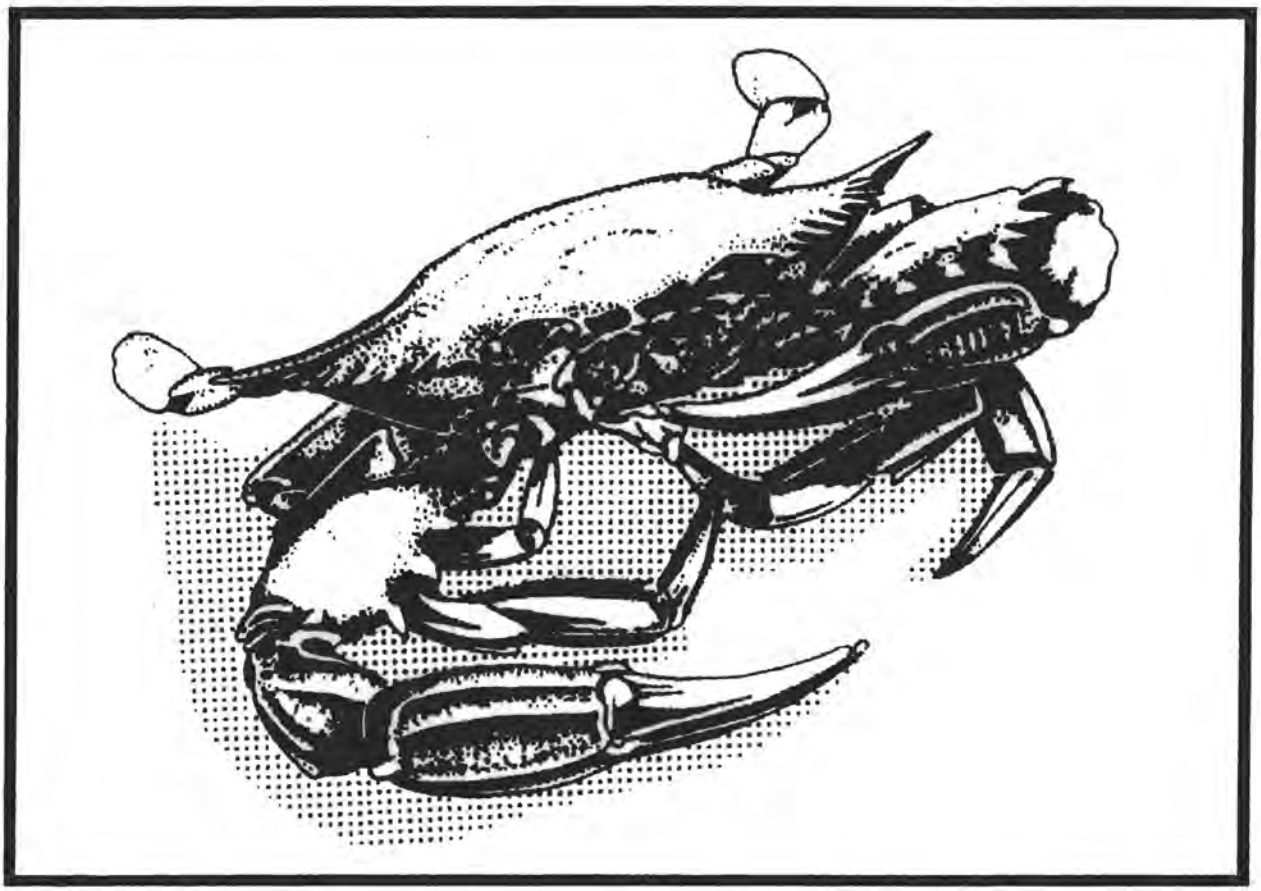
Survey of Recreational Blue Crabbing
by
Marine Recreational Fisheries Stampholders



Data Report Number 30

prepared by
Bob Low

South Carolina Department of Natural Resources
Marine Resources Division
Office of Fisheries Management
P.O. Box 12559, Charleston, South Carolina 29422-2559

Survey of Recreational Blue Crabbing by Marine Recreational Fisheries Stampholders

R.A. Low

Office of Fisheries Management

South Carolina Department of Natural Resources
Marine Resources Division
Charleston, S.C. 29422

July, 1998

Table of Contents

Page
Introduction 1
Methods 1
Results 2
Discussion 10
References 12

List of Tables

1. Distribution of stamp population and sample populations 5
2. Effort expansions as based on the 1995/1996 population 6
3. Estimated catches (numbers of crab) by fishing zone 8

List of Figures

1. Distribution of effort by mode 4
2. Distribution of effort by gear 4
3. Distribution of effort per respondent 7
4. Distribution of CPUE per respondent 7
5. Distribution of landings by area 12

Exhibits

1. Introductory statement and card questionnaire 3

Acknowledgements

Mary Jo Clise of the MRD Computer Services Section provided the list of stamp holders and mailing labels. The DNR Print Shop, supervised by B.R. Hook, provided printing services. Emily Schroeder of OFM assisted in preparation of the mail-outs. Joe Moran of the Fisheries Statistics Section provided commercial landings data. Karen Swanson did the layout. Cover art work by D. Bryan Stone III. Funding was supplied by OFM.

INTRODUCTION

Recent commercial blue crab landings (1992-1995 average 6.91 M pounds annually) have been the highest in ten years. After a decade of relative stability, the number of commercial crab pot licenses has increased (from 282 in 1991 to 429 in 1996). Commercial crabbers have requested a moratorium on additional license sales, because of concerns that the number of non-resident crabbers is increasing, due to licensing limitations and/or poor crabbing in other states, particularly in the Chesapeake Bay area.

Recreational crabbers have complained that their catches are concurrently declining. The Office of Fisheries Management (OFM) has very little information on the extent of recreational crabbing activity and no catch data with which to evaluate this situation. Although shore-based crabbers have often been observed during the MRD's creel census of marine anglers, practically no boaters have been intercepted with catches of blue crab or crabbing gear.

The marine recreational fisheries stamp is required of all anglers fishing from private boats. The population of stampholders therefore presumably represents a substantial portion (though not all) of those crabbers who use or own private boats. In 1996, the OFM employed a mail-out survey (Low 1997) to access this group in order to obtain information on their opinions regarding fisheries management. The section on crabbing was limited in scope. Results were subject to recall error, because specific periods of activity were not addressed on a timely basis. As a result, the rough estimates derived from the findings were given little credibility.

A second survey was conducted in 1997 to obtain more complete and reliable information on recreational crabbing. Objectives were to determine: 1) seasonal participation, 2) seasonal catch rates and landings, 3) effort, catch rates, and harvest by fishing areas, and 4) effort, catch rates, and landings by gear.

METHDS

Summers et al. (1983a) surveyed recreational crabbing activity in Maryland in 1980-1981. This fishery was similar to that in South Carolina in that 1) seasonal activity was largely limited to May-October with a July-August peak, 2) several gears were employed (pots, trotlines, and collapsible traps in Maryland), and 3) only a portion of the participants were required to have a license (i.e., those using the above gears; handline crabbers -"chicken-neckers" - did not need licenses). They determined that the most efficient, comprehensive design (for estimating the annual catch) was a simple random sample conducted once a year (after the peak season) with the questionnaire asking the annual magnitude of the catch and characteristics of the average trip. This was basically the same approach used here in the 1996 opinion poll (Low 1997).

Summers et al. (1983a) initially concluded that stratification of the sample by month, fishing location, or county of residence did not significantly reduce the overall variances of annual catch estimates. Additional work, however, demonstrated that unweighted stratification of the recreational sample by month (i.e., equal monthly sample sizes) reduced the total sample sizes required by >60% (Summers et al. 1983b).

The 1997 South Carolina survey was based on the marine recreational fisheries stampholder population on file as of August, 1997 (i.e., the FY 1996/1997 license purchasers). The survey was limited to residents of South Carolina (about 80% of the total population). An earlier general survey of stampholders in 1994 (Waltz 1996) determined that the percentage of nonresidents who crabbed was appreciably lower than that of state residents. Given the relatively small number of these individuals, excessive effort would have been required to access an adequate number of them.

The sampling strategy was based on information from the previous stampholder surveys, which indicated that at least 40% of the population in coastal and noncoastal counties crabbed sometime during the year, 8-10% of a mail-out would be nondeliverable, and the response rate would be at least 25%. Previous results also suggested that a larger percentage of the residents of the southern and central coastal areas participated than did residents of the inland and northern coastal counties. Anecdotal information implied that relative activity levels were higher during the summer than in the fall. Finally, the sampling intervals were limited to two months, as in the Marine Recreational Fishery Statistics Survey (MRFSS) administered by the National Marine Fisheries Service, due to the recall factor.

The survey consisted of an introductory letter containing instructions and a self-addressed, postage-paid

card questionnaire (Exhibit 1). The sample population was stratified on the basis of area of residence according to the following classifications:

Noncoastal

1	2	3	4
Abbeville	Cherokee	Aiken	Chesterfield
Anderson	Chester	Barnwell	Darlington
Edgefield	Fairfield	Calhoun	Kershaw
Greenville	Lancaster	Lexington	Lee
Greenwood	Spartanburg	Richland	Marlboro
Laurens	Union		Sumter
McCormick	York		
Newberry			
Oconee			
Pickens			
Saluda			

Coastal

5	6	7
Allendale	Berkeley	Dillon
Bamberg	Charleston	Florence
Beaufort	Clarendon	Georgetown
Colleton	Dorchester	Horry
Hampton	Orangeburg	Marion
Jasper		Williamsburg

The aggregate noncoastal/coastal classifications were the same as used by Waltz (1996) in the 1994 survey and were based on the definitions employed in the MRFSS.

The sample population was randomly selected in direct proportion to the number of stampholders in each county. Two mail-outs were made, one in September (5,200 units) to obtain information on the fishery during July/August and the second in November (7,800 units) to address the September/October period. The different sample sizes were based on the supposition that a larger percentage of the population crabbed during the summer interval. The entire sample population (N = 13,000) was drawn at one time, so there was virtually no duplication of respondents in the two mail-outs. A three-week return period was specified in the instructions and any responses received later than that were not included in the analysis.

Catch per unit of effort (CPUE) and catch data typically exhibit a positively skewed distribution (i.e., the mean is greater than most of the observations). Analysis of such data based on the assumption of normality tends to produce misleading results if sample sizes are small. Summers et al. (1983a) found that such problems were unimportant if the sample sizes were greater than 100 individuals and they used untransformed data for their estimates, because they provided the narrowest confidence intervals.

Catch estimates can be based on CPUE and/or catch data: 1) mean CPUEs can be multiplied by estimated effort and/or 2) mean catches can be multiplied by estimated participation. CPUE means can be calculated as either ratio of averages values or average of ratios values. The former are obtained by dividing the total catches by the total trips: these parameters have no variances. The alternative method is to sum the CPUE values and divide this by the number of observations: the average of ratios mean thus generated is usually more reliable and preferred for estimates based on expansion (Rothschild and Yong 1970). Catch estimates were thus derived using average of ratios mean CPUE estimators.

RESULTS

The distributions of the sample returns for the summer (July/August) and fall (September/October) mail-outs are shown in Table 1. The statewide return rates were virtually identical for each segment with an overall response rate of 28.3%. Area return rates were somewhat variable, although generally comparable for the two intervals. The percentages of respondents indicating that they had made at least one crabbing trip during the preceding two months were as follows:

	July/August	September/October
Noncoastal	20.6	23.5
Coastal	31.2	27.5

The overall crabber response rate during both segments was 27.4% of those stampholders returning the survey questionnaire.

Respondents were asked to indicate the primary mode in which they crabbed, i.e., boat, dock/bridge, or bank/beach. In the various treatments described below, all trips reported by the respondent were assigned to the indicated mode, although obviously there was some partitioning of actual effort. The percentages of respondents in each mode were as follows:

Exhibit 1.

ATTENTION FISHERMEN

Your name has been randomly selected from the current list of purchasers of the marine recreational fishing stamp. The enclosed card contains questions about your blue crabbing activity during the last two months. Please return the card, marked **appropriately, even if you did not do any** crabbing. Your answers will be used to estimate participation, effort, and catch by area. Consider a "trip" as a day or any part thereof during which you caught or tried to catch blue crab. The areas in question 4 are defined as follows:

BEAUFORT- from the Savannah River to the south end of St. Helena Island, including the Beaufort River
ST. HELENA SD.- from St. Helena Island to the South Edisto River and southern end of Edisto Island
WADMALAW/EDISTO IS. - from the South Edisto River to the Stono River (Edisto, Wadmalaw, Seabrook, Kiawah, and Johns Islands)
CHARLESTON- from the Stono River to the north end of Isle of Palms
BULLS BAY- from the north end of Isle of Palms to the Georgetown County southern line (near Santee River)
GEORGETOWN- Georgetown and Horry Counties, including Winyah Bay

The card requires no postage. **Please return it within three weeks of receipt.** Thank you for your cooperation.

Office of Fisheries Management
Marine Resources Division

1. What county do you live in?_____
2. How many trips did you make crabbing during the last two months?_____
3. Did you crab mostly from:
   _____ boat _____ dock/bridge _____ bank/beach
4. Please indicate the number of crabbing trips you made in each area, as indicated on the enclosed notice:
   _____ BEAUFORT _____ CHARLESTON
   _____ ST. HELENA SD. _____ BULLS BAY
   _____ WADMALAW/EDISTO IS. _____ GEORGETOWN
5. Which gears did you use?
   _____ trap (pot) _____ baited string _____ drop net
6. On an average trip, how many blue crabs did you keep?_____

	Boat	Dock/bridge	Bank/beach
Noncoastal			
Summer	39	40	21
Fall	60	28	12
Coastal			
Summer	44	43	14
Fall	45	42	13

Fig. 1 shows the distribution of effort by mode. In each instance, the relative distribution of participation and effort by mode for coastal residents showed little seasonal change. Among noncoastal crabbers, there was relatively more usage of boats during the fall indicated with correspondingly less shore-based

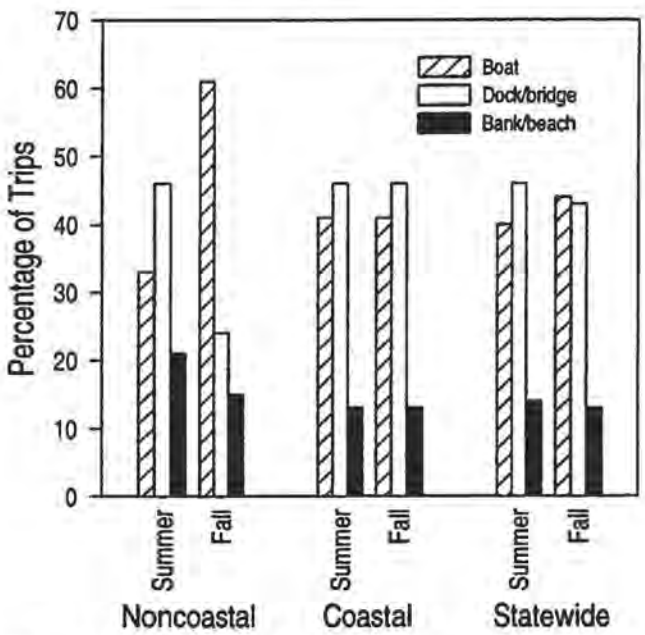


Figure 1. Distribution of effort by mode.

activity. Overall effort statewide during both seasonal intervals was somewhat higher in the shore-based modes (45% dock/bridge, 12% bank/beach) than in the boat mode (43%).

Respondents were also asked to specify the principal type of gear they employed: 1) crab trap, 2) baited string (i.e., handline), or 3) drop net). Again, all trips were assigned to the indicated gear, although some respondents noted that they used more than one type. The percentages of respondents selecting each gear type were as follows:

	Crab trap	Handline	Drop net
Noncoastal			
Summer	43	38	19
Fall	54	33	13
Coastal			
Summer	43	43	13
Fall	56	32	12

Within each interval, there was little difference in the percentages of crabbers preferring trap and handline gear by area of residence. Crabbers in both residence classifications indicated a greater preference for traps during the fall. For the 4-month interval statewide, 54% of the boating crabbers indicated traps as their principal gear, 37% handline, and 9% drop net. Shore-based participants indicated 47% traps, 36% handline, and 17% drop net. Drop net usage was relatively low regardless of the crabbers' residence or season.

Relative distribution of effort by gear is shown in Fig. 2. Coastal residents expended relatively more effort using traps than did noncoastal residents regardless of season. Overall statewide effort during the four month period was predominantly with traps (62% of the trips vs 28% for baited string and 10% for drop net).

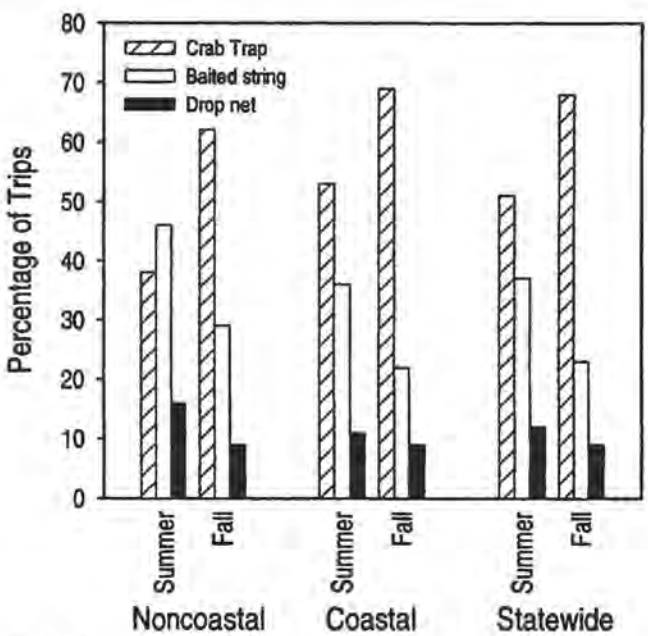


Figure 2. Distribution of effort by gear.

Table 1. Distribution of stamp population and sample populations. S - summer survey F - fall survey. Area is area of residence.

Area of Residence	Stamp popn.		Adjusted sample	Non-crabber	Crabber	Total returns	% return	% crabber
				Noncoastal				
1	2725	(S)	204	54	14	68	33.3	20.6
		(F)	317	84	27	111	35.0	24.3
			521	138	41	179	34.4	22.9
2	1787	(S)	148	33	6	39	26.4	15.4
		(F)	216	50	13	63	29.2	20.6
			364	83	19	102	28.0	18.6
3	6646	(S)	514	117	38	155	30.2	24.5
		(F)	785	167	61	228	29.0	26.8
			1299	284	99	383	29.5	25.8
4	2491	(S)	190	42	6	48	25.3	12.5
		(F)	284	47	6	53	18.7	11.3
			474	89	12	101	21.3	11.9
1-4	13649	(S)	1056	246	64	310	29.4	20.6
		(F)	1602	348	107	455	28.4	23.5
			2658	594	171	765	28.8	22.4
				Coastal				
5	10074	(S)	959	157	106	263	27.4	40.3
		(F)	1478	249	136	385	26.0	35.6
			2437	406	242	648	26.6	37.5
6	22354	(S)	1966	399	178	577	29.3	30.8
		(F)	2970	622	252	874	29.4	28.8
			4936	1021	430	1451	29.4	29.6
7	13995	(S)	777	153	37	190	24.5	19.5
		(F)	1158	282	47	329	28.4	14.3
			1935	435	84	519	26.8	16.2
5-7	46423	(S)	3702	709	321	1030	27.8	31.2
		(F)	5606	1153	435	1588	28.3	27.5
			9308	1862	756	2618	28.2	28.9
				Statewide				
All	60072	(S)	4758	955	385	1340	28.2	28.7
		(F)	7208	1501	542	2043	28.3	26.5
			11966	2456	927	3383	28.3	27.4

Table 2. Effort expansions as based on the 1995/1996 population.

Area of residence	Stamp holders	% crabbed	Crabbers	No. obs.	Average trips/crabber	Total trips
			Summer			
1-4	17,327	20.6	3,569	64	2.14	7,638
5	12,197	40.3	4,915	106	3.76	18,480
6	27,943	30.8	8,606	178	3.06	26,334
7	16,855	19.5	3,287	37	3.70	12,162
Total			20,377	385		64,614
				untransformed	3.20	65,206
				transformed	2.73	55,629
			Fall			
1-4	17,327	23.5	4,071	107	2.68	10,910
5	12,197	35.6	4,342	136	4.07	17,672
6	27,943	28.8	8,048	252	4.02	32,353
7	16,855	14.3	2,410	47	3.30	7,953
Total			18,871	542		68,888
				untransformed	3.70	69,823
				transformed	2.80	52,839

Respondents were asked to indicate the numbers of trips they made in each fishing zone. These were defined as follows:

Beaufort (1): from the Savannah River to the south end of St. Helena Island

St. Helena Sound (2): from St. Helena Island to the South Edisto River and southern end of Edisto Island

Wadmalaw/Edisto Islands (3): from the South Edisto River to the Stono River (including Edisto, Wadmalaw, Seabrook, Kiawah, and Johns Islands)

Charleston (4): from the Stono River to the north end of the Isle of Palms

Bulls Bay (5): from the north end of the Isle of Palms to the Georgetown County southern line

Georgetown (6): Georgetown and Horry Counties, including Winyah Bay

Within each residential classification, the numbers of trips for each zone were obtained, then divided by the total number reported to obtain the percentages for each area. Relative distribution of effort was as follows:

		Percentage by area fished					
Residence category	**Season**	**1**	**2**	**3**	**4**	**5**	**6**
Noncoastal							
	Summer	29	14	28	4	3	23
	Fall	28	18	33	9	4	8
Coastal							
	Summer	28	7	16	34	3	12
	Fall	28	6	16	36	7	7
Statewide							
	Summer	28	8	17	30	3	14
	Fall	28	8	19	32	6	7

Total participation and effort (trips) estimates were based on the 1995/1996 stampholder population (approximately 75,000), because the 1996/1997 file was short about 15,000 entries (although the proportional distribution by county was comparable to that in the previous year). The expansions are shown in Table 2. Because of small sample sizes, data were pooled for the noncoastal residence categories. The estimates were somewhat questionable for the north coastal area, because of the relatively few numbers of respondents. Because of the sample design (respondents addressed only the discrete 2-month intervals, not a single 4-month period), these data cannot be combined over

the entire survey period to produce larger sample sizes (for average trips/crabber) and more reliable estimates.

The distribution of the effort data was also strongly skewed (Fig. 3), approaching a negative binomial distribution. The usual correction would be a log(e)[x+1] transformation. The differences in the overall seasonal means for untransformed and transformed data are also shown in Table 2 with the corresponding total effort estimates.

Respondents were asked to indicate the average number of crabs kept per trip (CPUE) and the number retained during the two-month interval. Results were as follows:

Area	Season	No. obs.	Average CPUE	No. obs.	2-mo. catch
Noncoastal	Summer	64	14.6	64	28.6
	Fall	107	18.6	107	44.0
Coastal	Summer	320	15.8	314	51.3
	Fall	429	15.2	430	49.9
Statewide	Summer	384	15.6	378	47.4
	Fall	536	15.9	537	48.7

These data were also somewhat skewed (Fig. 4), though not as severely as the individual effort responses. Since sample sizes generally exceeded 100, no transformation was done based on the example of Summers et al. (1983a).

Catch rates (crabs/trip) by mode and gear are shown below:

		Trap	Hand-line	Drop net	Total	No. obs.
Boat	Summer	22.3	20.1	13.5	20.3	163
	Fall	19.5	18.7	10.7	18.6	255
Shore	Summer	12.0	14.0	9.1	12.3	214
	Fall	13.3	14.4	11.9	13.4	274
Total	Summer	16.5	16.8	10.6		
	Fall	16.5	16.5	11.6		
No. obs.	Summer	164	159	54		
	Fall	294	169	66		

Boat-based crabbers averaged more crabs per trip than shore-based crabbers regardless of gear or season. Within modes and seasons, crabbers using pots had comparable catch rates to those using baited string gear. Crabbers with drop nets had consistently lower catch rates regardless of mode or season. Because catch rates and distributions of effort by mode and gear type were similar between residence classifications, no adjustments to standardize effort were necessary.

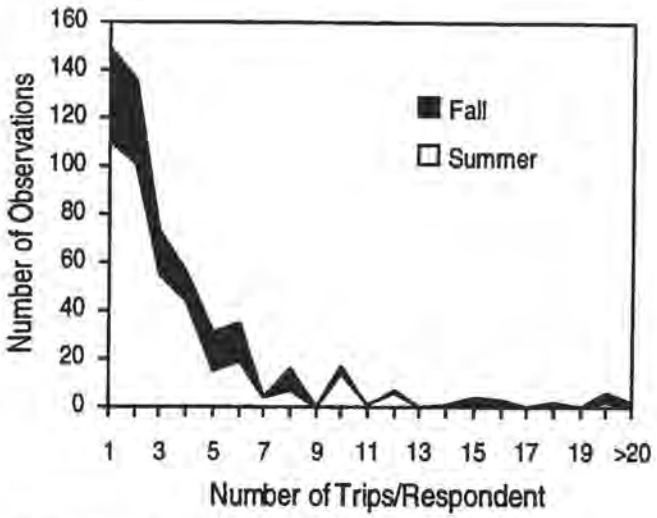


Figure 3. Distribution of effort per respondent.

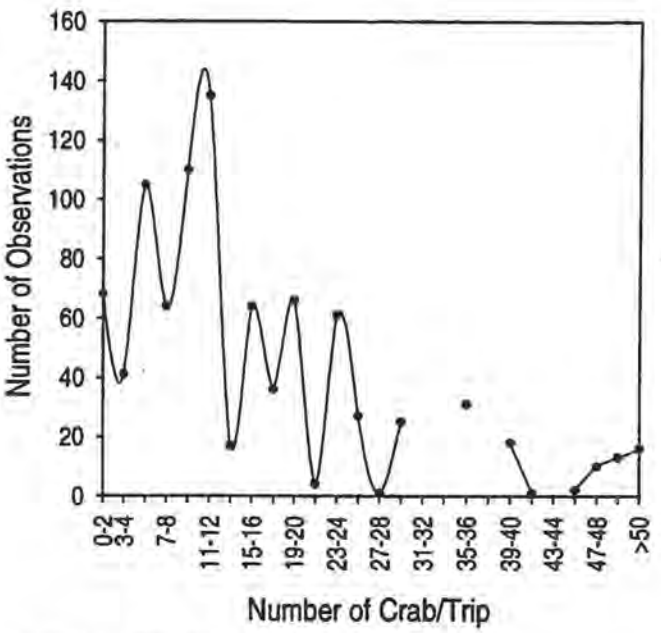


Figure 4. Distribution of CPUE per respondent.

Catches were estimated in various ways, depending on the desired categories. There were slight differences in the total estimates thus obtained.

The simplest estimate of total catch by season was obtained by multiplying the estimated numbers of participants by their average reported catch:

Table 3. Estimated catches (numbers of crab) by fishing zone.

Season	Zone	Trips	CPUE	No. obs.	Catch
			Untransformed effort		
July/August	1	18,092	17.4	93	314,801
	2	5,169	13.8	26	71,332
	3	10,984	17.2	62	188,925
	4	19,385	15.5	108	300,468
	5	1,938	18.5	11	35,853
	6	9,046	12.6	43	113,980
	All	64,614			1,025,359
September/October					
	1	19,289	17.8	146	343,344
	2	5,511	24.6	35	135,571
	3	13,089	17.2	89	225,131
	4	22,044	13.5	145	297,594
	5	4,133	12.5	30	51,663
	6	4,822	13.4	42	64,615
	All	68,888			1,117,918
July-October					
	1	37,381	17.6	239	657,906
	2	10,680	20.0	61	213,600
	3	24,073	17.2	151	414,056
	4	41,429	14.4	253	596,578
	5	6,071	14.1	41	85,601
	6	13,868	13.0	85	180,284
	All	133,502			2,148,025
			Transformed effort		
July-October					
	1	30,231	17.6		532,066
	2	8,637	20.0		172,740
	3	19,411	17.2		333,869
	4	33,447	14.4		481,637
	5	4,824	14.1		68,018
	6	11,418	13.0		148,434
	All	107,968			1,736,764

Residence area	Season	Estimated partici.	Ave. catch	No. obs.	Estimated total catch
Statewide	Summer	20,377	47.4	378	965,870
	Fall	18,871	48.7	537	919,018

The total catch estimate was 1,884,888 crabs for the 4-month interval.

A similar procedure was used to estimate the season catches by residental classification:

Residence area	Season	Estimated partici.	Ave. catch	No. obs.	Estimated total catch
Noncoastal	Summer	3,569	28.6	64	102,073
	Fall	4,071	44.0	107	179,124
	Total				281,197
Coastal	Summer	16,808	51.3	314	862,250
	Fall	14,800	49.9	430	738,520
	Total				1,600,770

The estimated statewide estimates from this procedure

were 964,323 crabs in the summer, 917,644 in the fall, and 1,881,967 total.

Catch by residential classification could also be derived by using effort and CPUE data, as follows:

Residence area	Season	No. of trips	Crabs/ trip	No. obs.	Estimated total catch
1-4	Summer	7,638	14.6	63	111,515
	Fall	10,910	18.6	107	202,926
5	Summer	18,480	17.5	106	323,400
	Fall	17,672	17.4	132	307,493
6	Summer	26,334	15.8	173	416,077
	Fall	32,353	14.6	250	472,354
7	Summer	12,162	12.4	36	150,809
	Fall	7,953	12.3	47	97,822

This procedure produced somewhat higher catch estimates, i.e. 1,001,801 crabs in the summer, 1,080,605 in the fall, and a total catch of 2,082,406.

Catch by fishing zone was also estimated by multiplying effort by CPUE, as shown in Table 3. With the seasons considered separately, the sample sizes for several zones were smaller than desirable and pooling data for the entire survey period was probably warranted. The sum of the summer and fall estimates (2,143,277 crabs) was slightly less than that obtained by pooling data for the entire 4-month period. The estimated catches based on transformed effort data are also shown with the total being 19% less than that derived from the untransformed data.

Estimated catches by gear were derived as follows. Total effort (from untransformed data) in each 2-month interval was multiplied by the percentage of trips attributable to each gear, i.e.,

	July/August	September/October
Crab trap	51	68
Handline	37	23
Drop net	12	9

to obtain the following effort estimates (numbers of trips):

	July/August	September/October
Crab trap	32,953	46,844
Handline	23,907	15,844
Drop net	7,754	6,200

These trip totals were then multiplied by the CPUE for each gear type to generate the catch estimates:

	July/August			September/October		
	CPUE	No. obs.	Catch	CPUE	No. obs.	Catch
Crab trap	16.5	164	543,725	16.5	294	772,926
Handline	16.8	159	401,638	16.5	169	261,426
Drop net	10.6	54	82,192	11.6	66	71,920
Total			1,027,555			1,106,272

The overall estimated total catch from this approach was 2,133,827 crabs. Results for transformed effort data can be similarly derived by substituting the appropriate effort estimates. The relative distribution of landings by gear type was then as follows:

	July/ August	September/ October	Total
Crab trap	53%	70%	62%
Handline	39%	24%	31%
Drop net	8%	6%	7%

Similar procedures were used to generate the relative distribution of the landings by mode:

		July/ August	September/ October
CPUE	Boat	20.3	18.6
	Shore	12.3	13.4
No. obs.	Boat	163	255
	Shore	214	274
% trips	Boat	40	45
	Shore	60	55
Trips	Boat	25,846	31,000
	Shore	38,768	37,888
Catch	Boat	524,674 (52%)	576,600 (53%)
	Shore	476,846 (48%)	507,699 (47%)
	Total	1,001,520	1,084,299

These catches summed to 2,085,819 crabs.

Catches can be converted into pounds for comparison with commercial landings by assuming 100 crabs per bushel (Jerry Gault, pers. comm.) and applying a multiplier of 40 pounds/bushel. The results are as follows (statewide 4-month totals in bold):

	July/ August	September/ October	Total Pounds
Residence category			
Noncoastal	40,829	71,650	112,479
Coastal	344,900	295,408	640,308
All	386,348	367,607	**753,955**
Fishing zone			
1	125,920	137,338	263,258
2	28,533	54,228	82,761
3	75,570	90,052	165,622
4	120,187	119,038	239,225
5	14,341	20,665	35,006
6	45,592	25,846	71,438
All	410,143	447,167	**857,310**
From transformed data			**694,706**
Gear type			
Crab trap	217,490	309,170	526,660
Handline	160,655	104,570	265,225
Drop net	32,877	28,768	61,635
All	411,022	442,508	**853,530**
Mode			
Boat	209,870	230,640	440,510
Shore-based	190,738	203,080	393,818
All	400,608	433,720	**834,328**

The comparison of reported commercial and estimated recreational landings (in pounds) is shown below:

		Commercial		Recreational	
County	**Zones**	**JUL/ AUG**	**SEP/ OCT**	**JUL/ AUG**	**SEP/ OCT**
BFT/ COLL	1-2	447,686	1,101,723	154,453	191,566
CHS/ BERK	3-5	549,505	535,950	210,098	229,755
GTN/ HORR	6	71,240	75,760	45,592	25,846
Total		1,068,431	1,713,433	410,143	447,167

Of the estimated total catch (1.48 M pounds) in July/ August, about 28% was recreational. During September/October, about 21% of the total landings (2.16 M pounds) were recreational. Landings for both user groups were greater during the fall interval.

DISCUSSION

At least five previous studies have addressed the extent of participation in the recreational blue crab fishery. These include the following:

Coastal tackle shop survey (1985)-card questionnaire/ collection boxes in popular tackle shops coastwide (Low 1986a)

Public ramp dropbox survey (1985/1986)-card questionnaire/collection boxes at popular coastal launching sites (Low 1986b)

Shrimp baiting permit holder survey (1989)-questionnaire mailed to a sample of baiting permit holders (Low 1990)

Marine fishing stampholder survey (1994)-generalized two-stage survey of a sample of stampholders (Waltz 1996)

Opinion poll (1996)-survey of a sample of stampholders (Low 1997)

Rates of participation (in percentages of respondents who crabbed) as indicated in these surveys are summarized below:

	Residence/location					
	Coastal				Non-	
Year/Source	**North**	**South**	**Central**	**All**	**coastal**	**Total**
1985/Tackle shop	21	34	23	25	-	-
1986/Ramp dropbox	9	25	28	26	-	-
1989/Baiter survey	---31---			33	30	23	30
1994/Stamp survey	-	-	-	43	44	43
1996/Opinion poll	43	75	68	62	58	61

Although more recent surveys have tended to identify higher participation rates, those obtained in the present survey (26-29%) are more consistent with results from earlier studies and other states. In Louisiana, for example, a mail survey of saltwater angler license holders found that about one-third of them went crabbing (Guillory 1996). The latest South Carolina survey results indicated that approximately 20,000 stampholders crabbed during at least a part of the 4-month interval. This is less than half of the projected annual population (about 46,000) derived from the 1996 opinion poll results.

The 1996 poll data suggested that annual effort was about 580,000 trips (in 1996), equivalent to an average of 13.5 trips/crabber (based on untransformed data). This was relatively high compared to estimated

individual effort in other states. Guillory (1996) found that recreational crabbers in Louisiana made 6-8 trips/year, regardless of whether they fished from a boat or the bank. About 70% of the recreational crabbers in Maryland averaged <10 trips/year (Summers et al. 1983a). The 1996 South Carolina survey found that 80% of the crabbers made 10 or fewer trips. The 1997 survey results suggested that stampholders averaged 6.8 trips/participant during July-October, the major recreational season, with the total effort about 133,500 trips. A more conservative estimate, based on transformed data, was approximately 108,000 trips.

The surveys of marine stampholders were obviously subject to bias attributable to the fact that their target population by definition consisted of people who presumably used private boats for most of their fishing activities, including crabbing. Results of the most recent survey, however, indicated that the majority of the crabbing (57% of all trips) took place in shore-based modes with docks particularly popular. This partly explains the scarcity of crabbers noted during the creel census of private boat anglers.

Surveys of the stampholder population consistently indicated that crab traps and handlines were the two most widely used gear types and about equally popular in terms of percentage of users. The amount of effort (trips) attributable to traps, however, was substantially greater than that for handlines. Dropnets were much less frequently used and accounted for considerably less effort. This was also true in Louisiana, where shore-based use of handlines exceeded that of drop nets by a 3:1 ratio (Guillory 1996).

The relative effectiveness of traps and handlines as measured in CPUE appeared to be comparable when deployed in the same mode. Either gear fished from boats had higher catch rates than when fished in the shore-based modes. Drop nets were considerably less effective, regardless of mode.

The 1996 poll did not obtain estimates of CPUE by mode, gear type, or season. Cohort recruitment to the harvestable stock generally begins in September and ends the following August. Presumably, CPUE would therefore be relatively low in the summer, reflective of the reduced abundance of the stock, assuming comparable harvestable populations in consecutive years. Reported commercial landings during July/October in 1997 were only 6% greater than those in 1996, suggesting that the 1996 and 1997 stocks were similar. Respondents to the 1996 survey indicated higher catch rates, however, as shown below in percentages of respondents in each CPUE category:

		Crabs/trip				
Survey	**No. obs.**	**0-5**	**6-10**	**11-20**	**21-30**	**>30**
1996	1,259	6	19	43	20	11
1997	915	16	26	35	13	10

The overall average CPUE reported was 18.9 crabs/trip in 1996, compared to 15.8 crabs/trip calculated from the 1997 (July-October) survey data. The impression therefore is that the average CPUE in 1996 was probably somewhat overestimated.

The 1996 opinion poll estimated that the annual (1996) catch by stampholders was approximately 4.4 M pounds, equivalent to 39% of the combined commercial and recreational landings. The 1997 total stampholder landings for July-October, based on similar estimation procedures, were about 857,000 pounds (the most conservative estimate was 695,000 pounds), equal to about 24% of the combined recreational and commercial landings during that period. As with the CPUE-based interpretation, the likely conclusion was that the 1996 catch was overestimated.

Results from both surveys agreed closely on the distribution of recreational landings by residence classification:

	Percent of catch			
Survey	**South Coast**	**Central Coast**	**North Coast**	**Non-coastal**
1996	29	44	11	16
1997	30	43	12	15

Fig. 5 illustrates the division of catch between the recreational and commercial sectors for major areas. The recreational share was consistently lowest in the southern coastal region, where the largest percentage of the state's commercial harvest was taken. Conversely, the overall recreational share was highest in the northern coastal region, where only a minor portion of the commercial harvest was taken. The estimated 1997 July/October recreational catch presumably represented the catch during at least half of the recreational season, including its most active and productive period. This harvest was roughly evenly divided between boat and shore-based modes.

The estimated participation and effort indicated in results of the 1997 survey were substantially lower than the level implied in the 1996 poll responses. Commercial landings data for comparable periods sug-

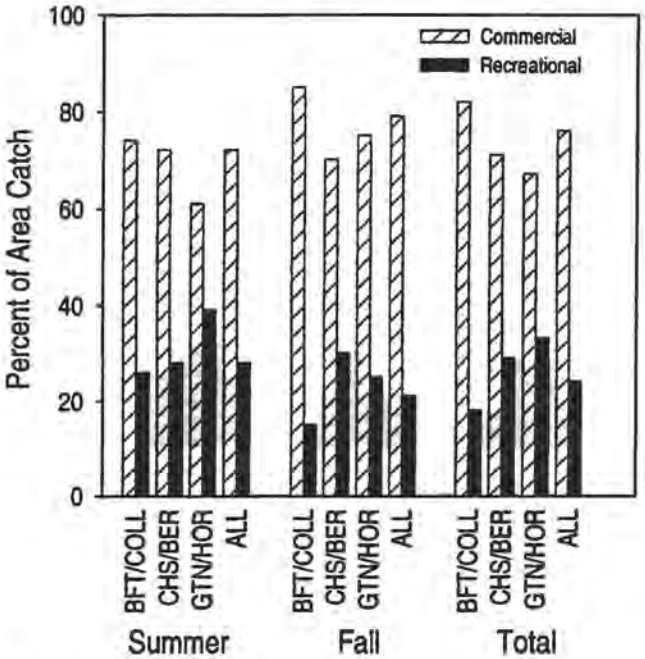


Figure 5. Distribution of landings by area.

gested that the 1996 and 1997 crab stocks were approximately equal, yet the 1997 average recreational CPUE appeared to be appreciably lower than that reported in 1996. This suggests that the recreational catch for 1996 was substantially overestimated. The statistical reliability of the 1997 survey was appreciably greater, leading to the conclusion that the 1996 survey significantly overestimated the extent of recreational crabbing by stampholders.

REFERENCES

Guillory, V. 1996. A survey of the recreational blue crab fishery in Terrebonne Parish, Louisiana. Proc. Blue Crab Symposium. (In press)

Low, R.A. 1986a. Tackle shop survey of marine recreational fishing activity in coastal South Carolina. SCWMRD, MRRI, Charleston, SC. (mimeo)

Low, R.A. 1986b. On-site drop box survey of marine recreational fishing activity in coastal South Carolina. Prel. Prog. Rep. SCWMRD, MRRI, Charleston, SC. (mimeo)

Low, R.A. 1990. Survey of the South Carolina shrimp baiting fishery, 1989. SCMRD, OFM, Charleston, SC. Tech. Rep. 73.

Low, R.A. 1997. South Carolina marine fishing stampholder survey, 1996. SCMRD, OFM, Charleston, SC. (mimeo)

Rothschild, B.J. and M.Y.Y. Yong. 1970. Apparent abundance, distribution, and migrations of albacore, *Thunnus alalunga*, on the North Pacific longline grounds. USFWS, Spec. Sci. Rep. Fish. 623:1-37.

Summers, J.K., H.W. Hoffman, and W.A. Richkus. 1983(a). Randomized sample surveys to estimate annual blue crab harvests by a multi-gear fishery in the Maryland waters of Chesapeake Bay. N.A.J. Fish. Mgt. 3:9-20.

Summers, J.K., W.A. Richkus, H.W. Hoffman, C. Bonzek, H.H. King, and M. Burch. 1983(b). Application of random sample survey designs to estimate the commercial blue crab harvest in Maryland. N.A.J. Fish. Mgt. 3:21-25.

Waltz, W. 1996. South Carolina saltwater fishing stamp survey, 1994. SCMRD, OFM, Charleston, SC. (mimeo)