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RELEASING SMALL FISH AND SHRIMP FROM TRAWL NETS

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INTRODUCTION

The rapid development of the shrimp fishery in Pamlico Sound, North Carolina, during recent years, accompanied by a general decline in finfish catches (other than menhaden), has resulted in a controversy regarding the relationship between the two industries. Many fishermen, and others, have been quite vociferous in their charges against the shrimp industry. Newspapers have carried feature stories describing the destruction of small fish by the shrimp trawls. There have been, however, very few facts which could be used as a basis for sound appraisal of the destruction.

During the summer of 1949, the University of North Carolina's Institute of Fisheries Research made a study of the release of small fish and shrimp from a highly-publicized and newly-developed webbing designed to retain shrimp and to release more fish than the type of webbing currently used in the industry. Two mesh sizes of standard webbing were used for comparison.

While gathering information on the escapement of fish from the three nets, data were also obtained regarding the kinds and amounts of finfish taken and the distribution and growth of small fish within Pamlico Sound during the summer. The primary objective of the study, however, was to study the release of small fish and shrimp from the various types of webbing and to determine whether changes in net mesh construction and/or size resulted in sufficient savings of small fish to justify a modification of present regulations relating to shrimp trawls.

GEAR

An 18-foot trawl, similar to the conventional shrimp trawl, was used during the earlier part of the study. It was found, however, that the catches with this net were small, and it was felt that larger catches would result if conditions for escape from the cod end more closely approximated those found in the commercial nets. The 18-foot net, therefore, was replaced by a 50-foot net. Of a total of 39 experimental tows, 15 were made with the small and 24 with the large net.

Three interchangeable cod ends were used in this study: (1) standard 32-thread twine, 2-inch stretched mesh (Figure 1-A); (2) same as above, 2¼-inch mesh (Figure 1-B); (3) a special cod end[1/] made of 2½-inch webbing, 18-thread twine (Figure 1-C), but with three softer and longer twines tied in with the regular twine. The longer, soft twines were designed by the inventor to entangle the shrimp and prevent their escape, while the larger mesh size would allow passage of small fish.

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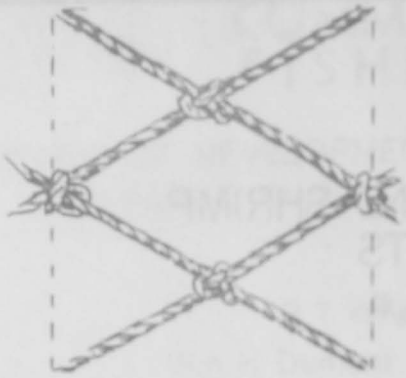
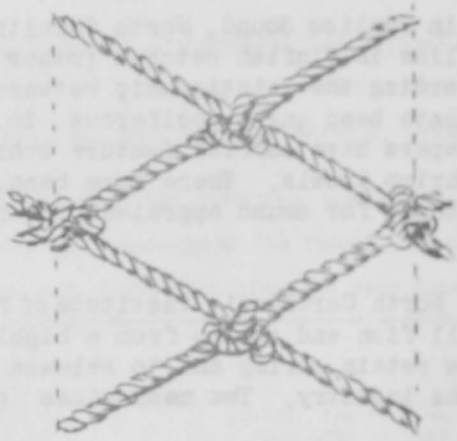
1/ THE SPECIAL COD END USED IN THE EXPERIMENTS REPORTED IN THIS ARTICLE WAS THE SO-CALLED "GUTHRIE COD END," INVENTED BY LOUIS GUTHRIE, MOREHEAD CITY, N. C. (EDITORS).



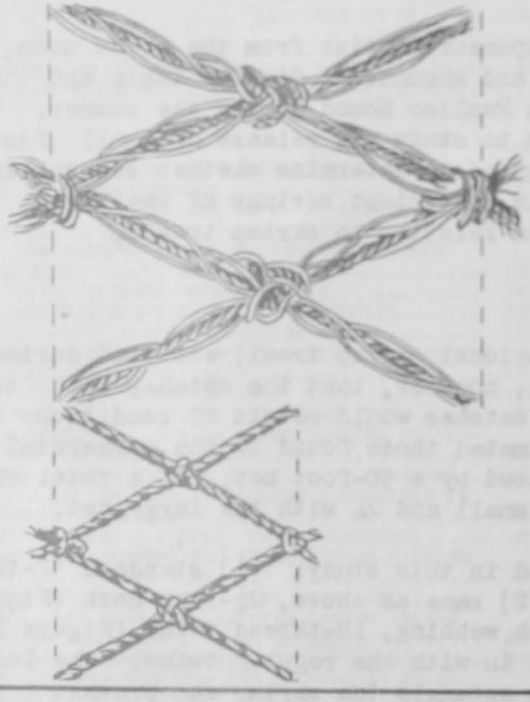
STANDARD COD END

2-INCH STRETCHED MESH
3 PLY 18-THREAD (MEDIUM)
COTTON (TARRED) A



LARGE-MESH COD END

2½-INCH STRETCHED MESH
3 PLY 36-THREAD (MEDIUM)
COTTON (TREATED) B



SPECIAL COD END

2⅜-INCH STRETCHED MESH
ONE 3 PLY 18-THREAD (HARD)
COTTON WITH THREE 6-THREAD
(SOFT STRANDS)
COTTON (UNTREATED) C

COVER BAG

1⅜-INCH STRETCHED MESH
3 PLY 18-THREAD (MEDIUM)
COTTON (TREATED) D

FIGURE 1 - MESH SIZES OF THREE COD ENDS AND COVER BAG USED IN THIS STUDY.

A cover bag, made of 1½-inch webbing and 21-thread twine, (Figure 1-D) was sewed onto the belly of the net, four meshes ahead of the cod end. The cover bag was longer than the cod end and completely surrounded it so that fish or shrimp passing through the meshes of the cod end would be caught in the cover bag (Figure 2).

METHODS

The net was towed from the Institute's launch, the Robert E. Coker (Figure 3). Towing speed was about 3 knots; length of tows varied from one-half hour to slightly over one hour.

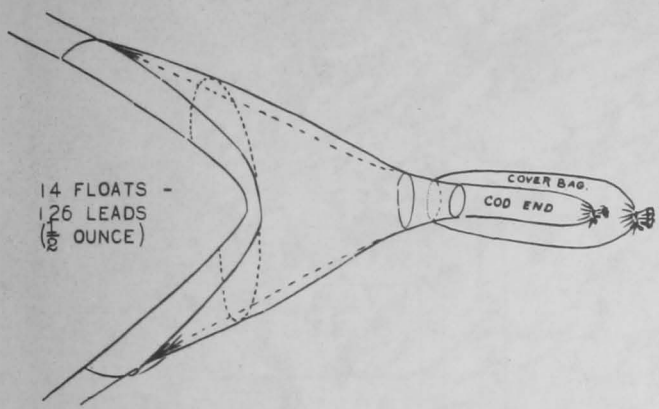


FIGURE 2 - THE COVER BAG SEWED ONTO THE BELLY OF THE NET, FOUR MESHES AHEAD OF THE COD END.

All of the tows were made in Pamlico Sound and the mouths of Pamlico and Neuse Rivers. No attempt was made to work in areas where shrimp were concentrated inasmuch as the study was primarily concerned with escapement of small fish. Shrimp were taken in all tows but in a smaller ratio to finfish than would have been taken by following the "schools" of shrimp throughout the Pamlico Sound area as practiced by commercial shrimpers.

When the net was lifted, the contents of the cover bag and the cod end were discharged into separate compartments on deck. All fish and shrimp were measured in 0.5 centimeter intervals.

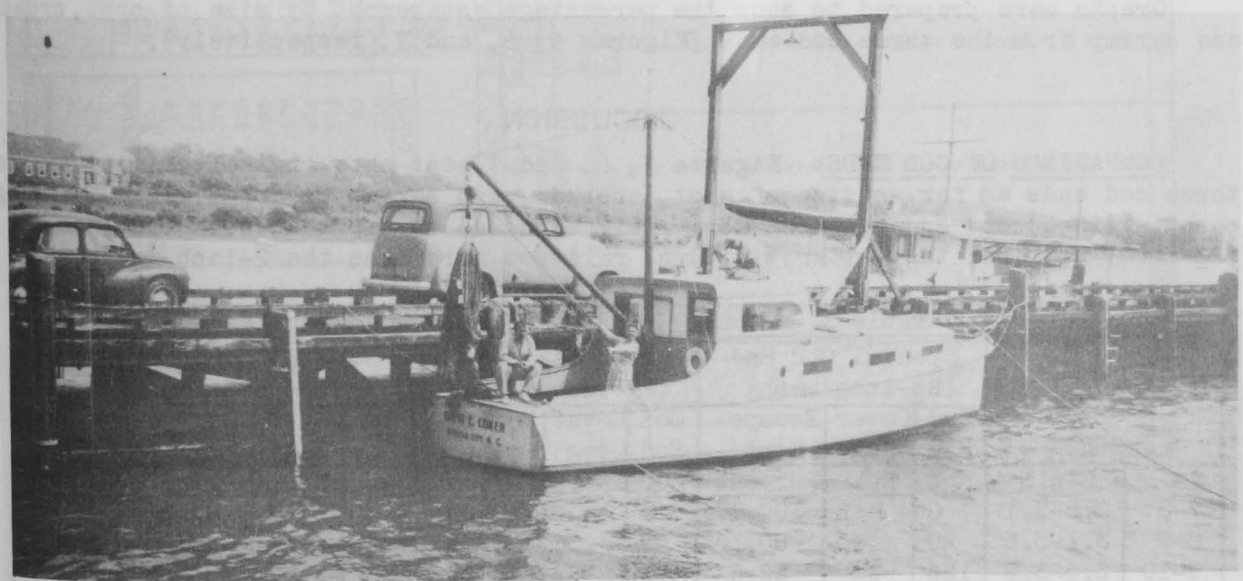


FIGURE 3 - MOTOR CRUISER ROBERT E. COKER OF THE UNIVERSITY OF NORTH CAROLINA'S INSTITUTE OF FISHERIES RESEARCH.

RESULTS

In the 39 experimental tows, 1,884 shrimp and 13,083 fish were taken. The number of spot, croaker, and shrimp taken in each cod end and cover bag is presented in Tables 1, 2, and 3, respectively. Included in these tables is the per-

centage of escapement from each cod end of one-centimeter size groups. Sea trout taken in the various cod ends and cover bags are given in Table 4. The number of sea trout was relatively small and percentage of escapement by size was not calculated. Total numbers and kinds of fish caught are shown in Table 5.

FIGURE 4 - WHEN THE NET WAS LIFTED, THE CONTENTS OF THE COVER BAG (UPPER CHECKER) AND THE COD END (LOWER CHECKER) WERE DISCHARGED INTO SEPARATE COMPARTMENTS ON DECK. SMALL FISH IN UPPER COMPARTMENT WERE RELEASED.

Graphs were prepared to show the percentage escapement by size of spot, croaker, and shrimp from the three cod ends (Figures 5, 6, and 7, respectively).

DISCUSSION

COMPARISON OF COD ENDS: Figures 5, 6, and 7 best show the selectivity of the three cod ends as far as size of spot, croaker, and shrimp is concerned. The large mesh ($2\frac{1}{4}$-inch) cod end releases more small fish and shrimp than does the special ($2\frac{1}{2}$-inch) cod end; the latter, in turn, releases more than the 2-inch mesh. The

Table 1 - Summary of Spot Escapement by Size

Length		Special Cod End ($2\frac{1}{2}$-inch mesh)			Large-Mesh Cod End ($2\frac{1}{4}$-inch mesh)			2-inch Mesh Cod End			Total
		Cod End	Cover Bag	Escape-ment	Cod End	Cover Bag	Escape-ment	Cod End	Cover Bag	Escape-ment	
Cm.	In.	No.	No.	Percent	No.	No.	Percent	No.	No.	Percent	No.
7-8	2.8-3.1	0	2	100.0	0	16	100.0	2	0	0.0	20
8-9	3.1-3.5	29	45	60.1	5	36	87.8	37	9	19.6	161
9-10	3.5-3.9	126	217	62.5	10	79	88.7	129	37	22.3	598
10-11	3.9-4.3	192	277	59.1	42	96	69.6	122	21	14.7	750
11-12	4.3-4.7	177	103	36.8	86	81	45.8	112	5	4.3	564
12-13	4.7-5.1	89	30	25.2	115	33	22.3	60	1	1.6	328
13-14	5.1-5.5	39	9	18.8	84	5	5.6	35	0	0.0	172
14-15	5.5-5.9	12	1	7.7	58	0	0.0	15	0	0.0	86
15-16	5.9-6.3	4	0	0.0	36	0	0.0	7	0	0.0	47
16 +	6.3 +	4	0	0.0	25	0	0.0	7	0	0.0	36
Total		672	684	50.5	461	346	42.8	526	73	12.2	2,762

Table 2 - Summary of Croaker Escapement by Size

Length		Special Cod End ($2\frac{1}{2}$-inch mesh)			Large-Mesh Cod End ($2\frac{1}{4}$-inch mesh)			2-inch Mesh Cod End			Total
		Cod End	Cover Bag	Escapement	Cod End	Cover Bag	Escapement	Cod End	Cover Bag	Escapement	
Cm.	In.	No.	No.	Percent	No.	No.	Percent	No.	No.	Percent	No.
7-8	2.8-3.1	5	0	0.0	1	8	88.9	2	1	33.3	17
8-9	3.1-3.5	34	41	54.7	12	29	70.7	16	25	61.0	157
9-10	3.5-3.9	202	172	46.0	46	118	72.0	276	202	42.3	1,016
10-11	3.9-4.3	476	372	43.9	169	376	69.0	862	398	31.6	2,653
11-12	4.3-4.7	464	255	35.5	332	646	66.1	936	200	17.6	2,833
12-13	4.7-5.1	179	77	30.1	290	424	59.4	457	51	10.0	1,478
13-14	5.1-5.5	80	17	17.5	185	104	36.0	68	2	2.9	456
14-15	5.5-5.9	21	5	19.2	95	28	22.8	25	0	0.0	174
15-16	5.9-6.3	18	4	18.2	32	1	3.0	14	0	0.0	69
16 +	6.3 +	53	3	5.4	43	0	0.0	16	0	0.0	115
Total		1,532	946	38.2	1,205	1,734	59.0	2,672	879	24.8	8,968

Table 3 - Summary of Shrimp Escapement by Size

Length		Special Cod End ($2\frac{1}{2}$-inch mesh)			Large-Mesh Cod End ($2\frac{1}{4}$-inch mesh)			2-inch Mesh Cod End			Total
		Cod End	Cover Bag	Escapement	Cod End	Cover Bag	Escapement	Cod End	Cover Bag	Escapement	
Cm.	In.	No.	No.	Percent	No.	No.	Percent	No.	No.	Percent	No.
5-6	2.0-2.4	1	2	66.7	0	3	100.0	1	8	88.9	15
6-7	2.4-2.8	5	6	54.5	4	13	76.5	4	2	33.3	34
7-8	2.8-3.1	4	2	33.3	11	14	56.0	17	4	19.0	52
8-9	3.1-3.5	34	15	30.6	21	35	62.5	16	1	5.9	122
9-10	3.5-3.9	39	15	27.8	34	20	37.0	30	5	14.3	143
10-11	3.9-4.3	103	6	5.5	67	13	16.3	37	2	5.1	228
11-12	4.3-4.7	149	11	6.9	104	13	11.1	74	2	2.6	353
12-13	4.7-5.1	120	3	2.4	152	3	1.9	90	2	2.2	370
13-14	5.1-5.5	69	0	0.0	102	0	0.0	81	0	0.0	252
14-15	5.5-5.9	40	0	0.0	84	0	0.0	50	0	0.0	174
15-16	5.9-6.3	17	0	0.0	45	0	0.0	28	0	0.0	90
16 +	6.3 +	12	0	0.0	26	0	0.0	14	0	0.0	51
Total		593	60	9.2	650	114	14.9	441	26	5.6	1,884

Table 4 - Summary of Sea Trout Escapement by Size

Length		Special Cod End ($2\frac{1}{2}$-inch mesh)		Large-Mesh Cod End ($2\frac{1}{4}$-inch mesh)		2-inch Mesh Cod End		Total
		Cod End	Cover Bag	Cod End	Cover Bag	Cod End	Cover Bag	
Cm.	In.	No.	No.	No.	No.	No.	No.	No.
5-6	2.0-2.4	0	0	1	0	0	0	1
6-7	2.4-2.8	1	1	0	0	1	0	3
7-8	2.8-3.1	0	0	1	2	4	2	9
8-9	3.1-3.5	3	2	0	1	5	8	19
9-10	3.5-3.9	5	5	4	10	41	2	67
10-11	3.9-4.3	3	6	3	4	61	9	86
11-12	4.3-4.7	4	2	3	5	37	9	60
12-13	4.7-5.1	9	3	3	2	18	4	39
13-14	5.1-5.5	6	1	5	5	18	3	38
14-15	5.5-5.9	10	3	0	2	10	0	25
15-16	5.9-6.3	2	0	3	2	7	0	14
16-17	6.3-6.7	2	0	2	1	5	0	10
17-18	6.7-7.1	1	0	3	0	1	0	5
18-19	7.1-7.5	1	1	1	0	0	0	3
19-20	7.5-7.9	2	0	0	0	1	0	3
20-21	7.9-8.3	10	0	0	0	2	0	12
21-22	8.3-8.7	4	0	2	0	7	0	13
22-23	8.7-9.1	1	0	5	0	10	0	16
23-24	9.1-9.4	2	0	4	0	5	0	11
24-25	9.4-9.8	1	0	3	0	5	0	9
25-26	9.8-10.2	1	0	0	0	3	0	4
26-27	10.2-10.6	1	0	1	0	3	0	5
27 +	10.6 +	0	0	0	0	1	0	1
Total		69	24	44	34	245	37	453

special net, however, allows greater escapement of the larger fish: spot over 12 centimeters (about 5 inches) and croakers over 14 centimeters (about 6 inches). In other words, the size range of fish escaping from the special net is slightly larger than that of the 2¼-inch mesh net. The first part of each curve in the figures is perhaps not accurate because some very small fish which passed through the cod end may have escaped from the cover bag, giving a lower percentage escapement than the actual one which could only be obtained by using a very small-mesh cover bag. When the net was lifted from the water, small fish (1 to 3 inches, mostly anchovies, but including a few spot and croaker) were occasionally observed falling from the cover bag. However, it is believed that the cover bag retained all of the fish over 4 inches and that the data are reliable for larger size groups.

Table 5 - Summary of Fish Taken in Savings-Gear Experiment

Species	Number	Percent
Croaker	8,968	68.5
Spot	2,762	21.1
Sea trout	453	3.5
Miscellaneous Food:		
Alewife	118	-
Flounder	64	-
Bluefish	20	-
Porgy	8	-
Hogfish	6	-
Sea mullet	6	-
Spanish mackerel	2	-
Catfish	1	-
Total Misc. Food	225	1.7
Non-food:		
Harvest fish	209	-
Sand perch	187	-
Pinfish	122	-
Menhaden	95	-
Hog choker	30	-
Lookdown	13	-
Cutlass fish	4	-
Tongue fish	3	-
Skate	3	-
Hardtail	3	-
File fish	2	-
Hickory shad	2	-
Toad fish	1	-
Total Non-food	674	5.2
Grand total	13,083	100.0

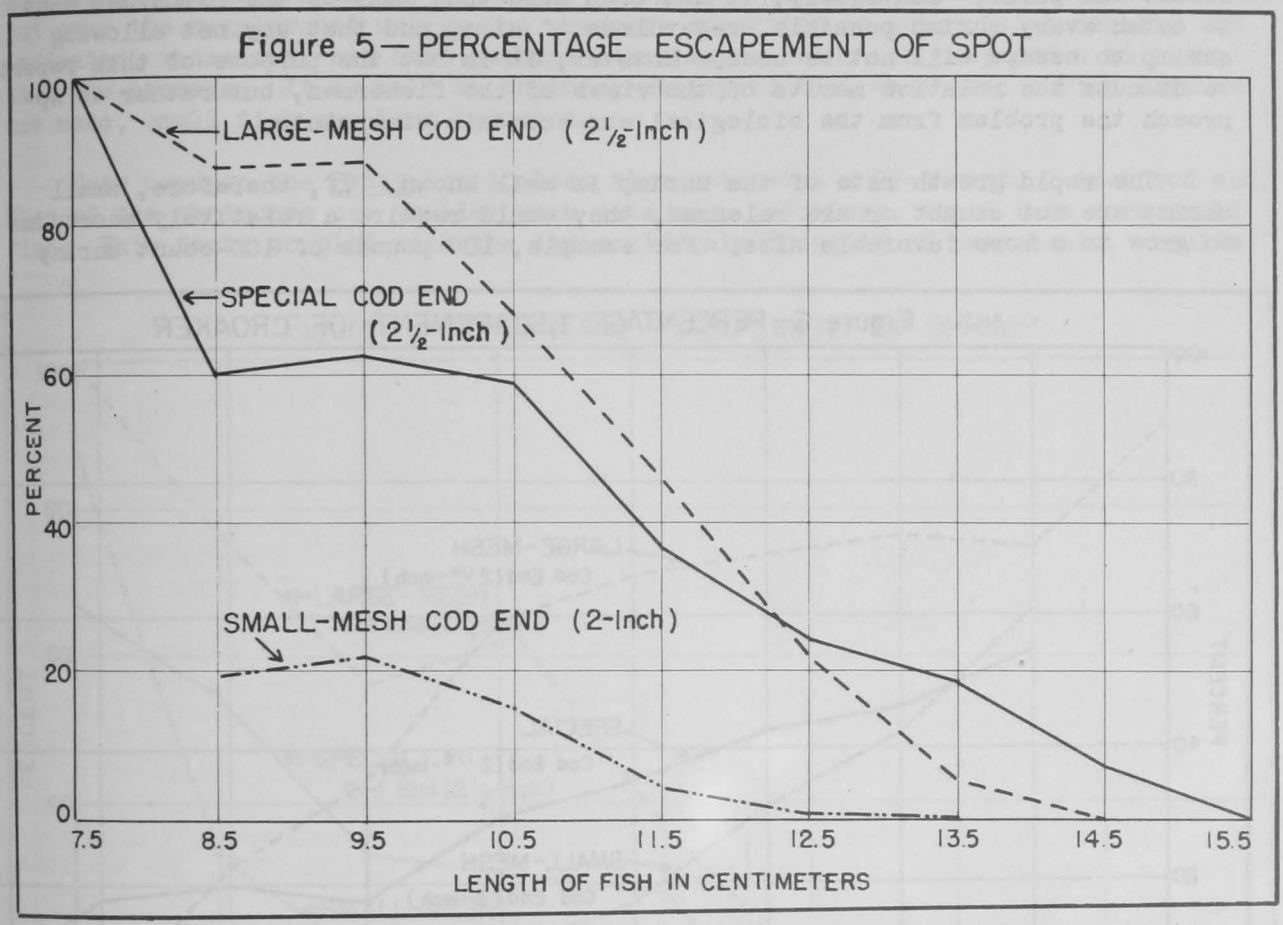
The general shape of the "shrimp curves" (Figure 7) is similar to those of the spot and croaker. The percentage escapement of shrimp from the special net occupies a point about midway between the large- and small-mesh nets. The critical portion of these curves is from 10.0 to 13.0 centimeters (3.9 to 5.1 inches). The large-mesh net allowed 16.3 percent of the 10.0-to 10.9-centimeter (3.9- to 4.3-inch) shrimp (75 to 100 count[2/]) to pass through, while only 5.5 percent of this same size group escaped from the special net. The 2-inch mesh net released 5.1 percent of the 10.0- to 10.9-centimeter size group.

The next size group, 11.0 to 11.9 centimeters or 4.3 to 4.7 inches (55 to 75 count), is best retained by the 2-inch net, with 2.6 percent escapement as compared with 6.9 percent and 11.1 percent from the special- and large-mesh nets, respectively. The large-mesh net allows escapement of about 50 percent more shrimp of this size group than does the special net. However, more detailed data show that most of the additional escapement occurs among the smaller individuals of the size group (65 to 75 count). When broken down into half-centimeter size groups, the percentage of escapement is as follows:

Length		Approx. Count Per Pound	Special-Mesh	Large-Mesh Net
Cm.	In.	No.	Percent	Percent
11.0-11.4	4.3-4.5	65-75	7.0	14.0
11.5-11.9	4.5-4.7	55-65	6.8	8.3

2/ NUMBER OF SHRIMP PER POUND.

The escapement of shrimp from 12.0 to 12.9 centimeters or 4.7 to 5.1 inches (44 to 55 count) was approximately the same (2.5 to 3.5 percent from all three cod ends.



None of the nets permitted the release of any shrimp over 13.0 centimeters or 5.1 inches (under 45 count).

It is apparent, therefore, that the large-mesh and special cod ends release more fish and more small shrimp than does the 2-inch mesh net.

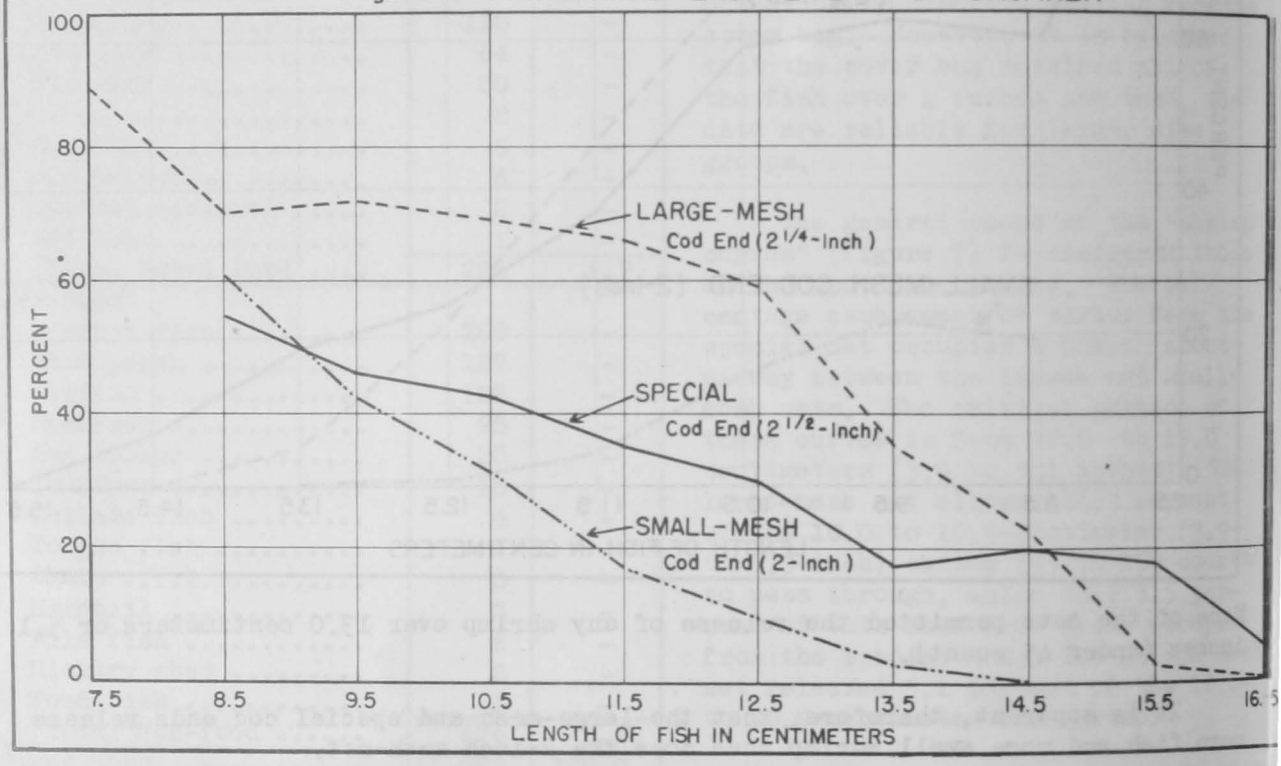
The large ($2\frac{1}{4}$-inch) mesh released 59.0 percent and 42.8 percent of the total croaker and spot catch, respectively; the 2-inch mesh released 24.8 percent and 12.2 percent of these same species. It is apparent that a $\frac{1}{4}$-inch increase or decrease in stretched-mesh size results in a considerable corresponding increase or decrease in escapement of small fish. The legal minimum mesh size of shrimp nets is $1\frac{3}{4}$-inch stretched mesh--$\frac{1}{4}$-inch smaller than the smallest mesh used in these experiments. Moreover, it is known that some shrimpers use nets $\frac{1}{4}$-inch smaller than the legal size, i.e. nets of $1\frac{1}{2}$-inch mesh. These nets are the same mesh size as the cover bag used in this study and release, for practical purposes, no fish or shrimp.

Escapement of shrimp on a weight basis was also determined. The special and large-mesh net both released slightly under 5 percent of the shrimp, and the 2-inch net released 1.7 percent. Escapement, of course, will vary with the average size of shrimp being taken. When the average size is small, more shrimp will escape than when shrimp are "running" large. The attitude toward catching or re-

leasing small shrimp varies. Most of the dealers, and fishermen who are also dealers, prefer not to catch or handle small shrimp due to their effect on the market and price. Conversely, it has been said that many of the fishermen want to catch every shrimp possible, regardless of size, and that any net allowing shrimp to escape will not be used. However, it is not the purpose of this report to discuss the relative merits of the views of the fishermen, but rather to approach the problem from the biological and economic viewpoints.

The rapid growth rate of the shrimp is well known. If, therefore, small shrimp are not caught or are released, they would require a relatively short time to grow to a more favorable size. For example, 100 pounds of 100-count shrimp

Figure 6—PERCENTAGE ESCAPEMENT OF CROAKER



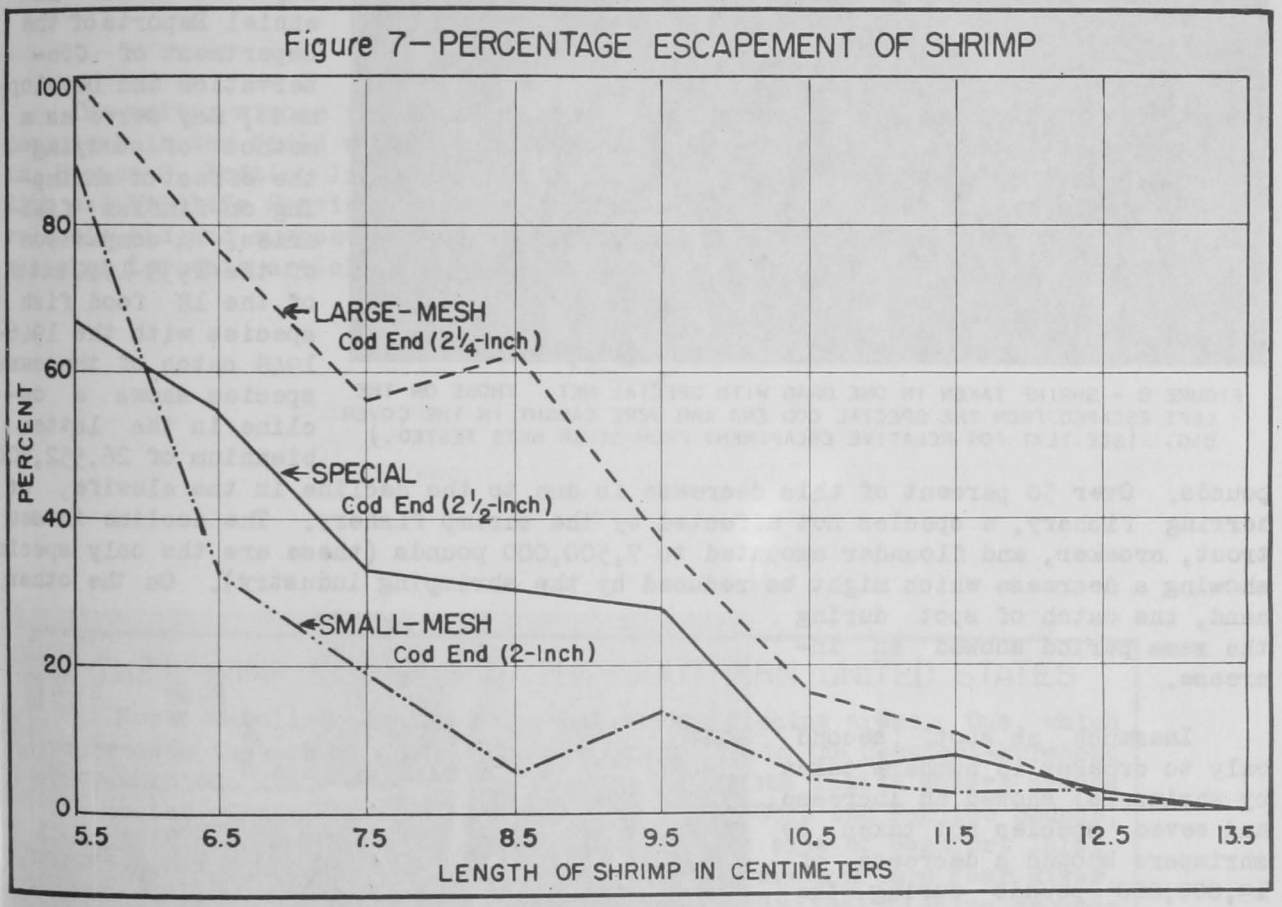
will be equal, about a month later, to 200 pounds of 50-count shrimp--if they all live. Since we do not know the natural mortality rate, we cannot tell exactly what advantage is to be gained. But if we assume a mortality as high as 50 percent in one month, the total weight would remain the same, but the shrimp would be of 50-count rather than 100-count size. A monthly mortality of 50 percent seems unreasonably high and, therefore, it seems certain that it would be economically profitable to release as many small shrimp as possible.

DESTRUCTION OF SMALL FISH: Inasmuch as the study described above was not carried out according to the normal shrimping operations, it was anticipated that the data obtained would not present a true picture of the relative amounts of shrimp and fish taken in the commercial fishery. Arrangements were therefore made with a commercial shrimper to keep accurate records of a number of tows.

Captain Merritt Moore, with the boat Penny, has provided records of 43 consecutive tows, 41 of which were made in Pamlico Sound from August 30 to September 9, 1949. Captain Moore took 122.5 bushels of shrimp, 64.5 bushels of nonedible

food-fish species, and 41 bushels of edible food-fish species. Of the latter, about 4 bushels were of marketable size. However, Captain Moore is probably one of the most astute shrimpers in the business. He uses a try net continuously and does not put over the regular net unless the presence of shrimp in substantial density is indicated, therefore, his boat perhaps takes more shrimp, in proportion to fish, than the average. It is well known among shrimpers that when good shrimp catches are made, small fish are less numerous.

Nets used on the Penny are 50-foot flat nets with a 32-thread, 2-inch cod end. Most of the shrimpers use smaller mesh nets and, therefore, would take more small fish. This fact, coupled with the indiscriminate dragging of many boats, results



in greater destruction of small fish than Captain Moore's figures would indicate. A more complete study of finfish destruction is planned in 1950.

Reports of dead fish covering the surface of large areas of Pamlico Sound during the shrimp season have appeared from time to time in newspapers. During the period of the experiment described here, dead fish were observed on only one occasion when the Institute's boat was dragging in the wake of a boat which had just lifted a net. Another Institute observer spent two days aboard the Hatteras, working in and around the main shrimp fleet, and saw no fish floating on the surface. It is believed that former reports have been grossly exaggerated.

That some destruction occurs must be realized due to the nature of the operation. Small fish are caught, and in some cases, in large numbers. However, many of the fish are not dead and are able to swim away when put back in the water. The

actual amount of destruction cannot be determined from studies to date; nor can the effect of this destruction on the croaker, sea trout, and spot fisheries. Catches of these species have shown fluctuations in the past and will undoubtedly continue to do so.

FIGURE 8 - SHRIMP TAKEN IN ONE DRAG WITH SPECIAL NET. THOSE ON THE LEFT ESCAPED FROM THE SPECIAL COD END AND WERE CAUGHT IN THE COVER BAG. (SEE TEXT FOR RELATIVE ESCAPEMENT FROM OTHER NETS TESTED.)

An examination of the catch records in North Carolina, as reported in the Biennial Reports of the Department of Conservation and Development, may serve as a method of studying the effect of shrimping on finfish fisheries. A comparison of the 1938-1940 catch of the 18 food fish species with the 1946-1948 catch of the same species shows a decline in the latter biennium of 26,552,600 pounds. Over 50 percent of this decrease is due to the decline in the alewife, or herring fishery, a species not affected by the shrimp fishery. The decline in sea trout, croaker, and flounder amounted to 7,500,000 pounds (these are the only species showing a decrease which might be reduced by the shrimping industry). On the other hand, the catch of spot during the same period showed an increase.

Inasmuch as spot (second only to croaker in numbers taken by shrimpers) showed an increase, and seven species not taken by shrimpers showed a decrease of 19,000,000 pounds during the heavy shrimping years, it would be difficult to ascribe decreases in finfish to destruction of young by the shrimp industry.

RECOMMENDATIONS: Inasmuch as the extent of current finfish destruction has not been adequately determined, there is as yet no biological basis for recommending a change in the present shrimping laws relating to mesh construction or size.

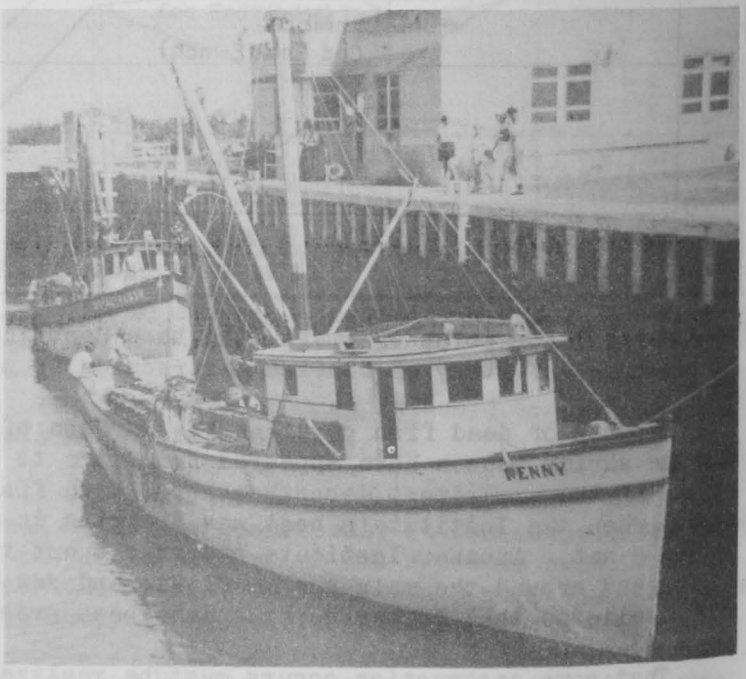


FIGURE 9 - SHRIMP TRAWLER PENNY.

It is pointed out, however, that the usé of larger mesh nets, up to $2\frac{1}{4}$-inch (stretched mesh) standard twine or $2\frac{1}{2}$-inch multiple twine, would release more small fish and small shrimp, thereby reducing labor and wearing of gear and providing whatever biological and economic benefits that might result from such releases. While accomplishing the above, the larger mesh sizes do not release sufficient shrimp to represent a significant loss.

Inasmuch as there appear to be no disadvantages in using larger mesh nets, their use by the shrimping industry should be encouraged.

Further studies, particularly regarding the amounts and kinds of fish taken by commercial shrimping vessels, are recommended for the 1950 shrimp season.

ACKNOWLEDGMENTS

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THE SHRIMP FISHERY OF THE SOUTHERN UNITED STATES

North Carolina has two principal shrimp fishing areas. One, which represents the northern limit of the fishery, is in the Beaufort-Morehead City section. Here most of the fishing is in the inside waters around the mouths of the Neuse and Newport Rivers, in Core and Pamlico Sounds, and in the coastal waters a short distance each side of Beaufort Inlet. The second area is in the coastal waters off the mouth of Cape Fear River, with Southport as the base for operations. Principal fishing grounds extend about 10 miles to the west from Cape Fear Point; but scattered fishing is done down to about Little River Inlet.

About 84 percent of the total yearly shrimp catch is obtained from August through November with the peak during October.

--Fishery Leaflet 368