	4	3	46

The two direct measures were exceedingly unpopular with shrimpers. A longer season was much more acceptable, but would not necessarily be very effective in reducing crowding.

The 1993 survey revisited this issue with other alternatives offered for comment. One was an increased permit fee in order to potentially reduce the number of purchasers. The following responses (based on the assumption that no other changes would be made) did suggest that a significant fee increase would result in an appreciable reduction in permit holders.

\$25 (current fee)	Percent willing to pay				
	\$26-30	\$31-35	\$36-40	\$50	>\$50
74	8	3	2	7	< 2

Approval ratings for the other alternatives were based on a scale of 1 (strongly oppose) to 5 (strongly support). Measures that could reduce crowding received the following ratings statewide:

Option	Rating	Percent strongly opposed
Daytime baiting only	1.52	69
Certain days/nights only	1.59	61
Certain areas only	1.60	58
Fewer poles	1.72	55
Limited no. of permits	1.86	51
Limited no. of trips (with a longer season)	2.27	42

The four most strongly opposed measures placed some restriction on effort. Some could potentially aggravate crowding in some circumstances. Obviously, a daytime only fishery would compete with anglers for both access and fishing space with potentially extensive interactions on weekends. Limiting baiting to certain areas could just increase the crowding within them if no other steps were taken. Others, such as a season limit on the number of trips/permit holder, are impractical, if not impossible, to enforce.

There is no indication that shrimpers have reduced their average effort (number of trips per season) in response to increased participation. There also appears to be no major shift in the ratio of shrimpers dropping out of the fishery (over frustration with crowding) vs newcomers who haven't yet experienced the situation. The 1998 survey asked respondents to indicate the number of previous years in which they had purchased permits (back to 1993) and if they planned to obtain one in 1999. Results were as follows in percentages of responses by residential category:

	Number of years in addition to 1998					1998 only	1999
	5	4	3	2	1		
North Coast	32	11	15	14	13	15	86
Central Coast	39	7	13	13	15	13	83
South Coast	40	6	11	13	15	14	78
Central Inland	30	12	14	15	16	13	84
Other	18	11	16	17	12	25	87
Total	34	9	13	14	14	15	83

About 13% more people purchased a permit in 1998 than in the previous year, comparable to the 15% of the respondents who noted that 1998 was their first season. About 83% of the respondents indicated that they planned to purchase a permit next year in the 1993 survey and 82% responded that they intended to purchase a 1994 permit. These results suggest that the annual turnover rate is typically well below 20% of the contemporary permit holders and is not increasing.

A well-publicized point of recent controversy has been the level of shrimp baiting in Bulls Bay, which is in the Cape Romain National Wildlife Refuge. Environmentalists have asserted that the night-time lights, noise, etc. associated with baiting are disruptive to wildlife, particularly birds, and thus contrary to the purpose of the Refuge. Suggested management changes within the Refuge have included limitation to daytime baiting only, a shorter season, and an outright ban.

The extent of negative impact from baiting in the Refuge is difficult to characterize in a quantitative sense. In contrast, the importance of continued access to this area to shrimp baiters is obvious. During 1990-1998, Bulls Bay had the highest CPUE of any area north of St. Helena Sound. Since 1990, it has hosted an annual average of 17% of the effort and produced 17% of the catch. In the last five years, the level of average annual effort expended in Bulls Bay by residential category has been as follows:

Central Coast . . .	23%
Other counties. . .	31%
North Coast	74%

Nearly 60% of the state's shrimp baiting population has relied on Bulls Bay for at least 20% of their effort.

Any direct approach to reducing the possible impact of shrimp baiting in Bulls Bay would have substantial adverse effects on these shrimpers. Several of the options proposed for the Refuge have been rejected generically by surveyed permit holders. In the 1993 survey, limiting (statewide) shrimping to daytime only was the least acceptable of the 14 alternatives proposed. Limiting shrimping to certain areas only was the third most strongly opposed measure and shortening the season was the fourth.

The Cape Romain Refuge issue is localized and its resolution should be so focused rather than resorting to statewide measures. Allocation of the fall shrimp crop appears to be the principal long-term, substantive, statewide issue. Commercial shrimpers (almost exclusively trawlers) have continually opposed the baiting fishery on three major grounds: 1) it sources illegal commercial product, 2) it confers an inequitable advantage to recreational users by allowing access in areas closed to trawlers, and 3) the fishery reduces their landings excessively. Item two

notwithstanding, most commercial shrimpers recognize and accept recreational cast netting without bait as a legitimate pursuit.

The first issue, that of illegal sales, has been dealt with extensively in previous surveys (e.g. that of the 1993 fishery) and by ad hoc committees. There has been little question that effective law enforcement is difficult and most recreational shrimpers favor more severe penalties for violators. The extent of illegal sales has not been documented, but is thought to be limited.

Baiting does occur almost exclusively in areas closed to trawling at least since 1987. Their characterization by commercial trawlers as nursery areas with the obvious negative connotation associated with harvest within them is not entirely accurate. In the baiting season, most of the actual shrimping locations serve primarily as staging areas for larger shrimp just prior to their movement into the ocean. The major nursery grounds, characterized by large populations of much smaller shrimp, are situated further up in the tidal creeks.

Trawlers argue that allowing baiting in estuarine areas results in excessive harvest of small shrimp and associated wastage. Whitaker et al. (1991) noted that "although recreational shrimpers prefer to fish in areas where large shrimp are abundant, ... changes in hydrological conditions can force small shrimp into the lower reaches of estuaries where larger shrimp are normally found." Whitaker and Wenner (1988) found that the size composition of white shrimp was not significantly different between baited and unbaited areas. If baiters are shrimping in the lower estuarine areas where larger shrimp congregate just prior to moving into the ocean, the size of the shrimp they catch is usually comparable to that taken by the trawlers. The same hydrological conditions that force small shrimp into these areas also drive them onto the trawl grounds. Thus, it seems to make little difference in terms of the size of shrimp caught by either group whether the recreational shrimpers are using bait. The solution to the small shrimp problem is independent of the use of bait and is a function of the size mesh used in the cast nets. Use of half-inch or larger (bar) mesh appreciably reduces the catch of small shrimp (Whitaker et al. 1991; Woodward 1989).

Recreational shrimpers obviously reduce the amount of shrimp available to trawlers regardless of whether they use bait or not. In what ways and by how much the baiters reduce the trawler catches is difficult to evaluate. Although bait has been conclusively shown to produce larger catches, it apparently does so by acting as a very short-term food attractant rather than in the sense of dove or deer baiting. The shrimp bait is quickly dissipated by water movement and the amount of food it then represents is insignificant compared to that ambient in the ecosystem.

Environmental conditions are believed to be the principal factor affecting the outmigration of shrimp and the distribution of the fall landings. The largest percentages of in-season and total combined fall catches attributed to baiters have occurred in years (1993, 1997, 1998) with unusually dry summer and fall weather, especially during August. Dry conditions delay outmigration with the result that a larger percentage of the shrimp stock remains vulnerable to the baiters for a longer period. In 1998, August was exceptionally dry and baiters accounted for a relatively large percentage of the total fall catch in spite of catch rates that were well below normal in nearly all areas. In years (e.g. 1992, 1994, 1995, and 1996) with heavy rainfall in August and/or early September, more of the population moves into the ocean earlier in the fall. As a result, trawler landings then are above average in August and early September and less shrimp remain available to the baiters at the opening of their season. The extent of rainfall and its timing thus contributes to the distribution of the fall landings, as indicated below:

	Average baiting share (percentage)	
	In-season	Total fall
Wet pre-season	50	35
Dry pre-season	57	43

Escapement from baiting areas to the trawl grounds is markedly influenced by environmental conditions, as noted above. The density of baiting effort partially determines fishing mortality, as do tide, wind, and weather conditions that affect gear effectiveness. The natural mortality rate and spatial and temporal distances between baiting and trawling areas are major variables. Even if it was known how many shrimp were initially present in baiting area X on day i, the number arriving on trawl ground Y on day i + n after being worked over by the baiters would vary enormously just as a function of the (natural mortality) rate at which they were dying between the end of the baiting fishery and beginning of their exposure to trawling. Simple modeling exercises have suggested that the average statewide fall commercial landings might increase by about 15% in the absence of baiting, but in reality the increase in a given year could be much larger or smaller.

Previous opinion polls of permit holders have consistently indicated that they are generally satisfied with the current overall management regime. For example, in the 1993 survey, the approval index (on a scale of 1-5 with 5= strongly support) for maintaining the current laws with no changes was 3.8. About 65% of the respondents were either supportive (26.6%) or strongly supportive (38.5%). In the 1998 survey, the percentages of respondents evaluating MRD's management of baiting were as follows:

	Evaluation				
	Poor(1)	Fair(2)	Satisfactory(3)	Good(4)	Excellent(5)
North Coast	3.0	8.2	25.3	30.6	32.8
Central Coast	3.2	4.9	20.3	44.4	27.3
South Coast	5.3	8.5	25.7	41.2	19.4
Central Inland	2.1	6.4	21.5	40.6	29.4
Other	0.8	3.2	21.4	46.0	28.6
Statewide	2.9	5.8	22.1	42.2	27.0

The statewide approval index was 3.8. These results reaffirm the permit holders' position set forth in the earlier survey.

Respondents' comments to both this survey and previous ones have consistently referred to the need for more law enforcement as the most preferred change in the management system. The principal reason is to control the illegal practice of selling shrimp caught over bait. Many survey respondents have commented that legitimate recreational shrimpers should not be subjected to more restrictions, since they do not contribute to the problem. They have instead advocated increased enforcement of existing laws and more severe penalties for violators.

REFERENCES

- Liao, D.S. 1993. Economic analysis of the 1991 South Carolina shrimp baiting fishery. S.C. Mar. Res. Div., Charleston, S.C. Tech. Rep. 81.
- Low, R.A. 1990. Survey of the South Carolina shrimp baiting fishery, 1989. S.C. Mar. Res. Div., Charleston, S.C. Tech. Rep. 73.
- Low, R.A. 1991. Survey of the South Carolina shrimp baiting fishery, 1990. S.C. Mar. Res. Div., Charleston, S.C. Tech. Rep. 76.
- Low, R.A. 1992. Survey of the South Carolina shrimp baiting fishery, 1991. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 9.
- Low, R.A. 1993. Survey of the South Carolina shrimp baiting fishery, 1992. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 14.
- Low, R.A. 1994. Survey of the South Carolina shrimp baiting fishery, 1993. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 15.
- Low, R.A. 1995. Survey of the South Carolina shrimp baiting fishery, 1994. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 21.

- Low, R.A. 1996. Survey of the South Carolina shrimp baiting fishery, 1995. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 23.
- Low, R.A. 1997. Survey of the South Carolina shrimp baiting fishery, 1996. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 25.
- Low, R.A. 1998. Survey of the South Carolina shrimp baiting fishery, 1997. S.C. Mar. Res. Div., Charleston, S.C. Data Rep. 29.
- Theiling, D. 1988. Assessment of participation and resource impact of shrimp baiting in coastal South Carolina during 1987. S.C. Mar. Res. Div., Charleston, S.C. Tech. Rep. 69.
- Waltz, W. and B. Hens. 1989. Survey of the South Carolina shrimp baiting fishery, 1988. S.C. Mar. Res. Div., Charleston, S.C. Tech. Rep. 71.
- Whitaker, J.D., J.E. Jenkins, and L.B. DeLancey. 1991. Catch rates and size of white shrimp caught by cast nets with different mesh sizes. S.C. Mar. Res. Center, Charleston, S.C. Tech. Rep. 77.
- Whitaker, J.D. and E.L. Wenner. 1988. Species and size composition of *Penaeus* taken by baiting in South Carolina estuaries. S.C. Mar. Res. Center, Charleston, S.C. Unpub.
- Woodward, A.G. 1989. Effects of mesh-size on the composition and quantity of white shrimp and finfish caught with the cast net in Georgia's estuarine waters. Georgia DNR, Coast. Res. Div. Contrib. Ser. No. 44.