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EXPERIMENTS ON THE ESCAPE OF UNDERSIZED HADDOCK THROUGH OTTER TRAWLS

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INTRODUCTION

The tremendous waste of small haddock caught by the otter-trawl fleet has been a matter of grave concern to the fishing industry for many years. This waste can be largely eliminated through the use of large-meshed nets. Experiments during the past half century on both sides of the Atlantic have shown that it is possible, by the use of nets with meshes of proper dimensions, to release most fish below a chosen size and to retain most fish above that size. The problem is to choose a size of mesh which will allow most of the small haddock to escape while retaining most of the marketable-size haddock.

At the request of the International Commission for the Northwest Atlantic Fisheries, experiments were conducted by the Woods Hole Laboratory of the Branch of Fishery Biology, U. S. Fish and Wildlife Service, in June 1952 to obtain additional information on certain specific sizes of net mesh. This report presents the results of these experiments.

METHODS

The experiments were conducted on two of the regular trips of the trawler Michigan, one of the large trawlers fishing out of Boston. The vessel fished on Georges Bank in a normal commercial operation, and the fish were sold through the



FIGURE 1--FINE-MESHED SHRIMP NET COVER ATTACHED TO UPPER PART OF COD END BEFORE ATTACHMENT OF BULL HIDES.

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New England Fish Exchange according to the usual practice. On both days that the Michigan landed fish from the experimental cruises, the vessel was "highliner" (landing more than any other vessel) for the day.

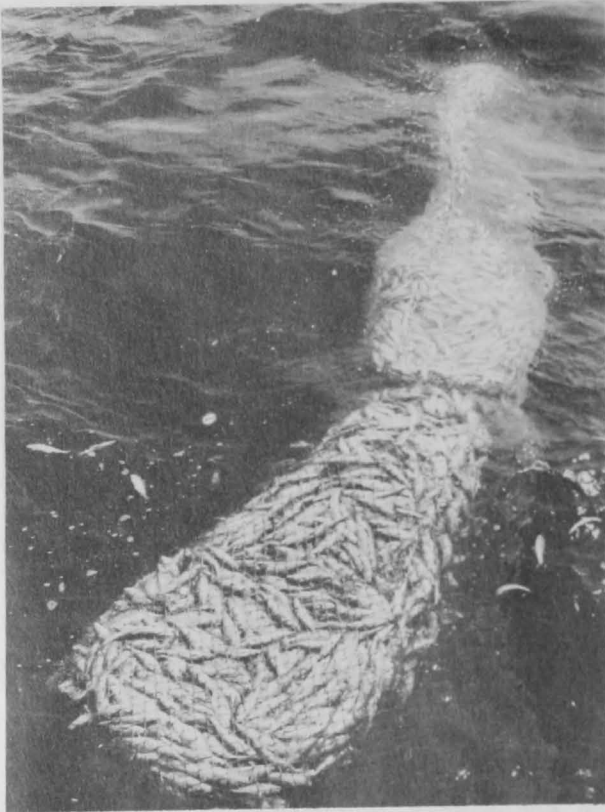


FIG. 2 - LARGE CATCHES IN THE COD END (FORE-GROUND) AND IN THE COVER (BACKGROUND).

ends. On the first cruise, cod ends of $4\text{-}7/8$ -inch mesh were used. On the second cruise, cod ends were increased to $5\text{-}1/2$ -inch mesh. These measurements are the "as ordered" and computed between knot centers. All nets were obtained from firms that normally supply the Boston fleet. Since greater strength is required for these larger meshes, the cod ends were constructed of 50-yard, four-thread, double manila twine.

A cover of fine-mesh shrimp netting was fitted to the upper side of the cod end in order to capture the small fish which escaped (figs. 1 and 2). The cover extended eight feet beyond the cod end of the trawl and terminated as a small "cover cod end" with its own cod-end line. The fish could not escape through the underside of the cod end because of the bullhide protectors attached there.

For purposes of the International Northwest Atlantic Fisheries Commission, measurements of mesh size are made by inserting a flat wedge-shaped gauge into the

The nets used were standard No. 41 otter trawls, with bellies all of 5-inch (between knot centers) mesh. Experiments were made on two sizes of mesh in the cod

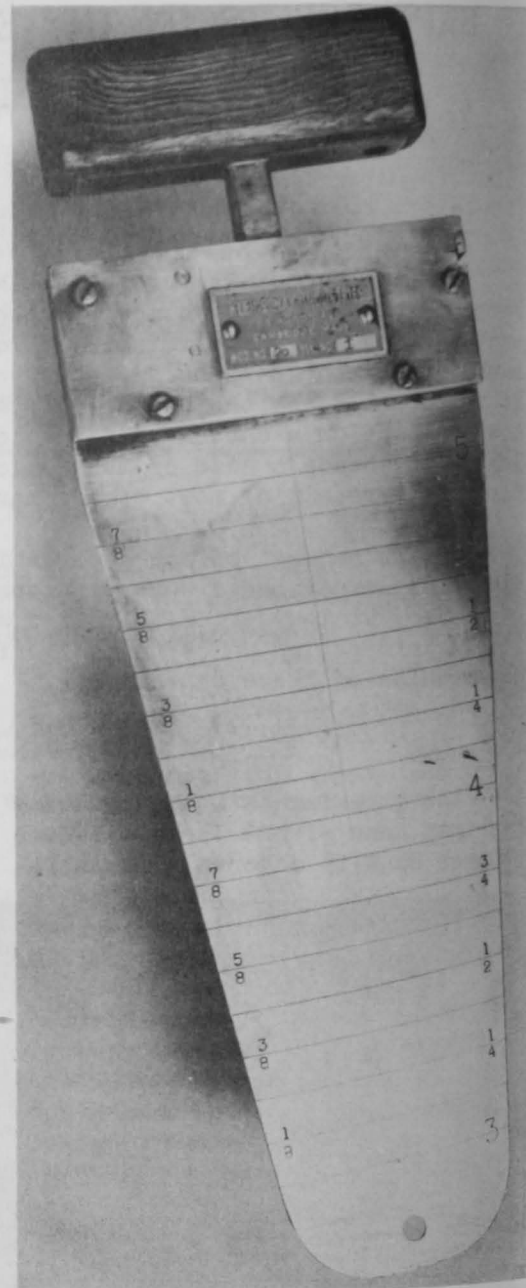


FIG. 3 - THE PRESSURE GAUGE FOR MEASURING THE INSIDE DIMENSIONS OF MESH UNDER A PRESSURE OF 12 POUNDS. A PRESSURE OF 12 POUNDS BRINGS THE NOTCH IN THE INDICATOR TO THE NOTCH IN THE PLATE.

mesh of a wet used net under a pressure of 12 pounds. A special gauge for this purpose, illustrated in figure 3, was constructed. The gauge has an indicator for a pressure of 12 pounds. Inside measurements made in this way are, of course, lower than the between-knots measurements which are normally used in ordering nets from manu-



FIG. 4 - COMPARISON OF CATCHES FROM THE COD END AND FROM THE COVER. FISH IN CHECKER TO THE LEFT WERE RETAINED BY THE 4-1/8-INCH MESH (INSIDE MEASUREMENT). FISH IN CHECKER TO RIGHT PASSED THROUGH MESHES OF COD END AND WERE CAUGHT IN THE COVER.

facturers. The experimental nets were measured before use and periodically throughout the experiments with the pressure gauge in order to record any changes taking place as the result of use. Measurements were made all along the cod end from fore to aft. All measurements of used nets were made when the nets were thoroughly wet.

All haddock from the cod end and from the cover were counted and measured except in cases of very large catches, when only a representative sample was taken and the total computed on the basis of this sample. The two catches were kept separate by emptying the cod end first while the cover was still hanging over-side. Then the cover was hoisted aboard and emptied onto another part of the deck. The two catches were kept apart until counted and measured (fig. 4, 5 and 6).



FIG. 5 - MEASURING HADDOCK AT SEA ON THE MICHIGAN.

It was necessary at the beginning of the experiments to determine whether the cover was having any effect on the selectivity of the cod end, either by impeding the flow of water through the net or by interfering with the escape of fish through



FIG. 6 - A LARGE CATCH OF UNDERSIZED FISH IN THE COVER. THESE FISH PASSED THROUGH THE MESHES OF THE COD END.

the large mesh by obstructing it in some way. For this purpose an uncovered net was used alternately with the covered net for a number of tows, and the catches of the two compared.

RESULTS

EFFECT OF NET USE ON MESH SIZE: When a new net is immersed in water, the meshes are reduced in size due to the shrinkage of the fibers of the twine. If

When Measured	Part of Cod End Measured				Approximate Average For Entire Cod End
	Q u a r t e r				
	1st (aft)	2nd	3rd	4th (fore)	
	(I n c h e s)				
New, dry	4-5/8	4-5/8	4-5/8	4-3/4	4-5/8
After 3 tows	3-3/4	3-5/8	3-5/8	3-5/8	3-5/8
After 24 tows	3-3/4	3-3/4	3-9/16	3-9/16	3-5/8
After 30 tows	4	3-7/8	3-7/8	3-7/8	3-7/8

the net is then subjected to strain, the meshes may increase in size due to the tightening of the knots. Since the strain may be greater in the aft part of the cod end in which the catch is hoisted, more stretching may occur there than in the fore part. Table 1 presents the measurements of one of the 4-7/8-inch (between knot centers) cod ends before use and at intervals during the trip. Measurements were taken at random within the four quarters running lengthwise of the cod end, on the upper side only.

It can be seen that the meshes shrunk considerably at first, then remained relatively constant, and finally stretched a little after the last few tows. In the first tow 3,000 pounds of fish were taken, causing the knots to tighten and

Table 2 - Sizes (Inside Measurements) of Mesh in a 5 1/2-Inch (Between Knot Centers) Cod End Before and After Use

When Measured	Part of Cod End Measured				Approximate Average For Entire Cod End
	Q u a r t e r				
	1st (aft)	2nd	3rd	4th (fore)	
	(I n c h e s)				
New, dry	5-1/8	5-1/8	5-1/4	5-1/8	5-1/8
After 3 tows	4-1/4	4-1/8	3-7/8	3-7/8	4
After 16 tows	4-7/16	4-1/4	4	3-13/16	4-1/8
After 25 tows	4-7/16	4-1/4	3-15/16	3-15/16	4-1/8
After 28 tows	4-1/2	4-3/16	3-15/16	3-7/8	4-1/8

the meshes to stretch almost to the maximum attained during the trip. During the next 27 tows the heaviest catch was 2,800 pounds. This was not sufficient to cause much additional stretching. Then, on tow 29, 5,000 pounds were taken and the meshes stretched an additional quarter of an inch. As expected, the meshes in the aft part of the cod end stretched more than those near the belly.

In table 2 are the measurements for one of the 5-1/2-inch (between knot centers) cod ends used on the second cruise. The usual initial shrinkage occurred and then there was appreciable stretching only in the aft part. The heaviest catch (3,100 pounds) was taken on tow 11, after which the mesh sizes changed but little. At the completion of the trip, the meshes in the aft part of the cod end were 5/8-inch greater than were those in the fore end.

The meshes in the bellies of the nets which were purchased as 5-inch (between knot centers) averaged 4-1/2 inches as measured with the gauge when wet after use. There was no material change in

Table 3 - Selectivity of the 3 3/4-Inch (Inside Measurements) Cod End

Gutted Weight	Length ^{1/2}	Fish in Cover	Fish in Cod End	Total Caught	Percentage Retained in Cod End
Pounds	Cm.	No.	No.	No.	%
.2	21	14	5	19	26.3
.3	24	74	8	82	9.8
.4	27	102	22	144	17.7
.5	30	276	149	425	37.9
.7	33	388	755	1,143	66.1
.9	36	177	1,377	1,554	88.6
1.2	39	22	1,391	1,413	98.4
1.4	42	-	969	969	100.0
1.7	45	-	661	661	100.0
2.1	48	-	418	418	100.0
2.5	51	-	270	270	100.0
2.9	54	-	90	90	100.0
3.4	57	-	38	38	100.0
3.9	60	-	22	22	100.0
4.5	63	-	12	12	100.0
5.1	66	-	5	5	100.0
5.8	69	-	3	3	100.0
Totals		1,053	6,195	7,268	

^{1/2}SIZE GROUPS BY 3 CM. INTERVALS. DUE TO THE METHOD OF RECORDING LENGTHS TO LOWER FULL CM. (E.G., ALL LENGTHS FROM 21.0 CMS. TO 21.9 CMS. ARE RECORDED AS 21 CMS.), AN ADJUSTMENT OF 0.5 CM. MUST BE MADE TO EACH LISTED GROUP LENGTH TO OBTAIN THE TRUE MIDPOINT OF THE GROUP.

size during use. The netting of the bellies is constructed of single twine so that there is a different relationship between the two types of measurements. In the cod ends with double twine, a 5-inch (between knot centers) mesh would have an internal dimension much less than 4-1/2 inches.

EFFECT OF COVER: Analysis of the results of the paired tows showed that the cover did not hinder the escape of small haddock from the cod end. Had the cover interfered, we would expect to find more small fish in the covered cod end. The greater number of small fish would, of course, lower the average size of haddock in the covered cod end as compared with the uncovered one. The average length of fish in seven pairs of tows in which the meshes averaged 3-3/4 inches (inside measurement) however, was exactly the same (40.7 cm.) in both the covered and uncovered cod ends. In 5 pairs of tows with the 4-1/8-inch (inside measurement) mesh the average length of haddock from the covered net was actually a little higher (42.7 cm.) than from the uncovered net (41.6 cm.). It can be stated with confidence, therefore, that under the prevailing conditions, the cover did not hinder the escape of small fish from the cod end. This has been verified by a detailed statistical analysis which will be reported elsewhere.

Table 4 - Selectivity of the 4-1/8-Inch
(Inside Measurements) Cod End

Gutted Weight Pounds	Length ^{1/} Cm.	Fish in Cover No.	Fish in Cod End No.	Total Caught No.	Percentage Retained in Cod End %
.1	18	1	-	1	0.0
.2	21	13	4	17	23.5
.3	24	17	-	17	0.0
.4	27	47	4	51	7.8
.5	30	192	39	231	16.9
.7	33	313	206	519	39.7
.9	36	349	486	835	58.2
1.2	39	211	785	996	78.8
1.4	42	39	627	666	94.1
1.7	45	6	454	460	98.7
2.1	48	2	325	327	99.4
2.5	51	-	154	154	100.0
2.9	54	-	69	69	100.0
3.4	57	-	28	28	100.0
3.9	60	-	11	11	100.0
4.5	63	-	2	2	100.0
Totals		1,190	3,194	4,384	

^{1/}SIZE GROUPS BY 3 CM. INTERVALS. DUE TO THE METHOD OF RECORDING LENGTHS TO LOWER FULL CM. (E.G., ALL LENGTHS FROM 21.0 CMS. TO 21.9 CMS. ARE RECORDED AS 21 CMS.), AN ADJUSTMENT OF 0.5 CM. MUST BE MADE TO EACH LISTED GROUP LENGTH TO OBTAIN THE TRUE MIDPOINT OF THE GROUP.

ESCAPE OF FISH THROUGH THE MESH: In a series of 5 tows with the 4-7/8-inch (between knot centers) cod end during which the size of mesh held close to 3-3/4 inches (inside measurement), a total of 7,268 haddock were taken; 6,195 of these were retained in the cod end while 1,053 escaped to be caught in the cover. The numbers of haddock of various sizes taken in the cod end and in the cover, as well as the percentages of these sizes which were retained in the cod end, are given in table 3. It will be noted that practically all fish weighing less than 0.4 pound escaped and that practically all fish weighing more than one pound were retained by this mesh which averaged 3-3/4 inches (inside measurement).

The selectivity of meshes is defined by the 50-percent selection point. This is expressed as the size of fish of which 50 percent are retained and 50 percent released by the net. For this net with 3-3/4-inch (inside measurement) mesh the 50-percent selection point was 32 cm. (12.6 inches). Haddock of this length weigh about 3/4 pound.

The results of the experiment with the 5-1/2-inch (between knot centers) mesh are given in table 4. In a series of eight tows with this cod end during which the meshes averaged 4-1/8 inches (inside measurement), 4,384 haddock were taken, of

which 3,194 were retained and 1,190 escaped through the meshes of the cod end and were caught in the cover. In this case, most fish weighing less than 0.6 pounds escaped, while practically all fish weighing more than 1.3 pounds were retained. The 50-percent selection point for this net of 4-1/8-inch (inside measurement) mesh was 35.5 cm. (14 inches). Haddock of this length weigh about one pound.

SUMMARY

1. The shrinkage and stretching in use of two sizes of mesh in cod ends of otter trawls was measured.
2. A well fitted fine mesh cover on the cod end does not interfere with the escapement of small fish, so that covered nets can be used for determining the selectivity of meshes.
3. The selectivity of two sizes of mesh was measured. The use of a net with meshes larger than the larger one used in these experiments (4-1/8 inches, inside measurement) would result in saving most of the haddock now discarded, and at the same time would retain most of the fish now caught and landed.

ACKNOWLEDGMENT

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U. S. CANNED FISHERY PRODUCTS PRODUCTION

DO YOU KNOW THAT

California led in the production of canned fishery products with a pack of 388,296,199 pounds, valued at \$122,572,382. Alaska was second with 168,439,139 pounds, valued at \$80,748,052. These areas accounted for 70 percent of the 1951 United States and Alaska pack of fishery products and 68 percent of its value.



Canned Fish & Byproducts--1951, C.F.S. No. 772