Development of a Self-Culling Blue Crab Pot

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Introduction

Benjamin Franklin Lewis of Harryhogan, Va., revolutionized the blue crab, *Callinectes sapidus,* fishery with the introduction of the crab pot in the middle 1930's (Wharton, 1956). Until then, the most widely employed method of catching crabs was the trot line. It produced about half the catch per man day as did the pot and therefore was rapidly replaced as the preferred fishing gear (Cronin, 1950).

Crab pots were introduced into South Carolina in the early 1950's and commercial catch by this gear was first reported in 1955 (Green, 1952; Anderson and Powers, 1957). The last trot line apparently was used by South Carolina crabbers in 1973 (Pileggi and Thompson, 1976; Wise and Thompson, 1977).

The crab pot is essentially a square cage constructed of 38-mm (1½-inch) galvanized poultry wire with a bait box to attract crabs and funnels to allow them to enter. It is a very efficient means of capturing blue crabs and this results in large numbers of sublegal size (<127 mm carapace width) crabs being retained along with legal size crabs. Numbers of sublegal crabs caught vary with season but are most abundant in May and June when they may make up over 60 percent of the catch (Cronin, 1950; Eldridge and Waltz, 1977; Van Engel, 1959). Law abiding crabbers must then spend considerable time culling out small crabs and returning them to the water. Many of these crabs may not survive as they are often injured by larger crabs while confined in the pot or baskets prior to being returned to the water. Less conscientious crabbers sell poorly culled catches containing many sublegals to processors who cannot legally or profitably handle small crabs.

This problem has led to efforts to develop self-culling pots. Some researchers have investigated the use of panels constructed of larger mesh (Cronin, 1950); entire traps made of larger mesh (Van Engel, 1959, 1961, 1964); or escape rings (ports) (Wootten, 1976). These studies have not been carried to fruition, i.e., all results tested statistically and made public with recommendations as to what changes should be made to crab pots.

Concern by crabbers, processors, and management groups led us to design a study to determine the feasibility of escape ports as a means of reducing the catch of sublegal crabs. It was hoped that the use of escape ports would result in less culling time for crabbers and a more efficient use of the blue crab resource by decreasing crab injuries associated with fishing.

The objectives were to determine if the concept of escape ports was sound and to determine the best configuration and size of escape ports. Criteria for pots with escape ports were: 1) Escape ports must reduce substantially the catch of sublegal crabs, 2) the catch of legal crabs in self-culling pots should not be significantly less than that of the standard pot presently used, and 3) that modification of standard pots to make them self-culling should not involve great expense or labor.

Material and Methods

The work discussed in this report was done in two phases. The first phase completed in the summer of 1977 was designed to test the feasibility of developing a self-culling pot. An associated objective was to determine the optimum configuration (size and number) of rectangular escape ports. The second phase, completed in the summer of 1978, evaluated the relative advantages of circular vs. rectangular escape ports as well as established the "best" configuration (size, number, and placement) of escape ports in commercial crab pots.

Experimental work was done in the Wando River, a small coastal river which flows into Charleston Harbor (Fig. 1). The Wando River was chosen because over 99 percent of crabs taken in it are male and it represents a typical South Carolina estuary where crabs are fished commercially. Experiments were conducted from June through October 1977 and May through August

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ABSTRACT–During 1977 and 1978 a series of experiments was conducted to develop a self-culling blue crab pot. A crab pot with two escape ports in the top chamber and one in the bottom chamber reduced the catch of sublegal crabs by 82 percent. The use of escape ports will reduce culling time of fishermen, reduce law enforcement problems, result in reduced deliveries of illegal crabs to processors, and lower the number of injuries to crabs during the fishing operation.

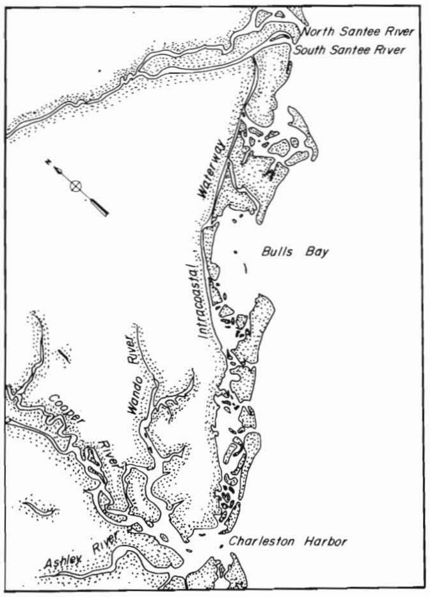


Figure 1.—Wando River where experimental blue crab pot work was conducted.

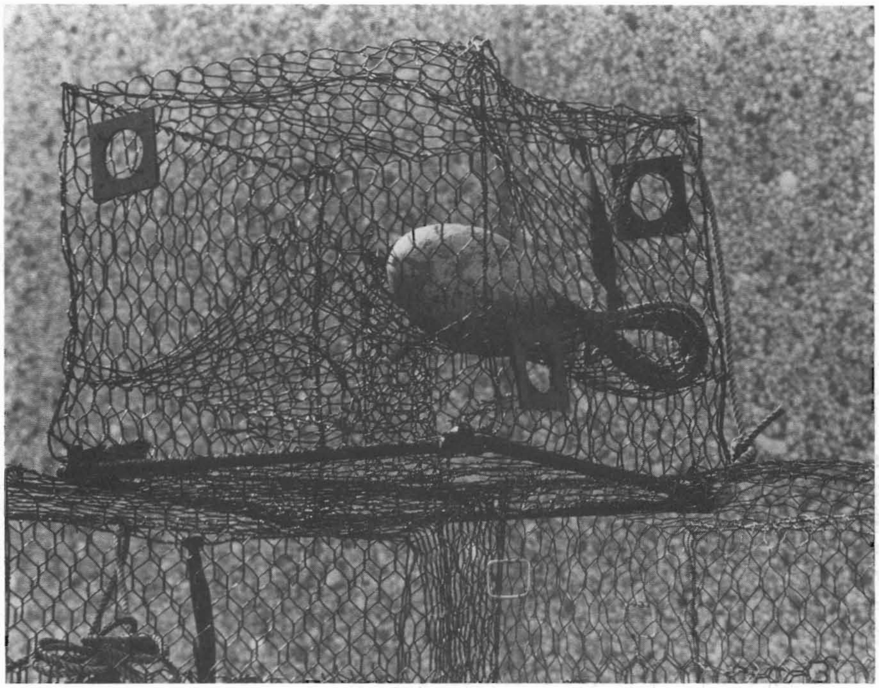


Figure 2.—Experimental blue crab pot with circular escape ports.

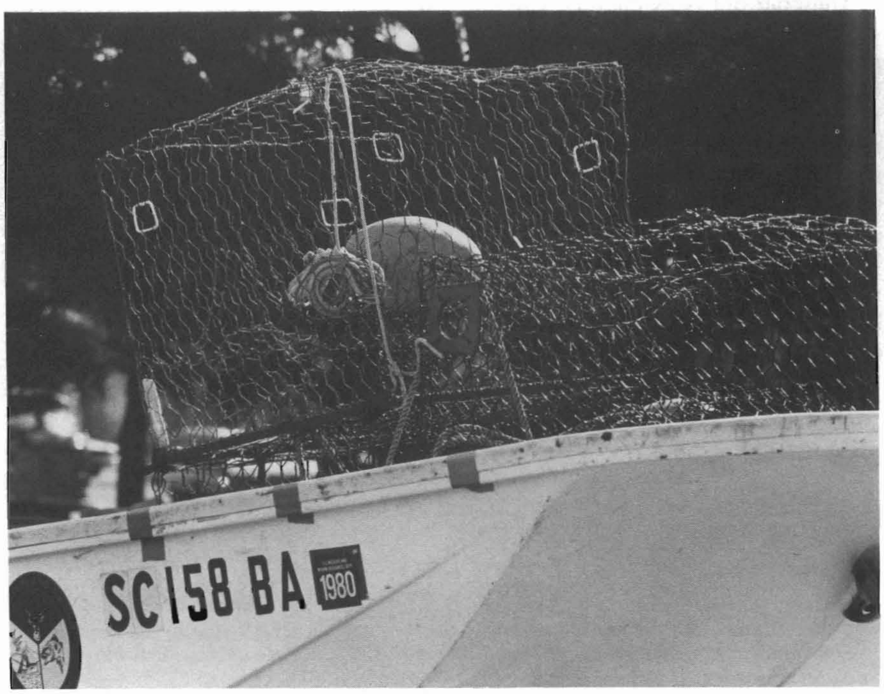
1978. A total of 11,860 crabs were taken during the project. Experimental pots, those with escape ports, were constructed from standard commercial pots. Circular and rectangular escape pots were constructed and placed into pots by personnel of the Marine Resources Research Institute (Figs. 2, 3).

Pots were set on Mondays, pulled and baited daily, and taken up on Fridays to insure uniform fishing time as well as to minimize pot theft. The latter objective was fully satisfied in that only one pot was lost during the project. Pots with different escape port configurations were uniformly mixed throughout the fishing area in order to sample the crab population as randomly as possible.

Carapace length, carapace width, total live weight, sex, stage of maturity, and missing appendages were recorded for crabs during 1977. Similar data were recorded for samples of 1978 catches except that sex and carapace width were collected for all crabs. All data were computerized.

The basic approach to experimental design was to test all practical sizes of

Figure 3.—Experimental blue crab pot with rectangular escape ports.



escape ports in a pilot study. After preliminary testing unsatisfactory ports were eliminated in order to expand most of the experimental effort on the best port sizes and configurations. Criteria selected to determine the best ports were that the ports must substantially reduce the catch of sublegal crabs while maintaining the catch of legal crabs. Escape ports that either failed to reduce the catch of sublegal crabs or resulted in a substantial reduction in the catch of legal crabs were eliminated from consideration after field testing.

Results and Discussion

Field Work, 1977

Work in Virginia by Van Engel during the early and mid 1960's showed that a 2 ×1.5 inch rectangular mesh pot would significantly reduce the catch of sublegal crabs. Based on this finding, the first experiment in the study used rectangular escape ports of 1.50 by *x* inches where *x* varied from 1.75 to 2.50 inches in ¼-inch increments. Table 1 shows general information which describes the series of experiments that were conducted in 1977 to select the "best" rectangular escape port.

The first experiment demonstrated that the use of a rectangular escape port 2.5 ×1.5 inches would not be practical because the legal catch was reduced by approximately 50 percent. The first and second experiments demonstrated that a 1.75- × 1.5-inch port did not greatly reduce the catch of sublegal crabs. The first through third experiments indicated that the most promising escape ports were 2.125 ×1.5 and 2.25 ×1.5 inches (Table 1). For this reason experiments 4 and 5 were concerned solely with the latter two escape ports. It should be noted that the 2.0- × 1.5-inch escape port compared well with the unmodified commercial pot, but was not as efficient as the two chosen.

The ratio of legal to sublegal crabs varied considerably between the control pots (standard commercial pots) and those with escape ports (Table 2). The reduction in catch of sublegal crabs was 43.53 and 58.91 percent, respectively, for the 1.5- × 2.125-inch and 1.5- × 2.25-inch escape ports.

Table 1.—Mean carapace width in millimeters and sample size in parenthesis of all crabs taken by escape ports by time period by legal size category in 1977.

Time period	Experiment	Commercial pot (control) Legal	Commercial pot (control) Sublegal	1.75 × 1.5 Legal	1.75 × 1.5 Sublegal	2.00 × 1.5 Legal	2.00 × 1.5 Sublegal
6-10 June	1	139.12 (43)	117.89 (66)	137.47 (53)	117.40 (52)	139.08 (49)	117.25 (36)
27 June-1 July	2	138.76 (72)	118.35 (34)	138.18 (61)	117.75 (28)	139.03 (99)	119.42 (33)
12-22 July	3	140.43 (183)	116.91 (115)			140.89 (174)	117.64 (89)
8-19 Aug.	4	145.47 (394)	117.05 (101)				
26 Sept.-7 Oct.	5	151.35 (378)	115.93 (73)				
Total number		(1,070)	(389)	(114)	(80)	(322)	(158)

Time period	Experiment	2.25 × 1.5 Legal	2.25 × 1.5 Sublegal	2.50 × 1.5 Legal	2.50 × 1.5 Sublegal	2.125 × 1.5 Legal	2.125 × 1.5 Sublegal
6-10 June	1	140.69 (32)	114.75 (24)	139.42 (19)	114.05 (19)		
27 June-1 July	2	141.72 (57)	115.63 (8)			140.39 (44)	116.42 (24)
12-22 July	3	141.68 (171)	118.48 (29)			140.11 (186)	118.49 (53)
8-19 Aug.	4	146.60 (429)	117.67 (33)			145.58 (407)	118.59 (63)
26 Sept.-7 Oct.	5	151.36 (326)	113.87 (31)			150.35 (344)	113.82 (34)
Total Number		(1,015)	(125)	(19)	(19)	(981)	(174)
Grand total = 4,466							

Table 2.—Numbers of legal and sublegal crabs taken by two most successful sizes of rectangular escape ports tested in 1977.

Time period	Commercial pot Legal	Commercial pot Sublegal	1.5×2.125 escape port Legal	1.5×2.125 escape port Sublegal	1.5×2.25 escape port Legal	1.5×2.25 escape port Sublegal
6-10 June	43	66			32	24
27 June-1 July	72	34	44	24	57	8
12-22 July	183	115	186	53	171	29
8-19 August	394	101	407	63	429	33
26 Sept.-7 Oct.	378	73	344	34	326	31
Total number	1,070	389	981	174	1,015	125
Ratio	2.75		5.64		8.12	
Percent sublegal	26.67		15.06		10.96	
Percent reduction of sublegals			43.53		58.91	

Chi square analyses confirmed that the differences in sublegal catch between the commercial pot (control) and those with escape ports were significantly different (data from experiments 2-5 were used for these tests—Table 3). Also, a chi square analysis showed that the 2.25-inch escape port reduced the catch of sublegals significantly more than did the 2.125-inch port.

Table 3.—Results of chi-square analyses concerning proportion of legal to sublegal crabs taken in pots with and without rectangular escape ports.

Test	Chi square value	df
Commercial pot vs. 2.125×1.5	30.73**	1
Commercial pot vs. 2.25×1.5	89.19**	1
2.125 vs. 2.25	17.15**	1

**$P<0.01$.

The 1977 results clearly demonstrated that the use of escape ports substantially decreased the numbers of sublegal crabs that were retained while maintaining the catch of legal crabs.

Other 1977 Results

It was thought that the use of escape ports might affect the average size of crabs retained by pots. Specifically, we wished to learn if the average size of legal crabs would be increased by using escape ports. We investigated this question by using One-Way Analysis of Variance (ANOVA) for each experiment. We tested the average size of legal crabs taken in control pots vs. the

Table 4.—Results of ANOVA tests to determine if use of escape ports affected the mean carapace widths of legal and sublegal crabs taken during experiments 1-5 in 1977 (each experiment analyzed separately).

Category	*F* value	Probability of obtaining greater *F* value
	Experiment 1	
Legal	0.58	0.6789
Sublegal	1.70	0.1524
	Experiment 2	
Legal	1.34	0.2559
Sublegal	0.75	0.5594
	Experiment 3	
Legal	0.91	0.4383
Sublegal	0.73	0.5411
	Experiment 4	
Legal	1.35	0.2604
Sublegal	0.95	0.3883
	Experiment 5	
Legal	0.74	0.4762
Sublegal	0.97	0.3831

average size of legal crabs in pots with escape ports. A similar test was conducted for sublegal crabs. Results are given in Table 4. The results clearly show that the mean carapace width of both categories (legal and sublegal) was not affected by the use of escape ports within experiments.

The second question was whether the mean carapace width of the two categories (legal and sublegal) changed among experiments. Results are given in Table 5 and show that the mean carapace width did change significantly among experiments for legal crabs which is in agreement with Eldridge and Waltz (1977). The mean carapace widths of sublegal crabs did not appear to change except for the pots using a 1.5- × 2.125-inch ports. There is no reason to believe that the mean size of sublegal crabs should change over time (selectivity of pot should be constant over time), thus, the result observed with the 2.125-inch port appears to be due to experimental error and it was concluded that the mean size of sublegals caught did not change among experiments.

Body Relationships

During 1977, carapace width, length, and total live weight measurements were routinely collected. The following relationships were determined by standard statistical least squares regression procedures: Carapace width-carapace length relationship, total live weight-carapace width, and total live weight-carapace length (Table 6). The latter two relationships were calculated by using the logarithms (base 10) of the weight and respective body measurement. Crabs used in the analysis ranged in size of carapace width from 94 to 184 mm.

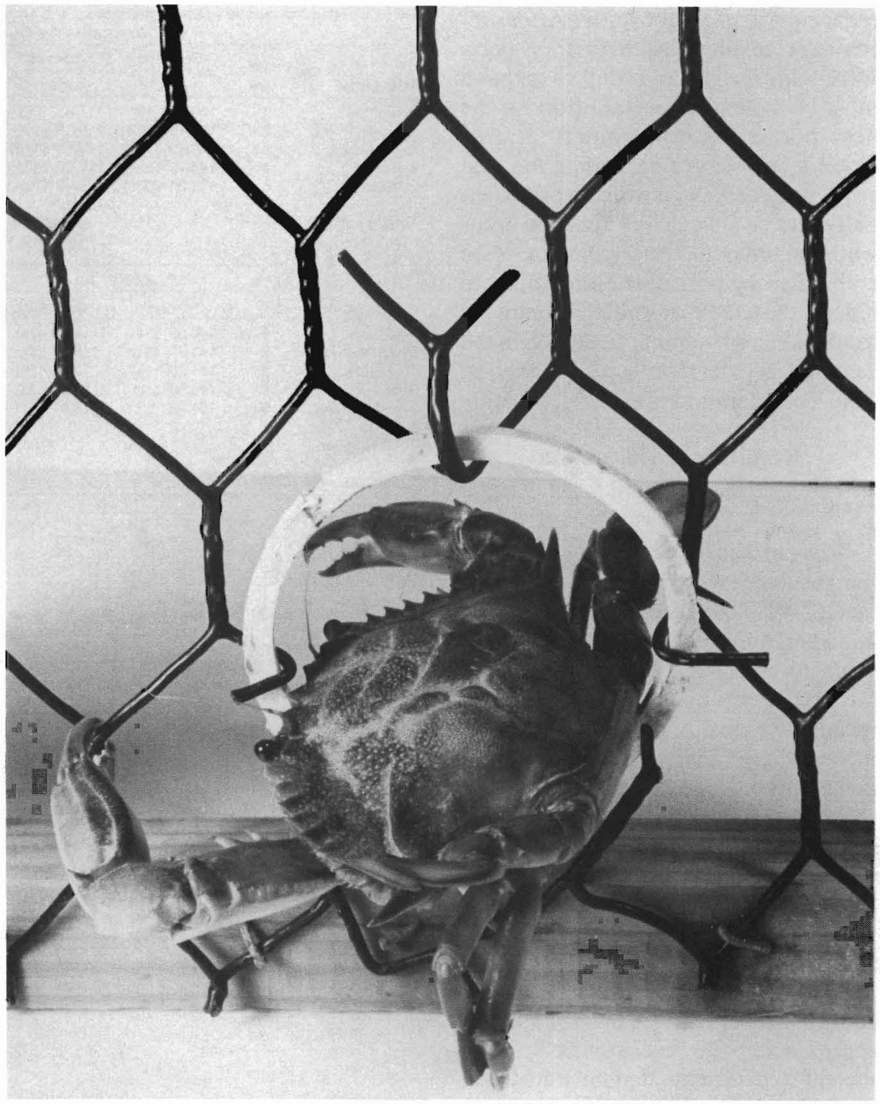


Figure 4.—Sublegal blue crab passing through escape port in experimental pot.

Missing Appendages

During 1977, missing appendages were noted to obtain an estimate of damage associated, at least in part, to capture by crab pots. Over one-half (56.67 percent) of all crabs appeared to sustain damage associated either with capture in pots or in transit to the laboratory (Table 7).

Results in 1978

Field work in 1978 lasted from 16 May to 18 August and five separate experiments captured 7,394 crabs (Table 8). An illustration of an escape port in use is shown in Figure 4. The first experiment conducted in May utilized rectangular escape ports, but varied the

Table 5.—Results of ANOVA tests to show differences in mean carapace widths among experiments utilizing commercial pots (control) and those using rectangular escape ports.

Pot	Category	*F* value	Probability of obtaining greater *F* value
Commercial	Legal	39.37	0.0001**
Commercial	Sublegal	1.07	0.3707
2.25×1.5	Legal	28.55	0.0001**
2.25×1.5	Sublegal	1.79	0.1351
2.125×1.5	Legal	33.45	0.0001**
2.125×1.5	Sublegal	2.80	0.0409*

Mean carapace width of crabs taken during experiments 1-5 for selected port types

		1	2	3	4	5
Commercial	Legal	139.12	138.80	140.43	145.50	151.30
Commercial	Sublegal	117.89	118.35	116.91	117.05	115.93
2.25×1.5	Legal	140.69	141.72	141.68	146.60	151.56
2.25×1.5	Sublegal	114.75	115.63	118.48	117.67	113.87
2.125×1.5	Legal		140.39	140.11	145.58	150.35
2.125×1.5	Sublegal		116.42	118.49	118.59	113.82

**$P<0.01$.
*$P<0.05$.

Table 6.—Body relationships as determined by standard least squares regression procedures for male blue crabs taken in Wando River, S.C., during 1977. Crabs ranged in size from 94 to 184 mm in carapace width.

Regression equation	*R* – Square
CW = −10.09221+2.34267 CL[1]	0.86
Log Wt = −3.43615+2.6492 Log CW[2]	0.87
Log Wt = −3.35610+3.10288 Log CL	0.90

[1]CL = Carapace length.
[2]CW = Carapace width.

Table 7.—Incidence of missing appendages observed in 1977 during the blue crab, *Callinectes sapidus*, self-culling crab pot project.

Missing appendages	Number of crabs	Percent of total
Walking legs	1,523	34.10
1 Claw (Cheliped)	302	6.76
2 Claws (Cheliped)	21	0.47
1 Claw & other appendages	373	8.35
2 Claws & other appendages	33	0.74
Back paddle (last walking leg)	132	2.96
Back paddle & other appendages	147	3.29
No injuries	1,935	43.33
Total	4,466	100.00

Table 8.—General catch results of 1978 field work showing legal to sublegal ratios (L:S)[1] and sample size.

Time period	Experiment	Experimental description	No. of traps	Catch	Commercial pot (control)	2.25 2 Ports	2.25 3 Ports	2.25 4 Ports	2.125 2 Ports	2.125 3 Ports	2.125 4 Ports	Total no. of crabs
16-26 May	1	Rectangular ports		L	67	82	68	77	72	82	54	
		(2.25×1.5 vs. 2.125×1.5)	24	S	130	52	48	31	70	78	63	974
		No. of Ports=2, 3, or 4		Ratio L:S	0.52	1.58	1.42	2.48	1.03	1.05	0.86	
					Commercial pot	2.25	2.375	2.50	2.625			
1-9 June	2	Circular ports		L	95	81	114	79	44			
		(2.25,2.375,2.50,2.625)	25	S	148	122	56	35	34			808
		No. of ports = 2		Ratio L:S	0.64	0.66	2.04	2.26	1.29			
					Commercial pot	2T+2B[2]	2T	2T+1B	1T+1B			
14-23 June	3	2.375 Circular port		L	160	156	209	166	179			
		Configuration test	25	S	186	63	94	60	82			1,355
				Ratio L:S	0.86	2.48	2.22	2.77	2.18			
					Commercial pot	2T+2B	2T	2T+1B	1T+1B			
28 June-14 July	4	2.50 Circular port		L	231	245	224	220	232			
		Configuration test	25	S	207	43	89	35	71			1,597
				Ratio L:S	1.12	5.70	2.52	6.29	3.27			
					Commercial pot	2.375 (2T+1B)	2.375 (1T+1B)	2.5 (2T+1B)	2.5 (1T+1B)			
26 July-18 Aug.	5	Circular ports		L	430	378	455	469	485			
		(2.50 vs. 2.375)	25	S	191	65	90	37	60			2,660
		Configuration test		Ratio L:S	2.25	5.82	5.06	12.68	8.08		Grand total	7,394

[1]L=legal crabs ≥127 mm in carapace width; S=sublegal crabs <127 mm in carapace width.
[2]T=top chamber of crab pot; B=bottom chamber of crab pot.

number of escape ports from two to four per pot. The best rectangular escape port configuration was four escape ports measuring 2.25×1.5 inches. That pot had a legal:sublegal ratio of 2.48 which was approximately five times better than the control (standard commercial pot) (Table 8).

The second experiment was designed

to test several circular escape ports in which inside diameters varied from 2.25 to 2.625 inches. The 2.375-inch escape port was one that was developed and tested during the summer of 1977 by the Office of Conservation and Management. This escape port had shown promise (Whitaker[1]). Each pot used in this experiment had two escape ports in the top chamber. The results clearly indicated that escape ports with 2.50- and 2.375-inch inside diameters were superior.

The third and fourth experiments were chosen to test the best number and placement of the 2.375- and 2.50-inch ports, respectively. The combinations used were two ports top chamber with two ports bottom chamber, two ports top chamber only, two ports top chamber with one port in bottom chamber, and one port top chamber with one port in bottom chamber. The results of these experiments indicated that two top ports with one bottom port was superior for both the 2.375- and 2.50-inch size (Table 8).

The final experiment was conducted to determine the "best" size and placement of ports. In this experiment the 2.375- and 2.50-inch ports with two top and one bottom or one top and one bottom were utilized. The latter was used because it may be somewhat advantageous from an implementation viewpoint to use the fewest number of rings possible.

The results of the final experiment indicated that the 2.50-inch port, two top and one bottom configuration was superior to all others. However, the 2.5-inch, one top and one bottom was also good. The former configuration resulted in a reduction in catch of sublegals of 82 percent, whereas the latter configuration reduced the catch of sublegals by 67 percent (Table 9). A chi-square analysis confirmed that the pot with three ports reduced the catch of sublegal crabs significantly more than did the pot with two. Both configurations of escape ports caught more crabs than did the control, which satisfies the original condition that the self-culling pot should at least maintain the catch of legal crabs.

Potential Benefits of Self-Culling Crab Pots

An obvious, but difficult to measure, benefit of using self-culling pots is the elimination of culling time by fishermen. The results indicate that over 80 percent of the sublegal catch would be eliminated. Since culling time is roughly directly proportional to the number of sublegals taken, one can project that culling time would be reduced about 80 percent.

However, the above statement applies only to conscientious fishermen. Eldridge and Waltz (unpublished data) noticed that culling efforts of individual fishermen varied substantially with a majority of fishermen having less than 5 percent sublegal crabs, whereas others commonly had 40 to 50 percent illegal crabs. It was a minority of crabbers that accounted for the total catch being comprised of approximately 10 percent sublegal crabs. Conscientious crabbers will have less culling to perform with escape ports and their catches as before will contain very few sublegal crabs.

The greatest beneficial impact of using escape ports will occur when less conscientious crabbers use them. Their catch of sublegal crabs should be reduced from the 40 to 50 percent range to approximately 10 percent even if they continue to do little or no culling. The reduction in capture of sublegal crabs will result also in a reduction of sublegal crabs delivered to processors. This should make the picking operation more efficient because of the elimination of smaller crabs.

Table 7 shows the incidence of missing appendages recorded during the study. Although some of the injuries may not have been caused by the fishing operation, it is probable that the majority were because of the freshness of the wounds observed. It is impossible to translate the incidence of missing appendages into mortality rates, however, it is logical to assume that some mortality occurs. Also, Van Engel (1958) reported that injuries, such as the loss of legs, could substantially reduce the change in size when a crab molts. This implies that a reduction in injuries certainly would not adversely affect the present growth rate of crabs and might even improve it. Moreover, many fishermen believe that substantial numbers of sublegal crabs are injured or killed when they are associated with larger crabs while in pots and in baskets prior to the time they are thrown overboard. This belief should help fishermen to accept the concept of self-culling pots and, in fact, some fishermen have been quite outspoken in their support of such a measure (Wootten, 1976).

Summary and Recommendations

The concept of using escape ports (rings) to reduce the catch of sublegal crabs without reducing the catch of legal crabs was tested and found to be valid. The "best" self-culling pot that was developed was one that employed 2.50-inch inside diameter escape ports with two in the top chamber and one in the bottom chamber. The reduction in catch of sublegal crabs was 82 percent.

The use of escape ports will reduce culling time of fishermen, reduce law enforcement problems associated with the sale of sublegal crabs, result in

Table 9.—Summary of crab catches utilizing the "best" configurations of the 2.50-inch escape port versus the standard commercial pot.

Item	Commercial pot (control)	2.50 escape port (2 top + 1 bottom)	2.50 escape port (1 top + 1 bottom)
Legal	661	689	717
Sublegal	398	72	131
Legal:Sublegal	1.66	9.57	5.47
Reduction in sublegal crabs	—	82%	67%
Percent of sublegal crabs in catch	37.58	9.46	15.45

[1]Whitaker, D. J. 1978. Data report for escape ring study. Unpubl. manuscr., 11 p.

reduced deliveries of illegal crabs to processors, and lower the number of injuries to crabs during the fishing operation.

The authors strongly recommend the adoption of escape ports as a management measure. However, while the present study documents the most efficient size and configuration of escape ports for South Carolina, we also recommend that pilot studies be conducted in other areas in order to insure the most efficient port size for any particular area. Based on our experience, it should be relatively easy to conduct the necessary pilot studies.

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Literatured Cited

Anderson, A. W., and E. A. Power. 1957. Fishery statistics of the United States. 1955. U.S. Fish Wildl. Serv., Stat. Dig. 41, 446 p.

Cronin, L. E. 1950. The Maryland crab industry, 1949. Chesapeake Biol. Lab. Publ. 84, 41 p.

Eldridge, P. J., and W. Waltz. 1977. Observations on the commercial fishery for blue crabs, *Callinectes sapidus*, in estuaries in the southern half of South Carolina. S.C. Mar. Resour. Cent. Tech. Rep. 21, 35 p.

Green, J. C. 1952. Effectiveness of crab traps in South Carolina. Bears Bluff Lab. Contrib. 14, 12 p.

Pileggi, J., and B. G. Thompson. 1976. Fishery statistics of the United States. 1973. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Stat. Dig. 67, 458 p.

Van Engel, W. A. 1958. The blue crab and its fishery in Chesapeake Bay. Part 1 - Reproduction, early development, growth, and migration. Commer. Fish. Rev. 20(6):6-17.

————. 1959. Studies of blue crab abundance. *In* Report of Commission of Fisheries in Virginia, p. 37-41. Annu. Rep. 60 and 61 for fiscal years ending June 30, 1958 and June 30, 1959.

————. 1961. Crab Department report. *In* Report of Commission of Fisheries of Virginia, p. 40-42. Annu. Rep. 62 and 63 for fiscal years ending June 30, 1960 and June 30, 1961.

————. 1964. Crustaceology Department report. *In* Report of Virginia Institute of Marine Science, p. 10-11. Annu. Rep. 22 for period ending June 30, 1963.

Wharton, J. 1956. The pot at the end of the rainbow. Baltimore Sunday Sun, 3 June, p. 5.

Wise, J. P., and B. G. Thompson. 1977. Fishery statistics of the United States. 1974. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Stat. Dig. 68, 424 p.

Wootten, O. V. 1976. Escape rings would save millions of crabs, Crisfield man contends. Natl. Fisherman 57(6):3-B, 15-B.