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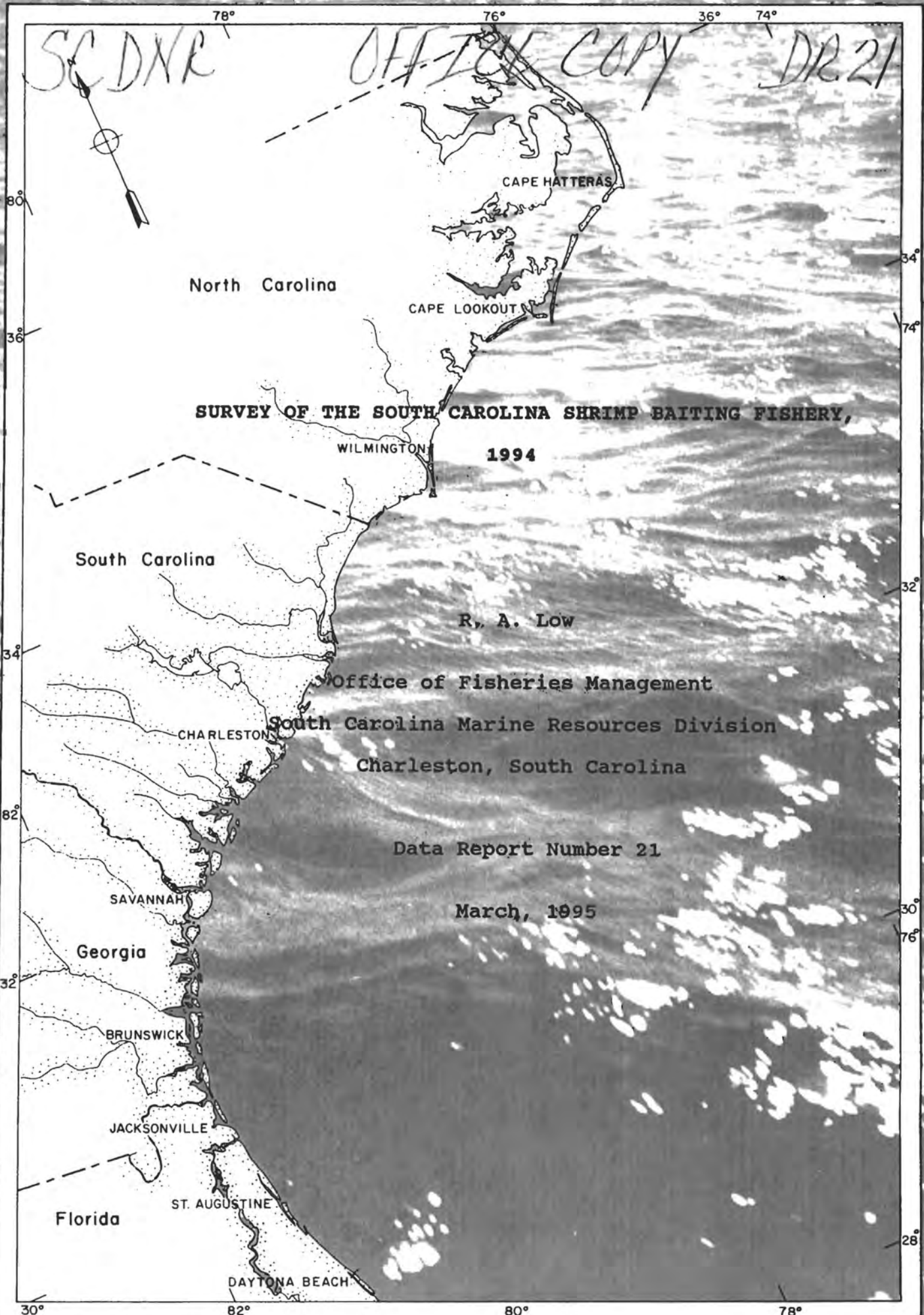


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INTRODUCTION

Theiling (1988) described the history of shrimp baiting in South Carolina and the first survey (in 1987) of the fishery. Surveys have been conducted for each subsequent season using various approaches (Waltz and Hens 1989; Low 1990, 1991, 1992, 1993, and 1994; Liao 1993). These studies have addressed diverse aspects such as demographics of participants, constituency opinions of management options, user group conflicts, and economic issues in addition to obtaining statistics on catch, effort, and participation.

Information on the fishery was obtained from a postseason mailout survey. Primary objectives were to estimate 1) total participation (i.e., the number of active permit holders and their assistants), 2) total effort (in numbers of trips), 3) total catch, and 4) effort and catch by shrimping area.

METHODS

The survey package consisted of an introductory statement and a self-addressed business reply postcard questionnaire (Fig. 1). The mailout was sent first class to 3,500 permit holders (26% of the total population of 13,366) and was stratified according to area of residence in direct proportion to the distribution of permit holders. In each county, 26% of the permit holders were randomly selected for inclusion in the sample.

Table 1 lists the numbers of permit holders by county or county group. After adjustment for nondeliverables ($N = 44$), the effective mailouts were as follows: 1) Northern Coastal Group - 285, 2) Central Coastal Group - 1,463, 3) Southern Coastal group - 729, 4) Central Inland Group - 638, and 5) other areas - 341.

In the introductory statement, permit holders were requested to submit their responses by December 15. Questionnaires received after this date were not included in the sample, due to the length of the recall period.

RESULTS

A total of 13,366 permits was sold. The file used to determine sample stratification by residence contained 13,347 individuals and was also used for other applications in this report. The figures contained in various tables were based on this file and thus a permit holder population of 13,347.

The overall response rate within the designated interval was 41.0% with 1,418 usable returns. Response rates by residential category were as follows: 1) Northern Coastal Group - 36.5%, 2)



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ATTN. SHRIMP SURVEY
P.O. BOX 12559
CHARLESTON, S.C. 29412



1. What county do you live in? _____
2. How many trips did you make using your permit and gear?
 _____ SEP _____ OCT _____ NOV _____ All season _____ NONE
3. Please indicate the number of trips you made in each area:

_____ BEAUFORT (incl. Calibogue Sd., Pt. Royal Sd., Broad R., Whale Branch R., etc. _____ St. HELENA Sd. (incl. Coosaw, Morgan, Combahee, & Ashepoo R.) _____ WADMALAW/EDISTO IS. (incl. N & S Edisto R.)	_____ CHAS., incl. harbor & area rivers _____ BULLS BAY, incl. McClellanville area _____ GEORGETOWN, incl. Santee & Winyah Bays & Horry County
--	--
4. How many different people assisted you on your trips? _____
5. What was your average catch of shrimp per trip? _____
 (in quarts of whole shrimp)
6. What was your total catch for the season? _____ quarts whole
7. Will you get a baiting permit next year?
 _____ YES _____ NO

Table 1. Distribution of permit holders.

Residence category	1994		1991-1993 average	
	N	%	N	%
Northern Coastal				
Georgetown County	854	6.4	612	5.0
Horry County	246	1.8	162	1.3
Total	1,100	8.2	774	6.3
Central Coastal				
Berkeley County	1,329	10.0	1,295	10.6
Charleston County	3,560	26.7	3,388	27.8
Dorchester County	770	5.8	719	5.9
Total	5,659	42.4	5,402	44.3
Southern Coastal				
Beaufort County	1,464	11.0	1,455	11.9
Colleton County	655	4.9	608	5.0
Hampton County	407	3.0	440	3.6
Jasper County	299	2.2	355	2.9
Total	2,825	21.2	2,858	23.4
Central Inland				
Aiken County	479	3.6	394	3.2
Allendale County	110	0.8	122	1.0
Bamberg	167	1.3	180	1.5
Barnwell	224	1.7	205	1.7
Lexington	612	4.6	486	4.0
Orangeburg	491	3.7	460	3.8
Richland	364	2.7	298	2.4
Total	2,447	18.3	2,145	17.6
Other	1,303	9.8	996	8.2
Nonresident	13	0.1	12	0.1
Grand total	13,347		12,187	

Central Coastal Group - 38.7%, 3) Southern Coastal Group - 37.3%, 4) Central Inland Group - 45.1%, and 5) other areas - 55.1%. The stratification of returned questionnaires by area of residence was as shown in Table 2.

Participation

About 14% of the responding permit holders did not make any trips with their tags and poles. The estimated number of active permit holders (Table 3) was 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 joined the permit holders on their trips. Undoubtedly, some individuals were counted by more than one respondent, but 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 number of active permit holders to obtain the estimated numbers of assistants. The total numbers of participants equalled the sum of the active permit holders and their assistants.

Effort

The average number of season trips per active permit holder was obtained by summing the number of trips reported in each residence category and dividing this figure by the number 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, as determined from the data provided by respondents who broke their seasonal effort down into complete monthly components. The estimated effort figures shown in the "total" category are those generated by adding the categorical figures.

An alternative procedure is to multiply the number of permits sold ($N = 13,366$) by the active percentage (85.6%) to generate the estimated number of total active permit holders ($N = 11,441$). This value multiplied by the pooled average trips/permit holder ($N = 6.0$) gives a slightly lower estimate of total effort ($N = 68,646$).

The coastal area was divided into six geographical components (Fig. 2). The relative distribution of estimated effort by shrimping area is indicated in Table 5. These figures were obtained by multiplying the total number of trips in each residence category by the percentages of effort reported for each area. Percentages were determined by summing all trips reported by area within each residence category, then dividing this figure by the number associated with each area.

Table 2. Distribution of permit holders and respondents by residence category.

Residence category	Percent	
	Permit holders	Respondents
Northern Coastal	8.2	7.3
Central Coastal	42.4	39.9
Southern Coastal	21.2	19.2
Central Inland	18.3	20.3
Other	9.9	13.3

Table 3. Estimated participation by residence category.

	Northern Coastal	Central Coastal	Southern Coastal	Central Inland	Other	Total
Permits issued	1,100	5,659	2,825	2,447	1,316	13,347
Percent active	87.5	91.2	77.2	84.0	83.5	85.6
Number active	963	5,161	2,181	2,055	1,099	11,459
Avg. no. assistants	2.57	2.53	1.81	2.24	2.31	2.32
No. of assistants	2,475	13,057	3,948	4,603	2,539	26,622
Total participants	3,438	18,218	6,129	6,658	3,638	38,081

Table 4. Estimated effort (number of trips) by residence category.

	Northern Coastal	Central Coastal	Southern Coastal	Central Inland	Other	Total
Avg. trips/permit	6.3	6.9	6.4	4.9	4.3	6.0
% total by month						
September	39	36	35	36	40	36
October	44	45	46	46	44	45
November	17	19	19	18	16	19
Estimated trips/month						
September	2,366	12,820	4,885	3,625	1,889	25,585
October	2,670	16,025	6,421	4,632	2,078	31,826
November	1,031	6,766	2,652	1,813	756	13,018
Estimated total trips	6,067	35,611	13,958	10,070	4,723	70,429
% of total effort	9	50	20	14	7	
Avg. % 1991-1993	7	47	27	14	6	

Table 5. Estimated effort (number of trips) by shrimping area.

Residence category	Beaufort	St. Helena	Wad.-Ed. Islands	Chas.	Bulls Bay	Georgetown
N. Coastal	0	0	12	158	3,264	2,633
C. Coastal	463	427	3,917	23,930	6,802	72
S. Coastal	9,142	3,992	600	209	15	0
C. Inland	3,947	2,266	1,591	1,440	725	101
Other	1,233	760	439	543	1,417	331
Total	14,785	7,445	6,559	26,280	12,223	3,137
% of total	21	11	9	37	17	5



- BF- BEAUFORT**, including Calibogue and Port Royal Sounds, Broad River
- SH- St. HELENA SOUND**, including Coosaw, Combahee, and Ashepoo Rivers
- WE- WADMALAW/EDISTO ISLANDS**, including N. and S. Edisto Rivers
- CH- CHARLESTON METRO**, including the harbor, Kiawah, Stono, Folly, Ashley, Cooper, and Wando Rivers
- BB- BULLS BAY**, including the McClellanville area
- GH- GEORGETOWN**, including Santee and Winyah Bays and Horry County waters

Fig. 2. Shrimp baiting areas.

The distribution of seasonal effort in terms of average number of trips/permit holder is shown in Table 6. More than half of the shrimpers made fewer than five trips and only 12% made more than ten.

Catch Rates

Table 7 lists the average seasonal catch rates for each residence category. These were obtained by adding the reported CPUEs in each category (in quarts of whole shrimp/trip) and dividing by the number of observations. The CPUEs in Table 8 were calculated by summing the season catch estimates for an area and dividing this figure by the corresponding effort. Only the data from respondents who limited their activity to one area were included, since there was no way to separate catch and effort by area for respondents who shrimped in more than one area.

The distribution of average seasonal CPUE is indicated in Table 9.

The residential stratification of the respondent population was generally comparable to that of the total active permit holder population. A reasonably unbiased estimate of the average statewide seasonal catch rate can then be obtained by dividing the sum of reported seasonal catches by the total reported number of trips. This is a ratio of averages value equivalent to 18.36 quarts of whole shrimp/trip. The average of ratios statistic is obtained by calculating the mean of the CPUES reported by each respondent (= 18.53). This statistic is usually preferable for expansions, etc. because it is unweighted by the distribution of effort and conforms better to normality assumptions (Rothschild and Yong 1970).

Catch

There are numerous ways to estimate the total catch and the following examples are included primarily to illustrate the range of values that can be derived.

Because the residential composition of the total permit holder population and that of the respondent group were fairly similar, a reasonably unbiased catch estimate can be obtained by multiplying the estimated total number of trips by the average of ratios CPUE statistic (70,429 trips x 18.53 quarts/trip = 1,305,049 quarts). Roughly similar values can be obtained by using the other estimate of total effort (68,646 trips) and the ratio of averages CPUE estimator in several combinations.

Another approach is to multiply the estimated number of trips in each shrimping area by the appropriate average CPUE and sum the results, as follows:

Table 6. Distribution of seasonal effort (in percent).

Residence category	Trips/individual/season				
	0-4	5-10	11-15	16-20	> 20
Northern Coastal	50	33	12	4	1
Central Coastal	44	39	12	4	1
Southern Coastal	61	26	8	3	2
Central Inland	63	31	5	1	0
Other	73	23	3	1	0
Total	55	32	8	3	1

Table 7. Catch rates (quarts of whole shrimp/trip) by residence category.

Residence category	1994	1993	CPUE		
			1992	1991	1990
Northern Coastal	17.9	26.5	15.0	18.2	28.3
Central Coastal	21.7	22.3	24.3	17.9	24.0
Southern Coastal	12.1	24.0	26.3	24.1	28.3
Central Inland	16.7	24.0	30.3	24.6) 25.5
Other	19.9	24.4	25.1	25.7	

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

Area	No. of 1994 observations	CPUE				
		1994	1993	1992	1991	1990
Beaufort and vicinity	234	13.2	22.2	28.7	24.4	28.6
St. Helena Sd. area	67	16.4	23.8	29.7	25.0	23.8
Wadmalaw/Edisto Islands	71	16.1	22.5	30.0	24.2	21.0
Charleston Harbor area	300	21.6	20.4	23.4	14.1	23.2
Bulls Bay	110	23.1	26.4	20.3	22.5	28.8
Georgetown	34	13.2	26.9	14.4	10.5	26.7

Table 9. Distribution of average CPUE in percentages of respondents.

Residence category	CPUE				
	0-9	10-20	21-30	31-40	41-48
Northern Coastal	27	40	19	8	6
Central Coastal	18	33	30	13	6
Southern Coastal	51	30	11	4	4
Central Inland	30	41	17	9	3
Other	26	31	22	16	5
Total	28	34	22	11	5

Area	Trips	CPUE	Catch (quarts)
Beaufort and vicinity	14,785	13.2	195,162
St. Helena Sd. area	7,445	16.4	122,098
Wadmalaw/Edisto Islands	6,559	16.1	105,600
Charleston Harbor area	26,280	21.6	567,648
Bulls Bay	12,223	23.1	282,351
Georgetown	3,137	13.2	41,408
Total	70,429		1,314,267

Another method is to multiply the number of active permit holders in each residence category by the average number of trips per permit holder to obtain the effort estimates, then multiply these by the mean CPUE for each category:

Residence category	Trips	CPUE	Catch (quarts)
Northern Coastal	6,067	17.9	108,600
Central Coastal	35,611	21.7	772,759
Southern Coastal	13,958	12.1	168,892
Central Inland	10,070	16.7	168,169
Other	4,723	19.9	93,988
Total	70,429		1,312,408

Within each residence 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 provided by the respondent can be used. The average season catch can then be calculated and multiplied by the number of active permit holders in that residence category. This procedure, using the season catch estimates provided by the respondents, yields the following catch estimates:

Residence category	Average catch	Active permits	Catch (quarts)
Northern Coastal	112.5	963	108,338
Central Coastal	142.8	5,161	736,991
Southern Coastal	73.8	2,181	160,958
Central Inland	82.3	2,055	169,127
Other	91.1	1,099	100,119
Total			1,259,344

The range in total catch estimates generated by these various methods is 1,259,344 - 1,314,267 quarts of whole shrimp. Using a conversion factor of 1.48 pounds per quart, the catch estimates

ranged from 1.86 M pounds to 1.95 M pounds. There are trade-offs in terms of probable accuracy and lack of bias associated with each approach and an intermediate value is probably the most reasonable choice. This would be approximately 1.91 M pounds of whole shrimp.

The distribution of catches per permit holder is shown in Table 10. Well over half of the participating permit holders caught less than 100 quarts during the season with the overall average being about 113 quarts (167 pounds). Assuming that this was evenly shared among the permit holders and their assistants, the typical participant in the 1994 fishery obtained about 50 pounds of whole shrimp.

In recent years, the relative distribution of the fall white shrimp harvest among shrimp baiters and commercial shrimpers has been a significant allocation issue. Beginning in 1992, a monitoring system was established that assigns commercial landings by area on a weekly basis and recreational and commercial landings in similar areas can therefore be examined during comparable time frames. The baiting areas and comparable commercial zones are as follows:

Baiting area	Commercial zone
Beaufort area	Hilton Head to Bay Point
St. Helena Sd. area	Bay Point to South Edisto River
Wadmalaw/Edisto Islands	South Edisto River to Stono Inlet
Charleston Harbor area	Stono Inlet to Dewees Inlet
Bulls Bay	Dewees Inlet to Cape Romain
Georgetown area	Cape Romain to N.C. line, including Winyah Bay

The comparison of recreational and commercial landings (for all gears) is shown in Table 11. In-season commercial landings were defined as those during week 2 of September through week 2 of November. The total commercial landings included those during August through the close of the season on January 27, 1995.

Comparisons between areas are influenced by such factors as the relative sizes of the baiting population and trawler fleets, proximity of population centers and trawler docks to the fishing areas, accessibility of inland waters to boaters, and the extent of estuarine areas vs trawlable coastal waters. Table 12 shows the percentages of the combined recreational and commercial landings attributable to the baiting fishery. Parameter values for principal characteristics of the 1994 baiting fishery are compared with those from previous years in Table 13.

DISCUSSION

Winter coastal water temperatures were colder than in the last few years with those in Charleston Harbor below the critical level for six consecutive days in January. The critical

Table 11. Estimated shrimp baiting catches and reported commercial landings (all gears) by area, in pounds of whole shrimp.

Area	Recreational	Commercial	
		In-season	Total
Beaufort	288,840	77,103	163,755
St. Helena Sound	180,705	385,165	935,725
Wadmalaw/Edisto Is.	156,288	230,506	454,610
Charleston metro	840,119	297,188	487,335
Bulls Bay	417,879	444,284	702,257
Georgetown	61,284	649,021	1,107,422
Total	1,945,115	2,083,267	3,851,104
Recreational and Commercial Combined Total			
	Baiting season	August-January	
Beaufort	365,943	452,595	
St. Helena Sound	565,870	1,116,430	
Wadmalaw/Edisto Is.	386,794	610,898	
Charleston metro	1,137,307	1,327,454	
Bulls Bay	862,163	1,120,136	
Georgetown	710,305	1,168,706	
Total	4,028,382	5,796,219	

Table 12. Shrimp baiting catches expressed as percentages of landings in designated categories.

Area	In-season	Total combined
Beaufort	79	64
St. Helena Sound	32	16
Wadmalaw/Edisto Is.	40	26
Charleston metro	74	63
Bulls Bay	48	37
Georgetown	9	5
Total	48	34

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

	1987	1988	1989	1990
Permits issued	NA	5,509	6,644	9,703
Percent active permits	NA	92	82	94
Assistants/permit holder	NA	2.50	2.14	2.79
Participants	21,735	17,749	17,171	34,662
Trips/permit holder	NA	7.0	5.7	7.8
Total effort (trips)	40,101	35,609	31,624	71,153
Quarts/trip (whole)	28.5	22.1	26.5	25.6
Total catch (M lbs whole)	1.80	1.16	1.25	2.75
Pounds/participant	83	65	73	79
% of total fall landings	29	32	24	46
	1991	1992	1993	1994
Permits issued	12,005	11,571	12,984	13,366
Percent active permits	89	87	91	86
Assistants/permit holder	2.24	2.15	2.43	2.32
Participants	34,821	31,812	40,620	38,081
Trips/permit holder	6.6	6.1	6.8	6.0
Total effort (trips)	71,034	62,459	80,709	70,429
Quarts/trip (whole)	21.3	25.4	23.5	18.5
Total catch (M lbs whole)	2.14	2.35	2.72	1.91
Pounds/participant	62	74	67	50
% of total fall landings	29	39	44	34

level (47 F) is the point at which mortality begins to occur. Spring abundance of overwintering, pre-spawning stock was estimated at 20-25% of the levels observed in the past three years. Sufficient shrimp were available, however, for adequate spawning.

Summer and fall were among the wettest on record. August commercial white shrimp landings (428,000 pounds heads-on), while well above average, did not reflect pre-season outmigration of the magnitude observed in 1991. Rainfall continued to be abnormally heavy during the baiting season and the weather undoubtedly curtailed effort somewhat.

Although the number of permits sold was the highest to date, participation declined slightly from the record level in 1993. This reflected both a lower percentage of active permit holders and a slight decrease in the average number of assistants per permit holder. Inclement weather was a contributing factor, as was low abundance of shrimp in the southern sounds area. The relative non-participation rate of shrimpers in that region was unusually high. Overall participation was greater in 1994 in all residence groups except the Southern Coastal (- 31%) and Central Inland (- 7%) groups, both of which typically concentrate their effort in the Beaufort area.

Total effort declined about 13% from the record 1993 level with the Other residence group posting the only increase. Declines were relatively moderate in the remaining categories, except for the Southern Coastal group (- 31%).

Distribution of effort by fishing area tended to reflect relative shrimping success. The highest CPUE was in Bulls Bay, where effort was up 77% over that in 1993. Although total effort declined somewhat in the Charleston area, the relative percentage there was nearly identical to that in 1993. The percentage of effort in the Beaufort area declined from 32% in 1993 to 21% and the number of trips was down 42%. The average catch rate was also very low in the Georgetown area and total effort there declined 58%.

Average seasonal CPUEs were below the 1990-1993 means in all areas except Charleston, where the four-year average was slightly exceeded. The 1994 catch rate in Bulls Bay was slightly below average, while that in the Beaufort area was barely half of the four-year standard.

The estimated total catch was below 2 M pounds for the first time since 1989 (the hurricane year) and the average yield/participant was the lowest to date.

Baiters accounted for about one-third of the total fall white shrimp harvest, virtually identical to their average annual share since 1987. Their in-season percentage shares were roughly

comparable to those in 1993, except in the Beaufort and Georgetown areas. The baiting share of the total landings was relatively much lower in those areas.

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