Cod Trap Mesh Selection Studies

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by

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ABSTRACT

Bishop, C. A. 1982. Cod trap mesh selection studies. Can. Tech. Rep. Fish. Aquat. Sci. 1075: iv + 47 p.

This report presents the results of cod trap mesh selection studies conducted primarily to determine an appropriate mesh size for the back or 'drying twine' portion of the cod trap. An experimental cod trap was fished using 4 different mesh sized backs over a 7 wk period and appropriate biological and physical data were collected. Based on selection curves from the data it was estimated that an increase in mesh from 89 to 103 mm would produce an 8% catch weight loss to cod trap fisherman while that to a 128 mm mesh could be 60%. Meshing of fish in the different backs used was not found to be a problem. Water temperatures showed considerable fluctuations over the experimental period but showed little relationship to catch. The average length of the catch showed an increase with an increase in mesh size. The selectivity of the 103 mm mesh cod trap was close to that of the 130 mm mesh currently enforced for otter trawls in the offshore fishery. It is predicted that in the long term cod trap fishermen would not regain losses caused by an increase in mesh size. The total cod fishery would gain in terms of catch weight and the gillnet component was predicted to show the largest percentage gain.

Key words: cod, cod trap, selectivity

RÉSUMÉ

Bishop, C. A. 1982. Cod trap mesh selection studies. Can. Tech. Rep. Fish. Aquat. Sci. 1075: iv + 47 p.

Le présent rapport présente les résultats d'études sur la sélectivité des mailles des trappes à morue, destinées surtout à déterminer un maillage approprié pour l'arrière ou la partie des "fils découvrants" de la trappe à morue. Pendant sept semaines, on s'est servi, d'une trappe à morue expérimentale, avec quatre maillages différents pour l'arrière et on a recueilli des données physiques et biologiques pertinentes. D'après les courbes de sélection obtenues, on a estimé que le passage un maillage de 89 à 103 mm occasionnerait aux pêcheurs une perte de 8 % des prises en poids, qui pourrait atteindre 60 % à 128 mm. On n'a pas trouvé que la capture des poissons dans les différents filets utilisés constituait une problème. Les variations de température de l'eau ont été très importantes au cours de la période d'essai mais n'avaient que peu de rapports avec les prises. On a constaté que la longueur moyenne des poissons capturés augmentait aves le maillage. La sélectivité des mailles de 103 mm était proche de celle des mailles de 130 mm actuellement utilisées, dans la pêche hauturière, pour les chaluts à panneaux. On prévoit que les pêcheurs utilisant des trappes à morue ne pourraient récupérer à long terme ce qu'ils auraient perdu par suite d'une augmentation du maillage. La pêche de la morue dans son ensemble y gagnerait sur le plan du poids des poissons capturés et on a prévu que les gains les plus substantiels en pourcentage seraient réalisés par la pêche aux filets maillants.

INTRODUCTION

The cod trap has been an important gear component of the Newfoundland inshore fishery since its first use approximately 100 years ago. Since 1976 the cod trap has accounted for approximately 30% of the total Newfoundland cod catch and over 40% of that taken on Newfoundland northeast coast (NAFO Div. 2J3KL). In 1980 there were approximately 4052 cod traps in Newfoundland 3225 of which were expected to be in use.

The basic structure of the cod trap, usually termed the Newfoundland cod trap, has remained the same since its first use (Fig. 1). Variations in design have usually been in response to the local conditions in which it was fished. The structure is basically rectangular with a circumference of approximately 111-119 m, has sides and a bottom but no top or cover. One side (the front) has an opening called the door through which the fish enter. The mesh size (stretched measurement, knot to knot) varies in different parts of the trap. The sides and front usually have mesh sizes ranging from 127-203 mm while the back or 'drying twine' area is usually 89 mm. The trap also has a leader of large mesh which extends approximately 2 meters into the trap through the door, and then away from the trap toward shallower water. The length of this leader varies according to the location in which it is set. The leader is effective in directing fish toward and into the trap through the door.

The regulations pertaining to cod trap as indicated in the Canada Gazette, Part II, Vol. 11, No. 10 state that mesh sizes in the walls or sides are to be no less than 3.5 in. (89 mm) extension measure while that in the leader is to be not less than 7 in. (178 mm).

The only other cod trap which has been used successfully in the Newfoundland inshore fishery is the Japanese type trap which was introduced in the mid 1960's. Originally it was a smaller trap (92-101 m in circumference) with two compartments. The mesh size in one compartment was 128 or 152 mm while that of the other, the main retaining area, was 89 mm on all sides and in the top or cover.

In 1979 experimental work was conducted in conjunction with the Industrial Development Branch toward a determination of an appropriate mesh size to be used in the back or drying twine area of a cod trap.

METHODS

The experiment was conducted over a period of 7 weeks during June-August 1979 from the port of St. John's. Through charter agreement a fisherman was hired to fish an experimental cod trap with specific objectives. The trap used was a modified Newfoundland cod trap which was constructed and owned by the Industrial Development Branch of Fisheries and Oceans. The trap had been used experimentally in 1978 to determine its effectiveness and traps of similar design have been used in the commercial cod trap fishery.

The experimental trap (Fig. 2) was 111 m in circumference and 20 meters deep. The trap differed from the traditional Newfoundland trap in having the front indented at the doorways to form a v-shaped cone which extends 5 m into the trap. The sides of this cone, referred to as winker panels, were of

178 mm mesh traplon as was the remainder of the trap front. The first 26 meters of both sides were of 152 mm mesh traplon while the remaining 5 meters were of 102 mm mesh vinylon. In the 1979 mesh selection experiment four different mesh size backs were used, namely 84 mm, 89 mm, 103 mm and 128 mm. The back also had fitted around its outside an additional section of 52 mm mesh, referred to as a pound, which extended off from the back approximately 3 m and ran the full length and depth of the back of the trap. This pound had a bottom panel as well. The purpose of the pound was to retain fish which might escape through the back of the trap when it was being hauled or 'dried up'. Each of the four backs were fished from 10 to 14 days at which time the back was removed and a new back of different mesh size was put in its place. The 52 mm mesh pound section remained attached to the back corner ropes of the trap for the duration of the experiment. Its head rope was fitted with floats (76 mm x 102 mm spaced 1.4 m apart) and its footrope with lead weights (7 per kg at 30 cm apart) in the same manner as were the headline and footrope of the remainder of the trap. The 84 mm, 89 mm, 103 mm and 128 mm backs were constructed of vinylon while the 52 mm pound mesh was of knotless nylon. The leader was 91 m long with 73 m having 178 mm mesh traplon and the remaining 18 m, 203 mm traplon. The smaller mesh portion was closest to the trap.

The trap was set in a berth located between Deadman's Bay and Blackhead Bay near St. John's (Fig. 3), designated as Chapel Berth No. 2. This berth was not a draw berth in the local cod trap fishery during 1979. The trap was set on June 21 and was hauled thereafter twice per day (once on Saturday) when weather and tide permitted, in the morning and afternoon. Each time the trap was hauled the fish caught were separated into three categories; those in the main part of the trap, those meshed (gilled) in the back of the trap, and those retained in the pound section. For each catch category the following information was obtained; weight and number of fish caught, fork length of as many fish as possible (usually total catch) and girth measurement (opercular and maximum) from up to three fish per 3 cm group. Weights were obtained using a 200 lb spring balance when possible or from fish plant records when the catch was large. Fork lengths were measured to the nearest cm using a standard measuring board with inset meter stick and offset by ½ cm. Lengths were recorded on frequency sheets by 3 cm group. Girths were measured to the nearest millimeter using a plastic coated measuring tape. A sample of otoliths (up to 25 per 3 cm group) was obtained from catches over the whole experimental period.

Surface temperatures and BT casts were also obtained on a daily basis if the trap was hauled. Temperatures were taken in the same location each day which was near the back of the trap at a depth of approximately 30 m.

Conversion tables are included in Appendix 1 to facilitate metric-English conversion. These include; pounds to kilograms, inches to millimeters, feet to meters, and fathoms to meters.

EXPERIMENTAL RESULTS

CATCHES

Table 1 provides a summary of catch information for each of the four backs used and for each section of the trap considered. Catches were sporadic and small at the start of experiment when the 84 mm back was in use. It was

permitted to remain in the trap for a longer period of time than originally intended so as to obtain additional catch data. The majority of the catch with the 84 mm back (98% by wt) was retained by the trap (trap and meshed) with little escaping through the back. Catches with the 89 mm back were small as well but a little more constant. The trap still retained 92% by wt of the fish entering the trap. Catches with the 103 mm back were best and produced the largest catch per trap-haul (3391 kg) with 84% of the fish caught being retained by the trap. Only one significant catch (2508 kg) was obtained with the 128 mm mesh back and only 16% of the total catch for this back was retained in the trap. The reasons for this sharp drop in % retention by the 128 mm mesh may be explained by difference in average size of fish caught when the different backs were in use. The average amount of meshed fish for all backs was always less than 10%.

LENGTH AND GIRTH MEASUREMENTS

Total length frequencies for each mesh size back and a per mille frequency for the same are shown in Tables 2 and 3 and Fig. 4 and 5. The average lengths of the total catch were similar when mesh sizes 84 mm, 89 mm and 103 mm were used namely 50.8 cm, 51.2 cm and 50.6 cm respectively. With the 128 mm mesh only one large catch was obtained, the average length of which was 45.5 cm. This might partially explain the large increase in quantitiy of fish found to escape to the pound when the 128 mm back was used (91%) as compared to that for the 103 mm back (25%).

The length frequencies for each section of the trap and for each mesh size used are shown in Fig. 6-9. The increase in proportion found in the pound as back mesh size increases can easily be seen.

Girth measurements, both opercular and maximum, were obtained from 1587 fish over the experimental period. These were obtained from fish that were retained in the trap, meshed in the back, and from the pound. The fork length to average girth at length relationship of all fish measured is shown in Fig. 10.

In any net fishery (otter trawl, gillnet, trapnet) the largest size fish that should be retained would be those having a circumference (girth) greater than the largest mesh size opening. In contrast to towed nets, which are under more tension, this largest mesh opening in free hanging nets should be equal to total circumference of each mesh which is equivalent to twice the stretched mesh measurement. In the present study the mesh size of the different backs and the pound were measured using a Westhoff gauge. This device is a pressure gauge which measures mesh size by exerting a constant force between opposite knots of a mesh. A total of ten measurements were made on different meshes in each back. The average of these was considered as the representative mesh size for each. As such the measured mesh sizes of the four backs used were 84, 89, 103 and 128 mm or with that for the pound being 52 mm. Table 4 shows the average lengths of fish caught by each mesh size and for each back used. The corresponding opercular and maximum girths as obtained from Fig. 10 are shown as well. The maximum stretched mesh circumference was generally smaller than the average opercular and maximum girths of fish found in the pound as well as those meshed. It would seem that a fish of somewhat larger

girth circumference than the mesh opening is able to escape or become meshed either by exerting considerable swimming force or by compressing itself to a smaller size than the relaxed girth measurement obtained in the field.

TEMPERATURES

Temperatures obtained daily at the surface and bottom near the experimental cod traps are shown in Table 5 and Fig. 11. Daily fluctuation was more pronounced with bottom temperatures than those at the surface. The extent of the day to day change in temperature was substantial as can be seen for the period July 6 to 7th when the bottom temperature went from 0.5 to 8.2¼C.

MESH SELECTION

Mesh selection values for each mesh size used were obtained by comparing length frequencies obtained from fish retained in the trap with the population exposed to the trap. This ;population; was made up of the fish retained by the trap plus those retained by the pound. From the length girth relationship (Fig. 10) and average girth per section of trap (Table 4), the pound mesh of 52 mm would probably retain fish averaging 16 cm in length.

The present selection at length and age for each mesh size used is shown in Table 6. Also included are the data obtained by Boulanger (1960, 1961) for mesh sizes 114 mm and 130 mm. These mesh sizes were used by Boulanger in the Gulf of St. Lawrence in a cod trap study similar to the present. The ages for each 3 cm length group shown in Table 6 were obtained from a von Bertalanffy growth curve (Table 7, Fig. 12) calculated from age and length data from the present study. This age structure was also applied to the frequencies in Boulanger;s study to obtain selection at age values. Figures 13-15 indicate selection curves from the values presented in Table 6. Percent selection (25, 50, 75%) at length was also calculated by the maximum likelihood method (Pope 1966). The results for the different mesh sizes used are shown in Table 8. The estimates for the 114 and 130 mm mesh were obtained from the selection curves (Fig. 14 and 15) only. Using the calculated ℓ_{50};s, selection factors were obtained for each mesh size (Table 9). The selection factors ranged from 4.0 to 4.4. Figure 16 indicates a good relationship between mesh size and 50% selection length (r; ½ .999).

Hodder (1964) presented data on mesh selection of cod by an otter trawl using different mesh sizes in the codend. Selection curves from his data are shown in Fig. 17. A comparison of mesh size with 50% selection length for Hodder;s data and that for the present study is shown in Fig. 18. Both data sets show good linear relationships. As would be expected the otter trawl ℓ_{50} selection value is lower than for trap with the same mesh size. Also it can seen that the ℓ_{50} obtained from a 128 mm mesh otter trawl (44.0 cm) corresponds closely with the ℓ_{50} for a 103 mm mesh cod trap (44.2 cm).

EFFECT OF DIFFERENT MESH SIZES ON TRAP CATCH

The portion of the trap which is most important in terms of its mesh selection properties is the back or drying twine area. In 1977 a cod trap

survey was conducted by the Conservation and Protection Branch which indicated that the mesh size in use in each statistical area (Table 10) was very close to the regulation size of 89 mm.

If we assume that a 89 mm mesh was in use in 1978 it is possible to analyze the possible effect of a change in mesh size in 1978 based on the selection values presented in this paper. We can further look at the fish that might be escaping (assuming a larger mesh size was used) to determine the catch returns that might be expected from each gear component of the fishery as this group of escaped fish passes through the fishery.

Table 11 shows the catch at age by gear for Can (Nfld) along with a total for all countries. By assuming that the selectivity of the traps involved in the commercial trap fishery is similar to the 89 mm mesh used in this study we can construct a table of probable catches by trap in 1978 if 84 mm, 103 mm, 114 mm, 128 mm and 130 mm mesh backs had been used. As shown in Table 12 the catch at age by trap in 1978 was adjusted by the ratio of the selectivity at age by the particular mesh (Fig. 13 to 15) to the selectivity by the 89 mm mesh. Table 12 also indicates the average weight at age from the commercial fishery in 1978 from which a total catch weight for each mesh size was calculated. The weight difference from that of the 89 mm mesh was obtained and this difference was expressed as a percentage so as to indicate immediate loss or gain in terms of the total catch by Can(N) traps, total Can N all gears and total catch all countries. The immediate loss if a 103 mm mesh back had been used was 8% by weight of the catch by a 89 mm mesh and 3% of the total Can N catch. With a 128 mm or 130 mm mesh the trap catch dropped by 61% of the 89 mm mesh catch and 23% of the total Can N catch.

With these estimates of trap catch by mesh sizes other than the conventional size, it is possible to estimate the fate of those fish released when a larger mesh size is used in the trap. This was done for each mesh size considered in Table 12 with the same procedure being used in each case. As an example, the details of the method as done for the 103 mm mesh is shown in Tables 13-18.

In each instance some assumptions had to be made. Firstly its assumed that the trap season was completed by Aug. 1 in 1978 and that the total mortality on this escaped population was that occurring on the remaining 5 months (i.e. 5/12Z). Thus the population at the beginning of 1979 would be equal to the population at age on Aug. 1, 1978 x $e^{-5/12Z}$. Natural mortality (m) was assumed to be 0.20 and the fishing mortality (F) calculated for each age with the 103 mm mesh is indicated in Table 13. These fishing mortalites were obtained from exploitation rates expressed as the ratio of the total catch at age by the 103 mm mesh to the population in 1978. The population at age was obtained from ICNAF Res Doc. 80/VI/63. Also it was assumed that the proportion of total catch by each gear in 1978 would remain the same throughout the period to be considered and that fishing would be carried out at the $F_{0.1}$ level. Table 13 indicates the total population in 2J3KL in 1978 along with a breakdown of catch by gear and total catch. From the total F as calculated from exploitation rates, partial selection values were obtained and these along with the average weights at age were used to calculate a yield per recruit curve. From this curve the $F_{0.1}$ was found to be 0.18.

Table 14 indicates the numbers of fish escaping had a 103 mm mesh been used in 1978, along with an estimate of this population in Jan. 1, 1979. Using the latter population at age a catch projection was calculated using

partial selection as shown in Table 13 and average weights as in Table 12 so as to obtain the total possible potential catch from this population in each year until it disappeared from the fishery (Table 15).

If we can assume that the proportion of catch by each gear in 1978, is the same in the years considered, then we can obtain a further breakdown of catch by gear (Tables 16-18). Table 19 presents a summary of immediate and long term gain and/or loss for the 103 mm mesh back. Tables 20-22 show similar summary tables for 114, 128 and 130 mm mesh backs.

CONCLUSIONS

As a result of relatively small catches by the majority of backs used it is difficult to assess the effect of catch size on mesh selection. The average length of fish retained by the 89 mm mesh was 52.2 cm while that for 103 mm and 128 mm was 53.1 and 57.2 respectively. The weight loss if a 103 mm back had been in use would be approximately 8%. With the 128 mm mesh the weight loss increased to a level of approximately 60%. Meshing of fish in the back was not a problem in that the amount of meshed fish was always less than 10%. In another study (Mercer and Allen 1979) it was found that as high as 39% of total catch were meshed by a 103 mm back while up to 52% meshed with a 114 mm back. However, the amount of meshing was found to vary a great deal in different areas.

It would appear from girth measurements that the measured girth of fish escaping through the back is equal to the measured circumference of the mesh opening.

The observed daily temperature fluctuations are most likely the result of changes in the tide and wind direction. If a fish or its prey species had temperature preferences it would not be unreasonable to assume that catches would be influenced by those physical factors. In this experiment the relationships between temperature and catch was not good possibly for reasons other than those mentioned. Temperatures when the trap was hauled might be substantially different, due to wind and tide changes, from those existing when the fish entered the trap. The trap berth location might have an important influence as well.

The pattern of average lengths of fish found in the pound, meshed and in the trap showed an increase except for the 89 mm mesh which showed a higher average length in the pound than those meshed. This might have resulted from sampling error or have occurred because of the small catches obtained when this mesh size was in use. The average lengths of those caught by the trap (trap and meshed) did show an increase in average length with increased mesh size (Table 2) while the average length of the total catch (trap and pound) declined over the same period (Table 3). The average length of the fish caught by each mesh size did not vary a great deal (52.0-57.2 cm) but the amount of fish caught would vary with the size structure of the population exposed to the trap.

As can be seen from Table 6 the 50% selection lengths increased progressively with increased back mesh size. The results were also comparable with those of Boulanger (1960, 1961).

The relationship of the 50% selection length to mesh size (selection factor) was fairly constant (Table 9) and found to agree closely with values obtained from other studies (Boulanger 1960, 1961). The relationship of pectoral girth at ℓ_{50} to mesh size for the four mesh sizes used varied from 1.9 to 2.2. Similarly Hodder and May (1965) obtained values of approximately 1.7 in experiments with selectivity of otter trawls using codend mesh size from 96 to 130 mm.

From a regulatory point of view it would appear that the selectivity of a 103 mm back (ℓ_{50} = 44.2 cm) in a cod trap most closely corresponds to the selectivity of the 128 mm mesh (ℓ_{50} = 44.6) currently in use in the offshore otter trawl fishery.

The possible effect of a change from the present 89 mm mesh back to that of 103, 114, 128 or 130 mm showed that initial losses to the trap fishermen ranged from a low of 8% with the 103 mm mesh to a high of 61% with the 128 or 130 mm mesh.

The predicted immediate and long term effect of changes in mesh size of the back indicate that the immediate losses to the cod trap fishery would range from 8 to 60% per mesh size ranging from 103 mm to 130 mm. It is predicted that the cod trap fishery would not regain this loss from the released fish in the long term with the mesh sizes indicated. The total fishery would show a gain in spite of trap losses and the gillnet component of the fishery would show the largest overall percentage gain as compared to other gears.

It is important to realize that these estimates and predictions have to be made with the stated assumptions and their validity has to be considered in light of these assumptions.

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Table 1. Summary of catch data (lb) for each section of the experimental trap.

Date	Back mesh size	Trap No.	Trap Wt.	Meshed No.	Meshed Wt.	Pound No.	Pound Wt.	Total No.	Total Wt.
June 23	84 mm	3	10.0	0	0.0	1	0.5	4	10.5
25		2	4.0	3	6.5	0	0.0	5	10.5
27		97	226.0	4	8.0	9	9.0	110	243.0
27		0	0.0	0	0.0	0	0.0	0	0.0
28		0	0.0	0	0.0	0	0.0	0	0.0
29		0	0.0	0	0.0	0	0.0	0	0.0
30		0	0.0	0	0.0	4	1.0	4	1.0
July 2		107	273.0	9	15.5	8	6.5	124	295.0
2		0	0.0	0	0.0	0	0.0	0	0.0
3		1	6.0	0	0.0	2	1.0	3	7.0
3		0	0.0	0	0.0	0	0.0	0	0.0
4		42	114.0	4	7.0	1	0.5	47	121.5
4		183	626.0	8	12.0	1	1.0	192	639.0
5		82	287.0	4	14.0	0	0.0	86	301.0
5		0	0.0	0	0.0	0	0.0	0	0.0
6		214	550.0	12	18.0	21	23.0	247	591.0
9		827	2980.0	15	38.0	17	28.0	859	3046.0
10		76	182.0	2	2.0	10	15.0	88	199.0
11		1	4.5	0	0.0	0	0.0	1	4.5
12		2	9.0	0	0.0	0	0.0	3	18.0
		1637	5271.5	61	121.0	74	85.5	1773	5487.0
	%	93	96.0	3	2.0	4	2.0	100	100.0
July 13	89 mm	435	1700.0	10	17.5	25	67.0	470	1784.5
14		6	17.5	1	1.7	1	2.5	8	21.7
16		263	1130.0	2	5.0	15	40.0	280	1175.0
17		99	336.0	4	5.0	20	36.0	123	377.0
18		280	875.0	29	36.0	103	206.0	412	1117.0
18		80	266.0	8	11.0	18	35.0	106	312.0
19		2	14.0	0	0.0	0	0.0	2	14.0
19		6	28.0	0	0.0	0	0.0	6	28.0
20		152	440.0	12	19.0	18	50.0	182	509.0
21		300	795.0	33	46.0	38	70.0	371	911.0
23		19	106.0	0	0.0	0	0.0	19	106.0
		1642	5707.5	99	141.2	238	506.5	1979	6355.2
	%	83	90.0	5	2.0	12	8.0	100	100.0

. . . Cont'd.

Table 1 (cont'd.)

Date	Back mesh size	Trap No.	Trap Wt.	Meshed No.	Meshed Wt.	Pound No.	Pound Wt.	Total No.	Total Wt.
July 25	103 mm	1	5.5					1	5.5
26		645	2449.0	58	144	129	241.0	832	2834.0
26		92	326.0	10	21	14	23.0	116	370.0
27		750	2911.0	65	133	116	207.0	931	3251.0
27		1180	3600.0	124	252	511	781.0	1815	4633.0
28		722	1922.0	149	304	358	594.0	1221	2820.0
30		1100	3646.0	132	268	288	536.0	1525	4450.0
31		158	470.0	15	36	128	234.0	301	740.0
31		11	40.0	1	4	11	17.5	23	61.5
Aug. 1		1648	5624.0	211	408	792	1420.0	2651	7470.0
2		387	1173.0	76	162	272	420.0	735	1755.0
		6694	22184.5	841	1732	2619	4473.5	10154	28390.0
%		66	78.0	8	6	26	16.0	100	100.0
Aug. 6	128 mm	21	112.0	15	64	207	394.0	243	570.0
6		0	0.0	0	0	0	0.0	0	0.0
7		57	224.0	134	469	2679	4831.0	2870	5524.0
8		1	4.0	0	0	0	0.0	1	4.0
9		20	102.0	7	32	31	72.0	58	206.0
10		4	17.5	1	4	10	22.5	15	44.0
		103	459.5	157	569	2927	5319.5	3187	6348.0
%		4	7.0	6	9	91	84.0	100	100.0

Table 2. Length frequencies of total catch by each portion of the trap and for each mesh size used.

	84 mm			89 mm			103 mm			128 mm		
cm	Pound	Trap	Total	Pound	Trap	Total	Pound	Trap	Total	Pound	Trap	Total
18-20												
21-23	1		1									
24-26	4		4							1		1
27-29	3		3	1		1	8		8	7		7
30-32	12	5	17	9		9	42		42	30		30
33-35	22	26	48	33	3	36	148		148	130		130
36-38	8	57	65	27	31	58	288	5	293	293		293
39-41	3	85	88	23	112	135	560	62	622	446	1	447
42-44	10	190	200	29	164	193	606	417	1023	531	2	533
45-47	4	190	194	32	247	279	417	1016	1433	577	7	584
48-50	2	233	235	31	286	317	222	1527	1749	493	21	514
51-53	4	266	270	21	226	247	146	1428	1574	266	33	299
54-56		187	187	17	183	200	100	1148	1248	123	61	184
57-59		149	149	9	164	173	42	753	795	25	61	86
60-62	1	104	105	3	107	110	25	493	518	5	37	42
63-65		61	61	2	85	87	12	313	325		15	15
66-68		50	50		57	57	2	152	154		8	8
69-71		33	33		33	33		96	96		8	8
72-74		24	24	1	20	21	1	45	46		3	3
75-77		19	19		10	10		37	37		1	1
78-80		6	6		7	7		12	12			
81-83		13	13		4	4		13	13			
84-86								7	7		2	2
87-89								3	3			
90-92					1	1		2	2			
93-95												
96-98					1	1		2	2			
99-101								3	3			
102-104												
105-107								1	1			
108-110												
111-113												
114-116												
117-119												
Total	74	1698	1772	238	1741	1979	2619	7535	10154	2927	260	3187
Ave. length (cm)		52.0			52.2			53.1			57.2	

Table 3. Total and per mille length frequencies for the catch with each mesh sized back.

	84 mm		89 mm		103 mm		128 mm		Total
	Catch Freq.	Per Mille	Catch Freq.	Per Mille	Catch Freq.	Per Mille	Catch Freq.	Per Mille	Catch Freq.
cm									
18-20									
21-23	1	1							1
24-26	4	3					1	-	5
27-29	3	3	1	1	8	-	7	2	19
30-32	17	11	9	5	42	4	30	9	98
33-35	48	30	36	18	148	15	130	39	362
36-38	65	40	58	29	293	29	293	89	709
39-41	88	52	135	68	622	61	447	140	1292
42-44	200	117	193	98	1023	100	533	170	1949
45-47	194	113	279	141	1433	141	584	187	2490
48-50	235	132	317	160	1749	171	514	164	2815
51-53	270	151	247	125	1574	155	299	95	2390
54-56	187	105	200	101	1248	124	184	57	1819
57-59	149	81	173	87	795	78	86	25	1203
60-62	105	55	110	56	518	53	42	12	775
63-65	61	34	87	44	325	32	15	4	488
66-68	50	27	57	29	154	15	8	2	269
69-71	33	15	33	17	96	9	8	2	170
72-74	24	11	21	11	46	5	3	1	94
75-77	19	9	10	5	37	4	1	-	67
78-80	6	3	7	4	12	1			25
81-83	13	7	4	2	13	1			30
84-86					7	1	2	1	9
87-89					3				3
90-92			1	1	2				3
93-95									
96-98			1	1	2				3
99-101					3				3
102-104									
105-107					1				1
TOTAL	1772	1000	1979	1003	10154	999	3187	999	17092
Average length(cm)	51.4		51.2		50.6		45.5		

Table 4. Average length and average opercular and maximum girths of cod from each section of the trap end for each mesh size used.

Mesh size (mm)	Stretched mesh circumference (mm)	Pound	Meshed	Trap
			Ave. length (cm)	
84	168	36.8	44.7	52.3
89	178	44.2	40.3	52.9
103	206	43.4	46.4	53.9
128	256	44.5	55.8	59.2
			Ave. opercular girth (mm)	
84		176.4	218.2	258.4
89		215.5	194.9	261.6
103		211.3	227.2	266.8
128		217.1	276.9	294.9
			Ave. maximum girth (mm)	
84		190.7	235.7	278.9
89		232.8	210.7	282.4
103		228.3	245.4	288.0
128		234.6	298.8	318.2

Table 5. Total daily catch (lb) by the experimental trap along with surface and bottom temperatures for the corresponding days.

Date	Total Catch	Temp. °C Surface	Bottom
June 23	10.5	5.2	
25	10.5	6.9	
27	243.0	10.0	0.5
28	0.0	9.9	0.1
29	0.0	9.3	5.4
30	1.0	9.9	4.6
July 2	295.0	10.5	0.8
3	7.0	9.7	0.0
4	760.5	7.5	2.4
5	301.0	8.0	5.1
6	591.0	9.5	0.5
7	0.0	8.7	8.2
9	3,046.0	8.5	2.9
10	199.0	5.6	2.0
11	4.5	9.3	7.0
12	18.0	9.0	5.0
13	1,784.5	9.0	1.6
14	21.8	9.1	1.0
16	1,175.0	10.1	5.5
17	377.0	9.8	1.0
18	1,429.0	6.0	0.7
19	42.0	2.9	1.4
20	509.0	3.5	2.0
21	911.0	8.7	2.9
23	106.0	11.0	1.1
25	5.5	10.8	8.3
26	3,204.0	9.5	1.5
27	7,884.0	9.7	3.6
28	2,820.0	11.6	6.3
30	4,450.0	10.6	6.9
31	801.5	13.1	9.0
Aug. 1	7,470.0	13.2	5.5
2	1,755.0	12.6	10.0
3	0.0	14.1	6.9
6	570.0	15.2	6.0
7	5,524.0	14.9	4.5
8	4.0	15.3	
9	206.0	14.3	4.5
10	44.0	12.3	9.0
TOTAL	46,580.0		

Table 6. Mesh selection values by length and age.

Length	Age	84 mm	89 mm	103 mm	114 mm[a]	128 mm	130 mm[a]
27-29		.00					
30-32	2.6	.29	.00				
33-35	2.9	.54	.08	.00			
36-38	3.2	.88	.53	.02	.00		
39-41	3.6	.97	.83	.10	.03	.002	.00
42-44	3.9	.95	.85	.41	.10	.004	.03
45-47	4.3	.98	.89	.71	.35	.010	.07
48-50	4.7	.99	.90	.87	.61	.040	.19
51-53	5.1	.99	.91	.91	.81	.110	.30
54-56	5.5	1.00	.92	.92	.96	.330	.41
57-59	5.9		.95	.95	.96	.710	.52
60-62	6.3		.97	.95	1.00	.880	.60
63-65	6.8		.98	.96	.98	1.000	.63
66-68	7.3		1.00	.99	.97		.61
69-71	7.8			1.00	1.00		.74
72-74	8.4						.65
75-77	8.9						.74
78-80	9.5						.79
81-83	10.1						.74
84-86	10.8						.92
87-89	11.5						1.00
L_{50}		33.70	36.70	45.00	48.00	56.400	57.00

[a]from Boulanger 1960, 1961.

Table 7. Growth data obtained using a Von Bertalanffy analysis of age-length data from the 1978 commercial fishery in 2J3KL.

AGE	LENGTH
0.0	3.94
1.0	15.29
2.0	25.64
3.0	35.07
4.0	43.67
5.0	51.52
6.0	58.67
7.0	65.19
8.0	71.13
9.0	76.56
10.0	81.50
11.0	86.01
12.0	90.12
13.0	93.86
14.0	97.28
15.0	100.40
16.0	103.24
17.0	105.83
18.0	108.19
19.0	110.34
20.0	112.30
21.0	114.10
22.0	115.73
23.0	117.22
24.0	118.57
25.0	119.81
26.0	120.94
27.0	121.97
28.0	122.91
29.0	123.76
30.0	124.54

ESTIMATE OF T%0< # -0.326651

FINAL ESTIMATE OF K # 0.09233606

ESTIMATE OF L%INF< # 132.601761

CONFIDENCE LIMITS FOR T # 1.960000

VARIABLE	STANDARD ERROR	T X S.E.	LOWER LIMIT	UPPER LIMIT
K	0.018655	0.036564	0.055772	0.128900
T%0<	0.664997	1.303393	-1.630044	0.976742
L%INF<	9.880707	19.366180	113.235580	151.967941

Table 8. Percent selection (25, 50, 75) obtained by the Maximum Likelihood method with the associated parameters.

	MESH SIZE (mm)					
	84	89	103	128	114	130
50% selection length in (cm)	33.3	37.2	44.2	56.43	48	57
Variance	.245	.092	.007	.071		
STD. Dev.	.495	.304	.084	.266		
25% sel. l.	31.2	35.3	41.7	53.9	45	51
75% sel. l.	35.5	39.0	46.7	58.9	51	73
Chi-square	.752	1.757	26.247	1.969		
D.F..	2	2	3	4		

Table 9. Selection factors for each experimental mesh size used along with estimates obtained by Boulanger (1960, 61).

Measured mesh (mm)	$L_{50\%}$ (mm)	Girth (mm)	Girth/mesh	Selection factor
84	33.3	157.9	1.88	4.0
89	37.2	178.5	2.01	4.2
103	44.2	215.5	2.09	4.3
128	56.4	280.1	2.19	4.4
		(From Boulanger)		
114	48.0			4.2
130	57.0			4.4

Table 10. Nfld. cod trap survey 1977 mesh size (inches) in the back or 'drying twine' area.

	Newfoundland Fisheries Statistical Areas						
	A	B	C	D	E	F	G
	3K		3L				
Mean	3.5	3.5	3.5	3.5	3.5	3.3	3.4
Min	1.5	1.0	2.2	2.5	2.5	2.0	3.0
Max	4.5	4.0	4.0	4.0	4.5	3.8	3.5
Mode	3.5	3.5	3.5	3.5	3.5	3.2	3.5
# Meas.	123	175	69	170	86	97	33

Table 11. Numbers (X 10^{-3}) at age from the commercial cod fishery in 2J3KL in 1978.

Age	OT	Trap	GN	LT	HL	Can(N) total	Total all countries
3	32	721	5	40	33	831	1170
4	1305	8533	96	695	905	11534	16925
5	4716	16615	767	1492	2143	25733	39649
6	3392	6103	1780	896	1500	13671	21250
7	1058	1364	2154	431	759	5766	8289
8	425	249	1105	200	244	2223	3236
9	157	101	624	130	107	1119	1504
10	129	65	429	69	67	759	1053
11	66	17	140	41	28	292	424
12	24	7	88	24	17	160	216
13	15	7	44	12	11	89	115
14	11	2	40	2	1	56	66
15	5	4	19	4	3	35	40
16	5		13			18	
17			4	2	1	7	
18	1	1	3	2		7	59
19			1		1	2	
20	4		1		1	6	
>20	4		4			8	
#	11349	33789	7317	4040	5821	62316	93996
landings (MT)	18670	36698	23137	9064	10788	98357	136010

Table 12. Catch (X 10^{-5}) at age by cod trap in 2J3KL in 1978 with the conventional 89 mm mesh along with the predicted catches by other mesh sizes given the ratio of selection patterns shown.

Age	Trap Catch 1978 in 2J3KL	Ave. Wts.	84mm Select 89mm	Catch 84mm	103mm Select 89mm	Catch 103mm	114mm Select 89 mm	Catch 114mm	128mm Select 89mm	Catch 128mm	130mm Select 89mm	Catch 130mm
3	7.21	.44	4.643	33.48	.071	.51						
4	85.33	.70	1.126	96.08	.575	49.06	.280	23.89			.046	3.93
5	166.15	.99	1.088	181.77	.989	164.32	.844	140.23	.099	16.45	.319	53.00
6	61.03	1.59	1.053	64.26	1.000	61.03	1.032	62.98	.800	48.82	.568	34.66
7	13.64	2.53	1.010	13.78	1.000	13.64	1.010	13.78	1.010	13.78	.646	8.81
8	2.49	3.40	1.000	2.49	1.000	2.49	1.000	2.49	1.000	2.49	.690	1.72
9	1.01	4.26	1.000	1.01	1.000	1.01	1.000	1.01	1.000	1.01	.730	.74
10	.65	4.75	1.000	.65	1.000	.65	1.000	.65	1.000	.65	.800	.52
11	.17	5.51	1.000	.17	1.000	.17	1.000	.17	1.000	.17	.940	.16
12	.07	7.32	1.000	.07	1.000	.07	1.000	.07	1.000	.07	1.000	.07
13	.07	8.25	1.000	.07	1.000	.07	1.000	.07	1.000	.07	1.000	.07
14	.02	8.43	1.000	.02	1.000	.02	1.000	.02	1.000	.02	1.000	.02
Calc. Wt. 376.99 (MT X 10^{-2})				417.03		346.84		308.60		146.82		146.23
Wt. Diff. from 1978 catch				+37.04		-30.15		-68.39		-230.17		230.76
% diff.				+9.8		-8.0		-18.1		-61.0		-61.2
% of total reported catch for 2J3KL in 1978				3		-2		-5		-11		-11
% of total Can N catch in 2J3KL in 1978				4		-3		-7		-23		-23

Table 13. Population and catch numbers ($X\ 10^{-5}$) at age data for 2J3KL cod in 1978 with estimates of fishing mortality (F) and partial selection (P.S.) assuming that a 4.0" had been used.

Age	Population 1978	Trap catch	Other inshore gears	Offshore gears	Total	Total F	P.S.	$F_{0.1}$
3	(4900)	.51	.78	3.71	5.00	.0011	.004	
4	5132	49.04	16.96	66.96	132.96	.0290	.10	.02
5	3602	164.32	44.02	186.32	394.66	.1286	.46	.08
6	1293	61.03	41.76	109.71	212.50	.1993	.71	.13
7	423	13.64	33.44	35.81	82.89	.2425	.87	.16
8	155	2.49	15.49	14.38	32.36	.2605	.93	.17
9	73	1.01	8.61	5.42	15.04	.2566	.92	.17
10	51	.65	5.65	4.23	10.53	.2573	.92	.17
11	19	.17	2.09	1.98	4.24	.2811	1.00	.18
12	9	.07	1.29	.80	2.16	.3058	1.00	.18
13	5	.07	.67	.41	1.15	.2911	1.00	.18
14	3	.02	.43	.21	.66	.2766	1.00	.18

Table 14. Population numbers ($X\ 10^{-5}$) at age of 2J3KL cod in 1978 with predicted catch by a103mm mesh.

Age	Trap catch 1978	Trap catch if 103mm mesh used	No.'s escaping ($X\ 10^{-3}$)	Pop^N at Jan. 1, 1979
3	7.21	.51	670	
4	85.33	49.04	3629	616
5	166.15	164.32	183	3299
6	61.03	61.03		160
7	13.64	13.64		
8	2.49	2.49		
9	1.01	1.01		
10	.65	.65		
11	.17	.17		
12	.07	.07		
13	.07	.07		
14	.02	.02		

Table 15. Total catch at age (numbers X 10^{-3}) by all gears from the 'population' of fish that might have escaped if a 103mm mesh had been used in 1978.

Age	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Total	Average wt.
4	9																9	.70
5	240	35															275	.99
6	17	273	40														330	1.59
7		15	238	35													288	2.53
8			11	177	26												214	3.40
9				7	121	18											146	4.26
10					5	84	12										101	4.75
11						4	63	9									76	5.51
12							2	43	6								51	7.32
13								1	29	4							34	8.25
14									1	20	3						24	8.43
15											13	2					15	8.21
16												9	1				10	11.93
17													6				6	11.61
18														4			4	9.33
19															3		3	10.57
20																2	2	16.12
#																	1588	
Wt. (MT)																	5049	

Table 16. Predicted catch (numbers X 10^{-3}) by trap and handline (HL) of the total catch shown in Table 15.

Age	Ratio of trap catch to total catch	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Total
4	.504	5																5
5	.419	101	15															116
6	.287	5	78	11														94
7	.165		2	39	6													47
8	.077			1	14	2												17
9	.067					8	1											9
10	.062						5	1										6
11	.040							3										3
12	.032								1									1
13	.061									2								2
14	.030										1							1
15	.100																	1
16																		
17																		
18	.017																	
19																		
20																		
#																		302
Wt. (MT)																		568

Age	Ratio of HL catch to total catch	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Total
4	.053																	
5	.054	13	2															15
6	.071	1	19	3														23
7	.092		1	22	3													26
8	.075			1	13	2												16
9	.071					9	1											10
10	.064						5	1										6
11	.066							4	1									5
12	.079								3									3
13	.096									3								3
14	.015																	
15	.015											1						1
16																		
17																		
18	.051																	
19																		
20																		
#																		108
Wt. (MT)																		325

Table 17. Predicted catch (numbers X 10^{-3}) by otter trawl (OT) and line trawl (LT) of the total catch shown in Table 15.

Age	Ratio of OT catch to total catch	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Total
4	.396	4																4
5	.470	113	16															129
6	.516	9	141	21														171
7	.432		6	103	15													124
8	.444			5	79	12												96
9	.360				3	44	6											53
10	.402					2	34	5										41
11	.467						2	29	4									35
12	.370							1	16	2								19
13	.357									10	1							11
14	.318										6	1						7
15	.250											3						3
16													4					4
17														3				3
18	.424														2			2
19																1		1
20																	1	1
#																		704
Wt. (MT)																		2097

Age	Ratio of LT catch to total catch																	
4	.041																	
5	.038	9	1															10
6	.042	1	11	2														14
7	.052		1	12	2													15
8	.062			1	11	2												14
9	.086				1	10	2											13
10	.066						6	1										7
11	.097							6	1									7
12	.111								5	1								6
13	.104									3								3
14	.030										1							1
15	.100											1						1
16													1					1
17																		
18	.068																	
19																		
20																		
#																		92
Wt. (MT)																		342

Table 18. Predicted catch (numbers X 10^{-3}) by gillnet (GN) of the total catch shown in Table 15.

Age	Ratio of GN catch to total catch	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Total
4	.006																	
5	.019	5	1															6
6	.084	1	23	3														27
7	.260		4	62	9													75
8	.341			4	60	9												73
9	.415				3	50	7											60
10	.407					2	34	5										41
11	.330						1	21	3									25
12	.407							1	18	2								21
13	.383									11	2							13
14	.606									1	12	2						15
15	.475											6	1					7
16													4					4
17														3				3
18	.441														2			2
19																1		1
20																	1	1
#																		374
Wt. (MT)																		1612

Table 19. Predicted immediate and long-term loss or gain in cod catch (MT) in 2J3KL by gear if a 103mm mesh had been used in 1978.

	OT	Trap	GN	LT	HL	Total
Immediate loss	0	3,015	0	0	0	3,015
% of total (1978) catch		8				2
Long-term gain	2,097	568	1,612	330	325	4,932
Total 1978 catch	56,323	36,698	23,137	9064	10,788	136,010
% long-term gain	4	2	7	4	3	4
Overall loss or gain	+2,097	-2,447	+1,612	+330	+325	+1,917
%	4	-7	7	4	3	1.4

Table 20. Predicted immediate and long-term loss or gain in cod catch (MT) by gear in 2J3KL if a 114mm mesh had been used in 1978.

	OT	Trap	GN	LT	HL	Total
Immediate loss	0	6,839	0	0	0	6,839
% of total (1978) catch		19				5
Long-term gain	4,765	1,230	3,810	790	861	11,456
Total 1978 catch	56,323	36,698	23,137	9064	10,788	136,010
% long-term gain	8	3	16	9	8	8
Overall loss or gain	+4,765	-5,609	+3,810	+790	+861	+4,617
%	8	-15	16	9	8	3

Table 21. Predicted immediate and long-term loss or gain in cod catch (MT) in 2J3KL by gear if a 128mm mesh had been used in 1978.

	OT	Trap	GN	LT	HL	Total
Immediate loss	0	23,017	0	0	0	23,017
% of total (1978) catch		61				
Long-term gain	14,205	3,329	11,961	2445	2,478	34,418
Total 1978 catch	56,323	36,698	23,137	9064	10,788	136,010
% long-term gain	25	11	52	27	23	25
Overall loss or gain	+14,205	-19,688	+11,961	+2445	+2,478	+11,401
%	25	-54	52	27	23	8

Table 22. Predicted immediate and long-term loss or gain in cod catch (MT) in 2J3KL by gear if a 130mm mesh had been used in 1978.

	OT	Trap	GN	LT	HL	Total
Immediate loss	0	23,076	0	0	0	23,076
% of total (1978) catch		61				
Long-term gain	13,321	3,005	11,405	2331	2,283	32,345
Total 1978 catch	56,323	36,698	23,137	9064	10,788	136,010
% long-term gain	24	8	49	26	21	24
Overall loss or gain	+13,321	-20,071	+11,405	+2331	+2,283	+9,269
%	24	-55	49	26	21	7

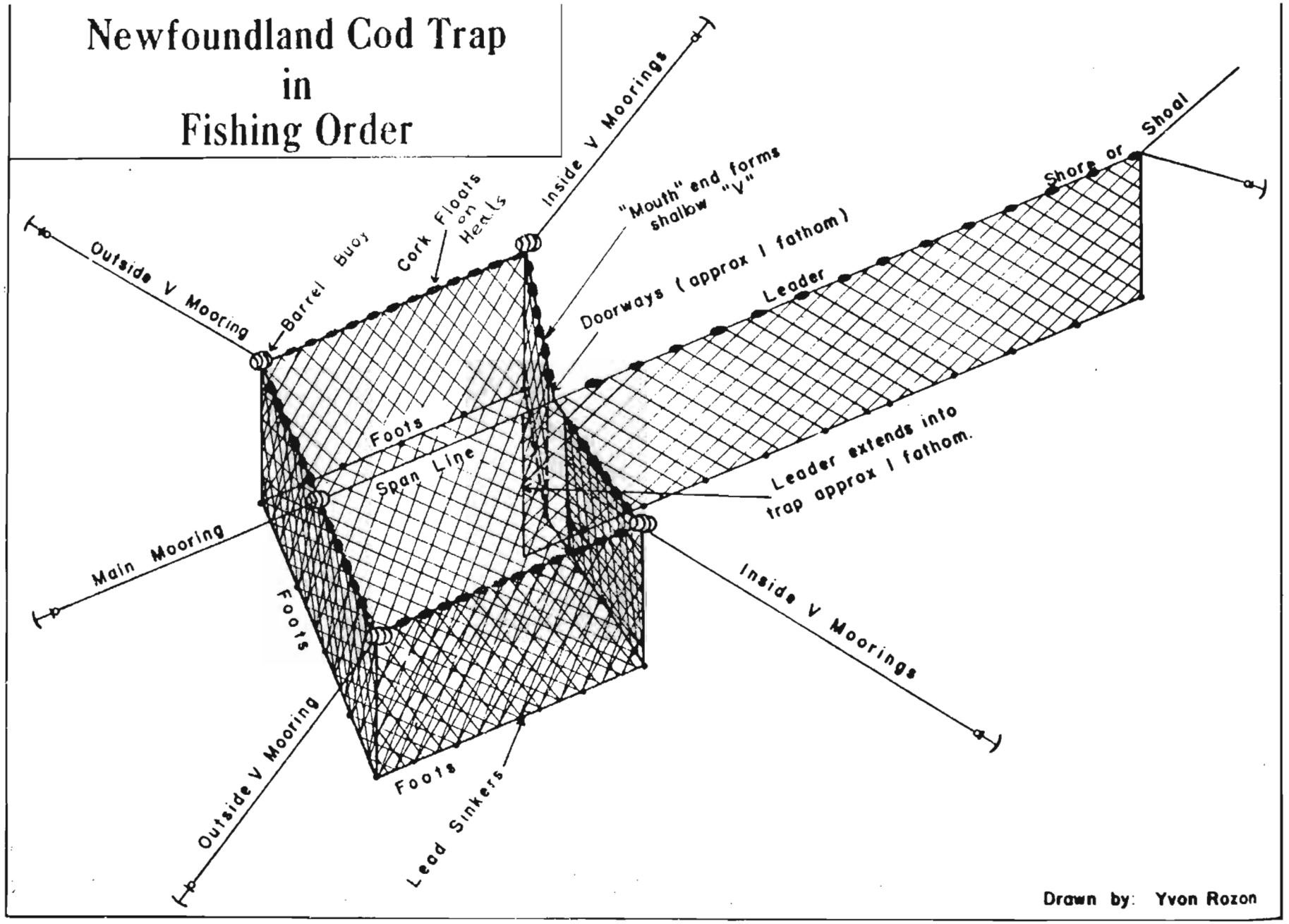

Fig. 1. Diagram of the traditional Newfoundland cod.trap. From Department of Fisheries, Trade News, Dec. 1956.

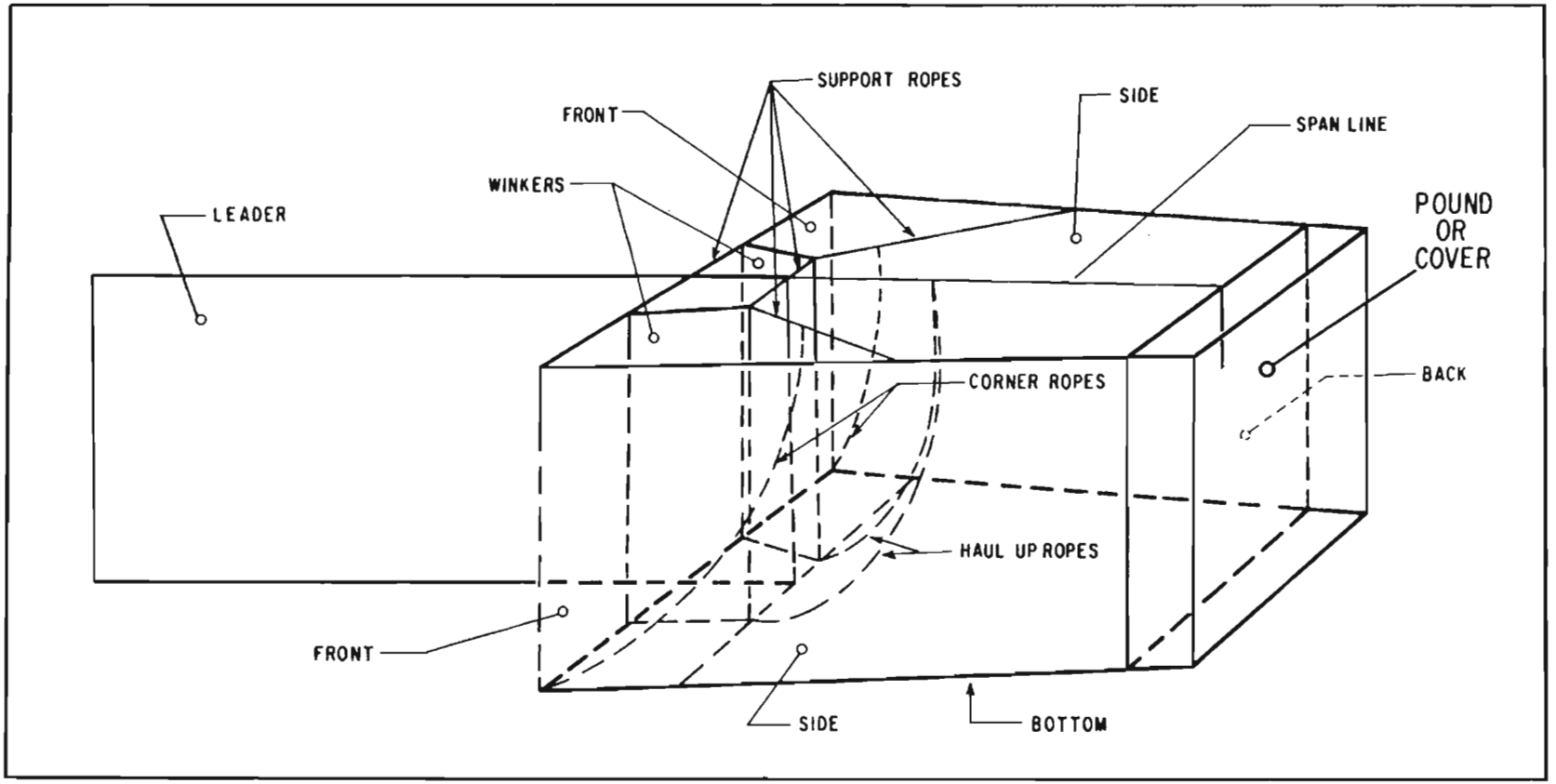

Fig. 2. Diagram of experimental trap indicating the additional pound or cover section.

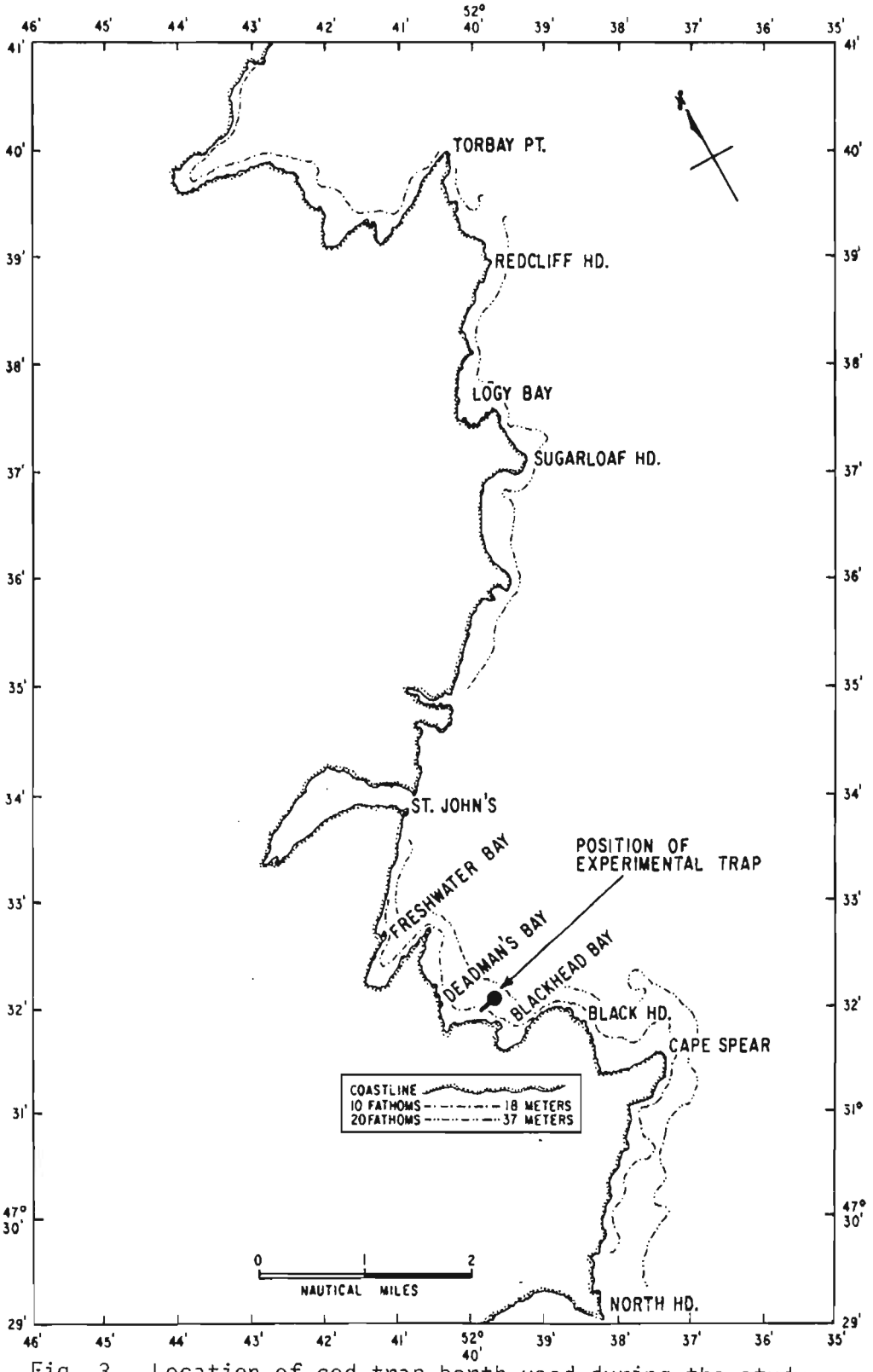

Fig. 3. Location of cod trap berth used during the study.

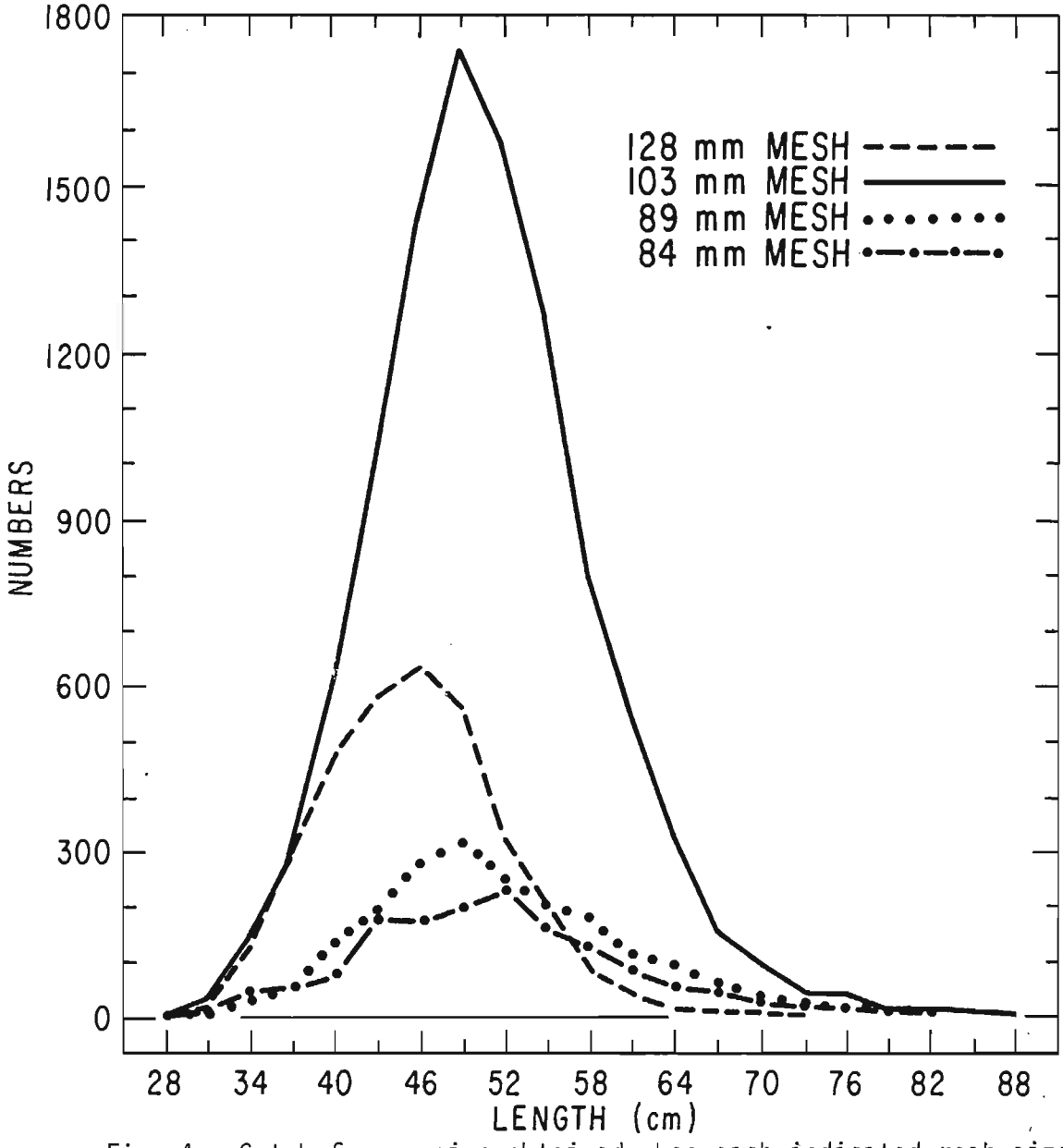

Fig. 4. Catch frequencies obtained when each indicated mesh sized back was used.

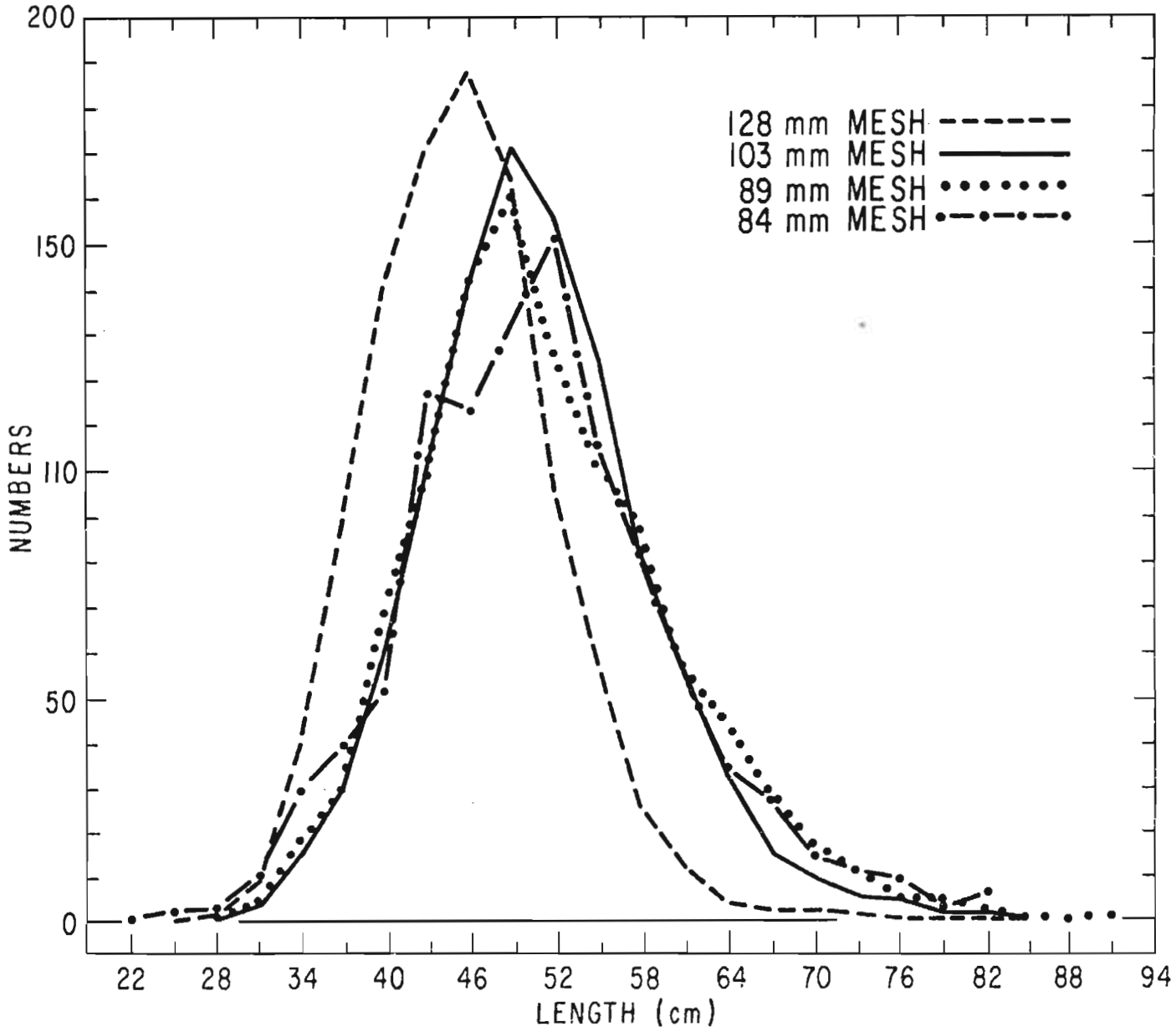

Fig. 5. Per mille catch frequencies obtained when each indicated mesh sized back was used.

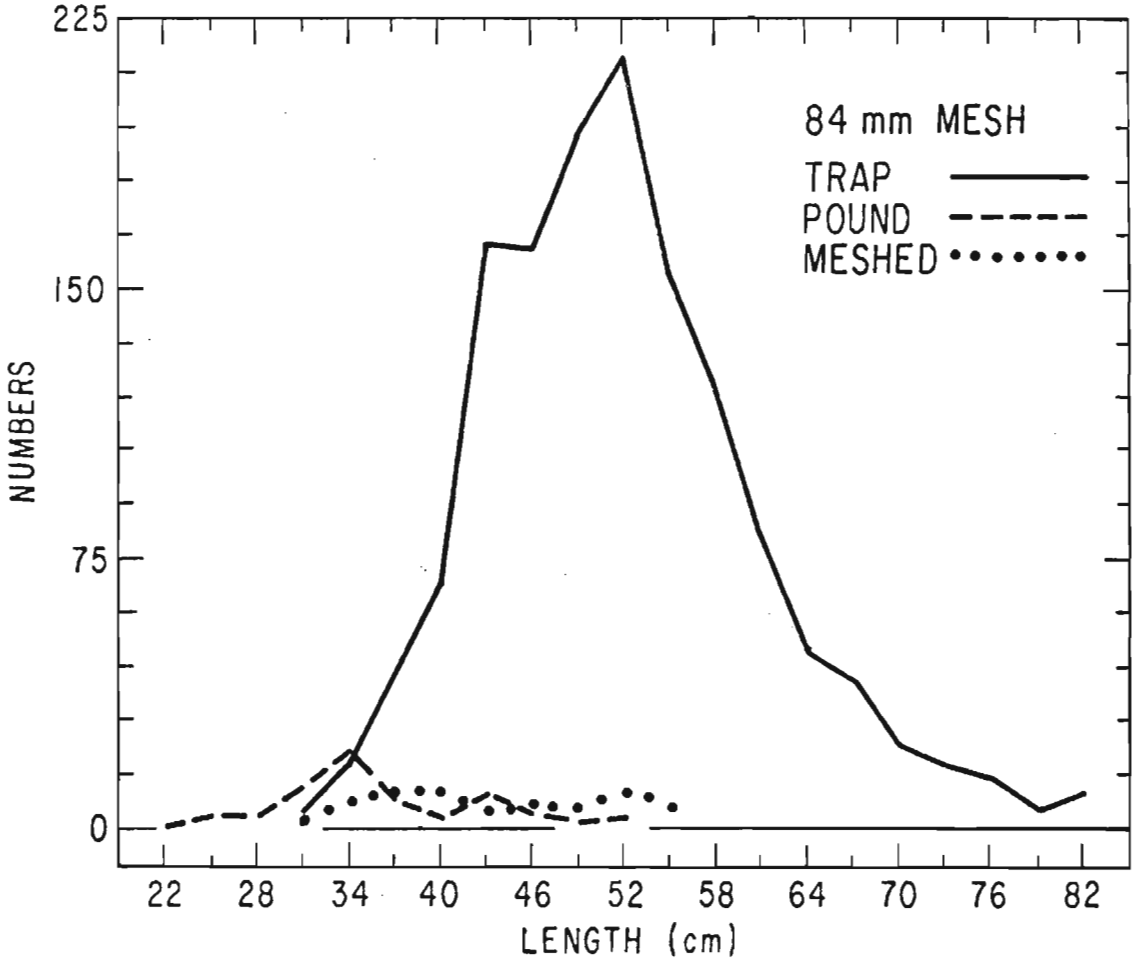

Fig. 6. Length frequencies of catch by each section of the trap when a 84 mm mesh back was used.

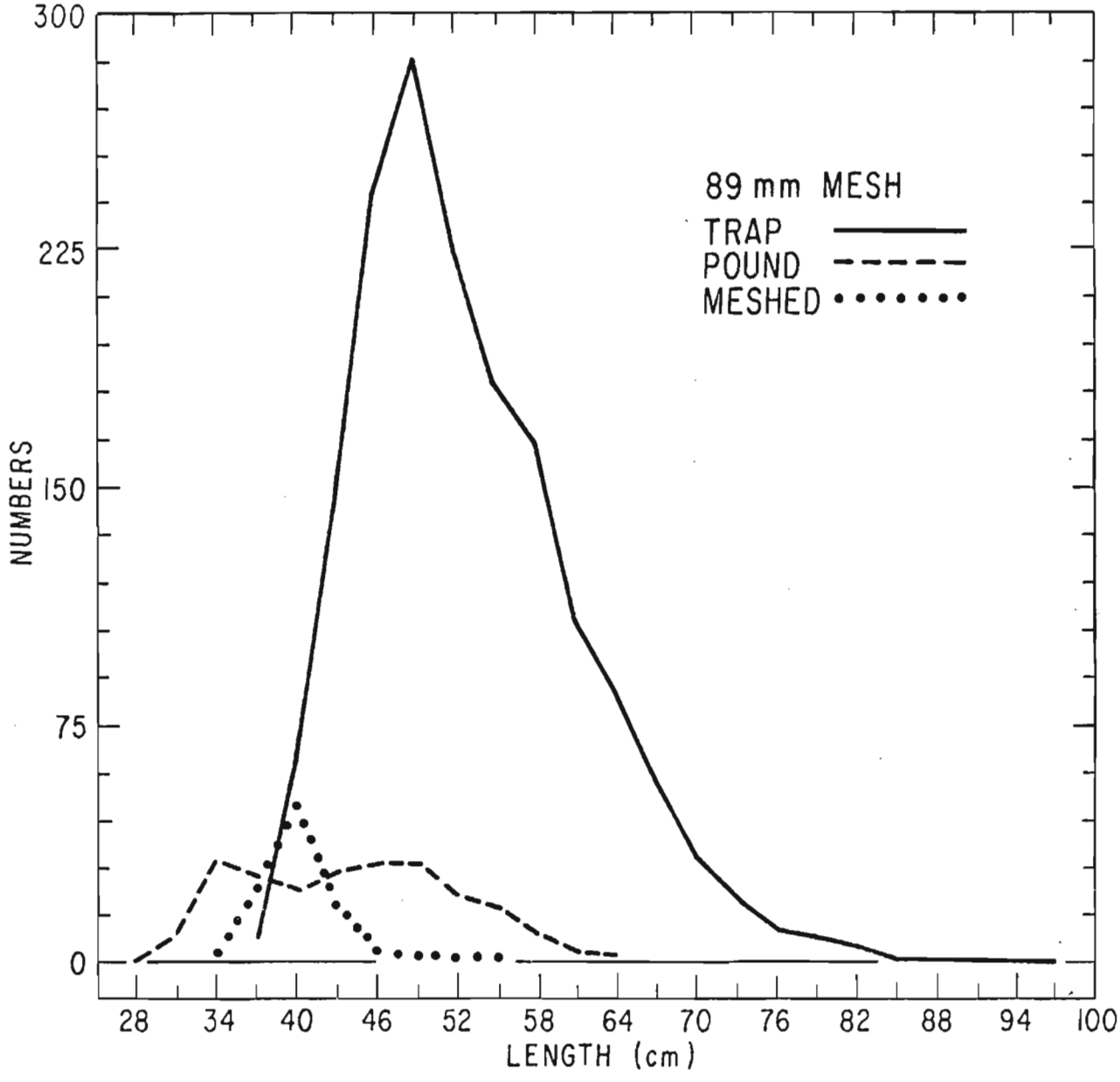

Fig. 7. Length frequencies of catch by each section of the trap when a 89 mm mesh back was used.

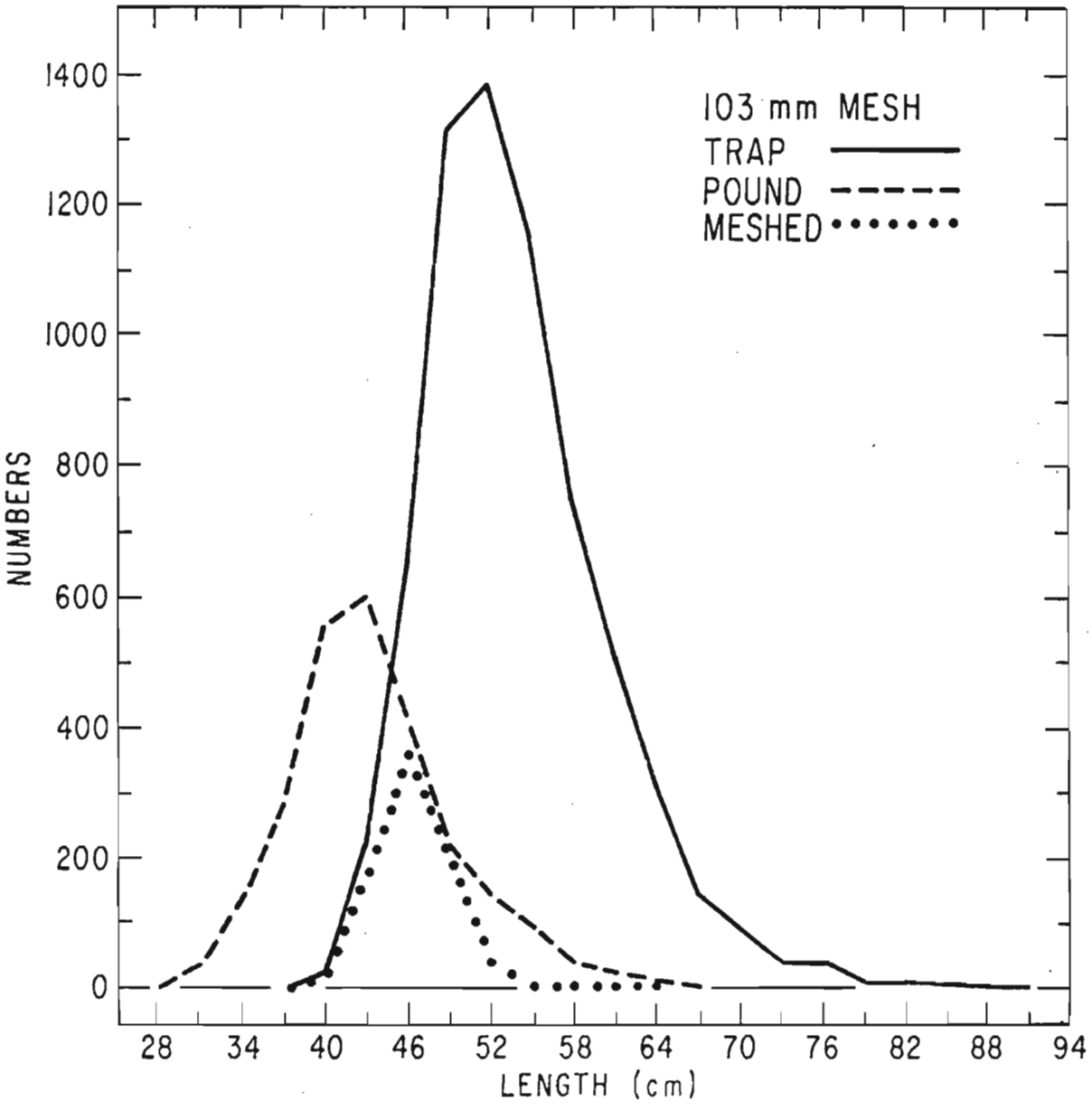

Fig. 8. Length frequencies of catch by each section of the trap when a 103 mm mesh back was used.

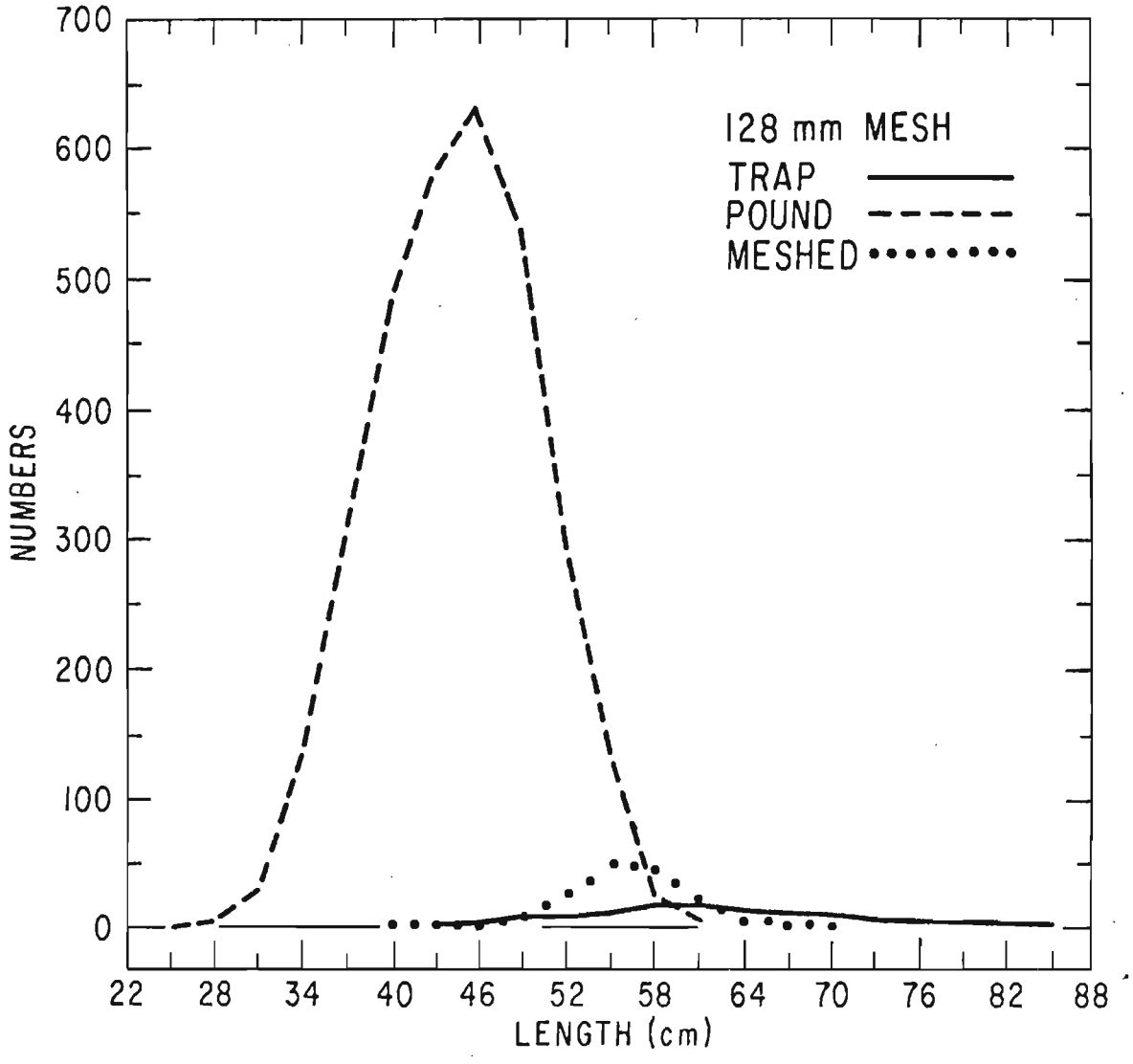

Fig. 9. Length frequencies of catch by each section of the trap when a 128 mm mesh back was used.

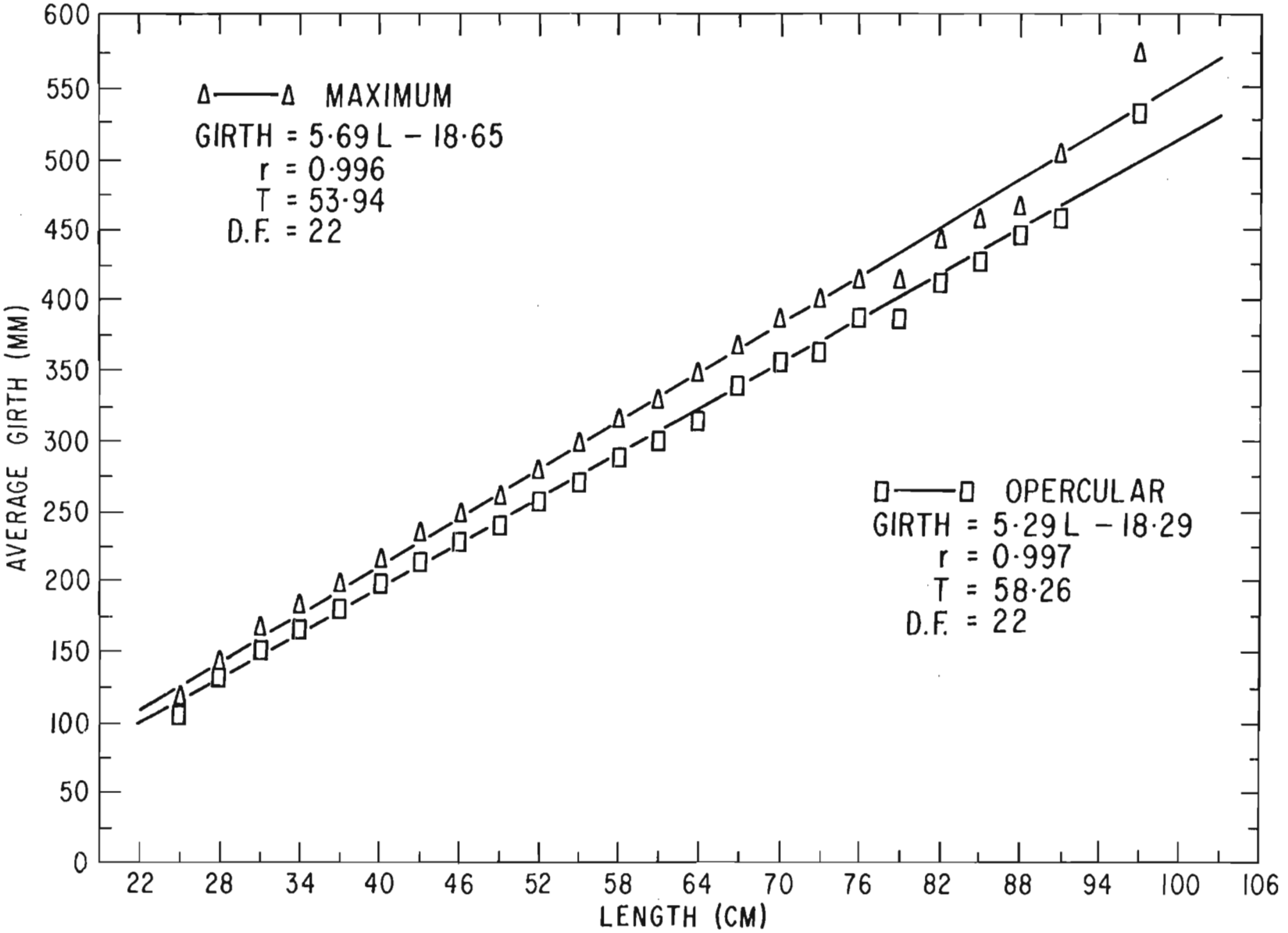

Fig. 10. Relationship of average girth at length to length from a total of 1587 measurements over the entire experimental period and from all parts of trap that were sampled.

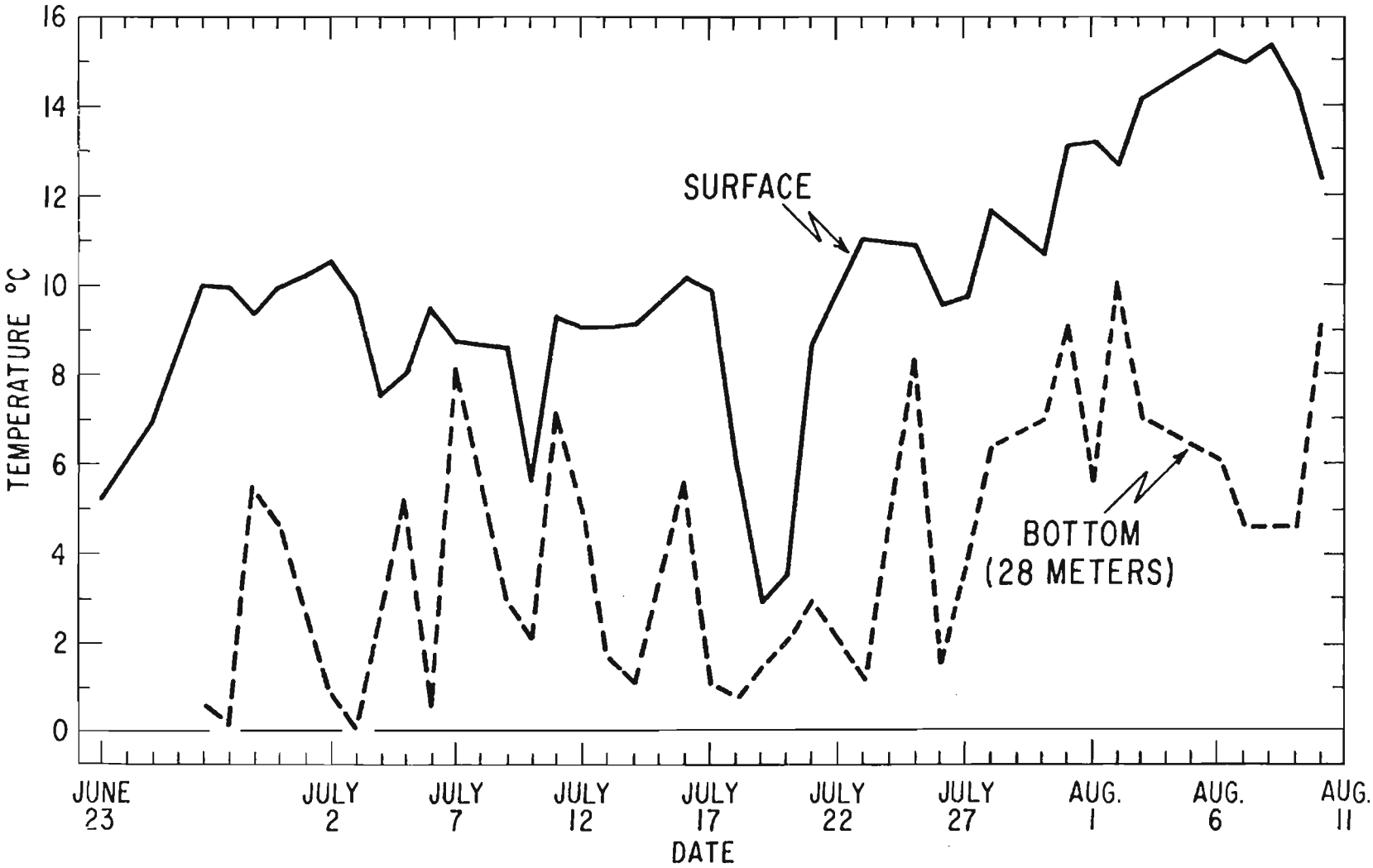

Fig. 11. Temperatures obtained at the surface and bottom by day over the experimental period.

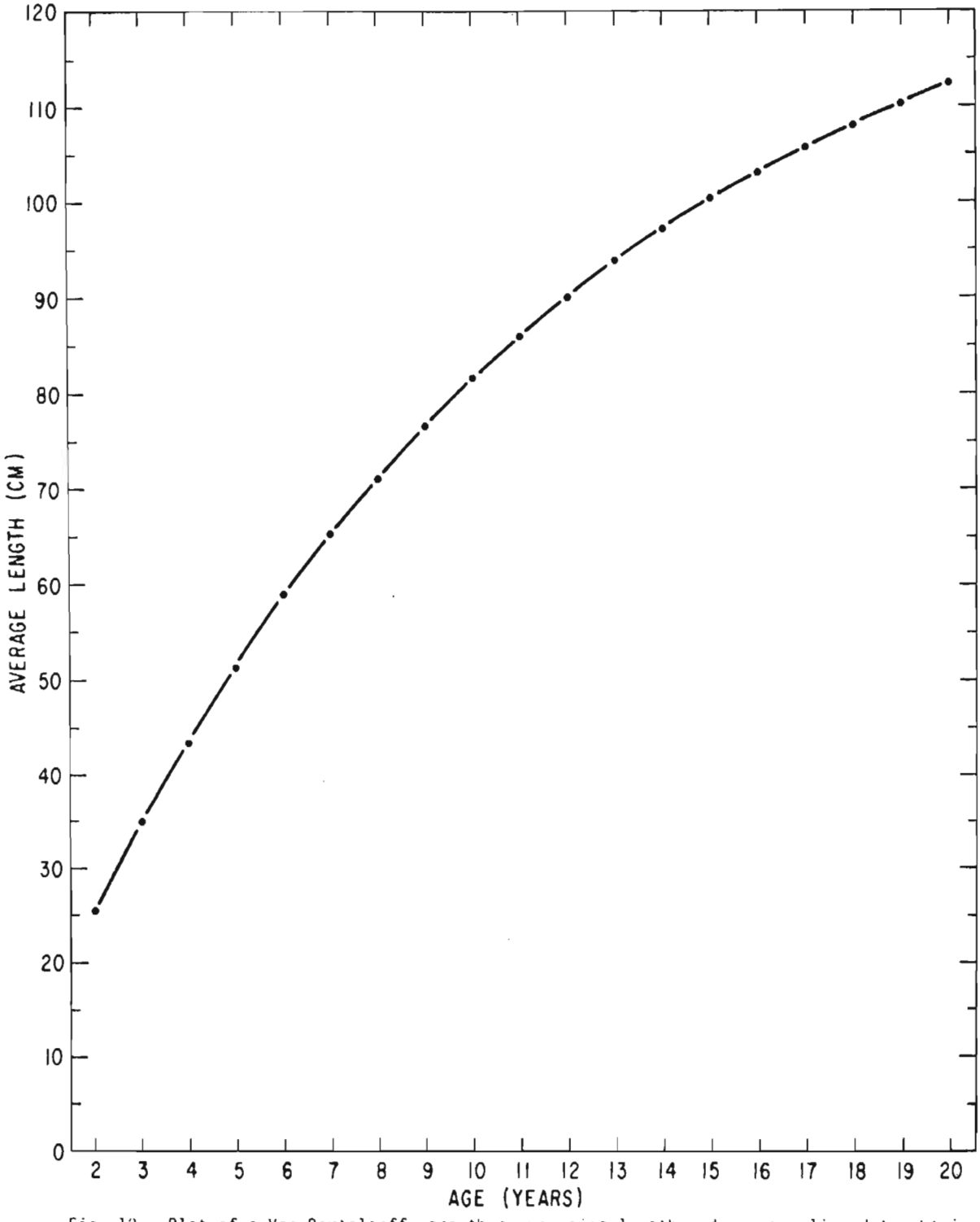

Fig. 12. Plot of a Von Bertalanffy growth curve using length and age sampling data obtained over the experimental period.

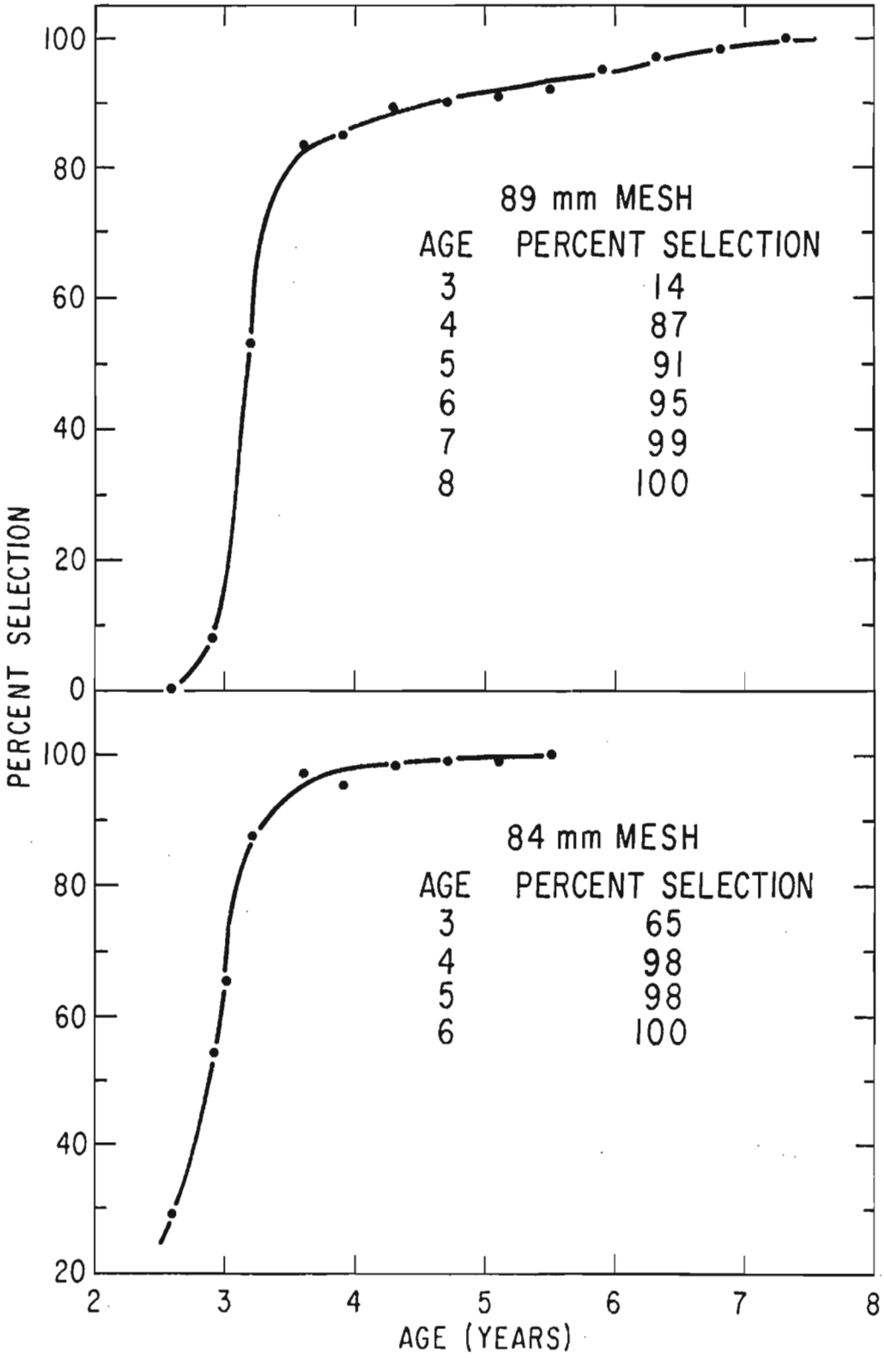

Fig. 13. Percent mesh selection at age by the 89 and 84 mm mesh backs.

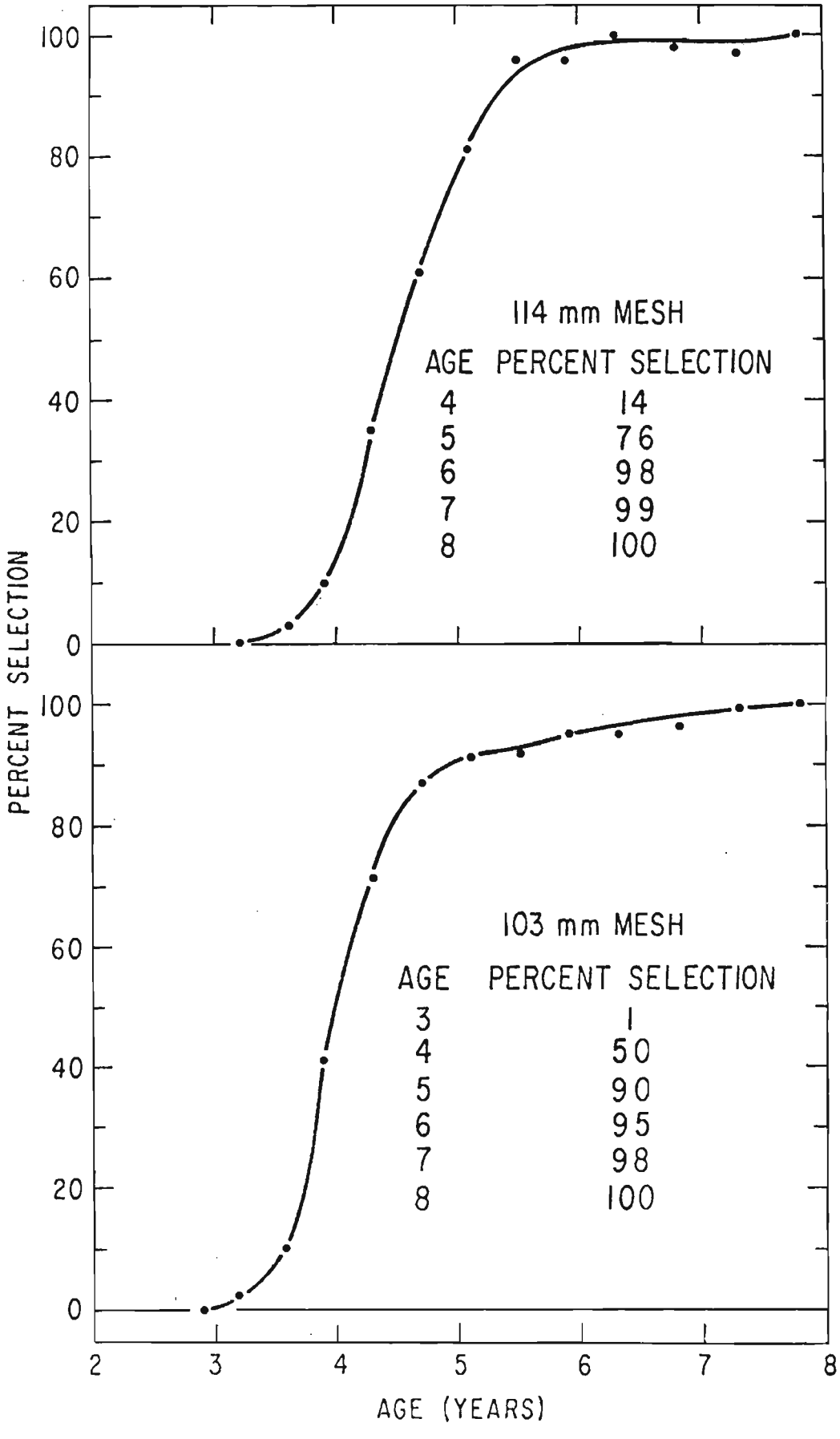

Fig. 14. Percent mesh selection at age by the 103 and 114 mm mesh backs.

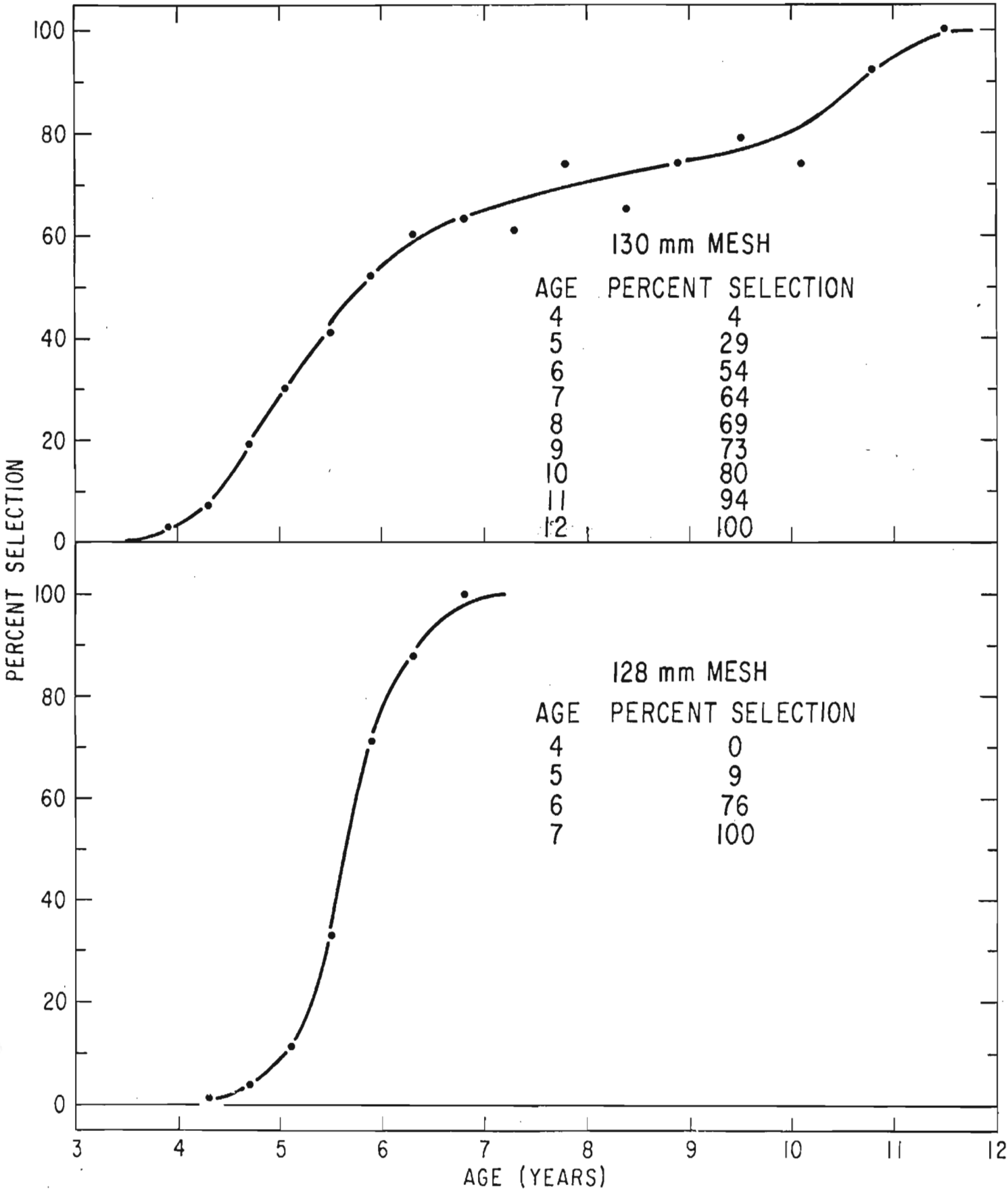

Fig. 15. Percent mesh selection at age by the 128 and 130 mm mesh backs.

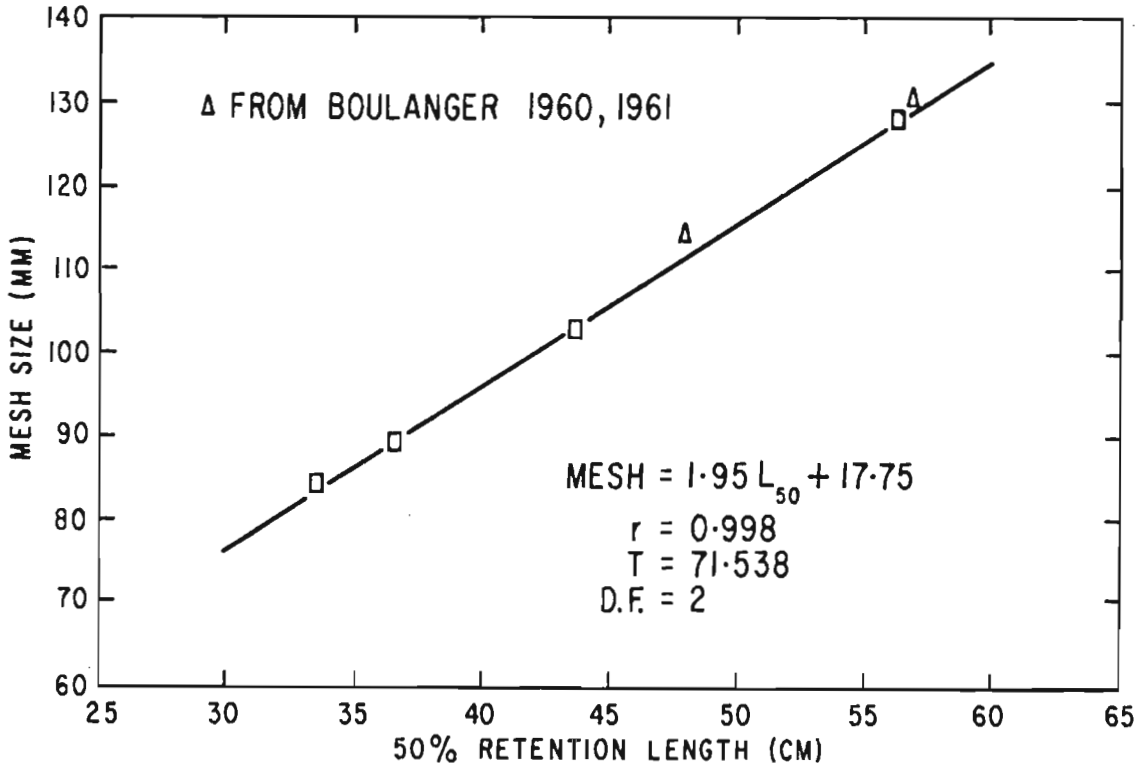

Fig. 16. Relationship of mesh size of the back of the cod trap with its 50% retention length from the experimental study along with similar data obtained in studies by Boulanger (Regression values apply to data from the present study only).

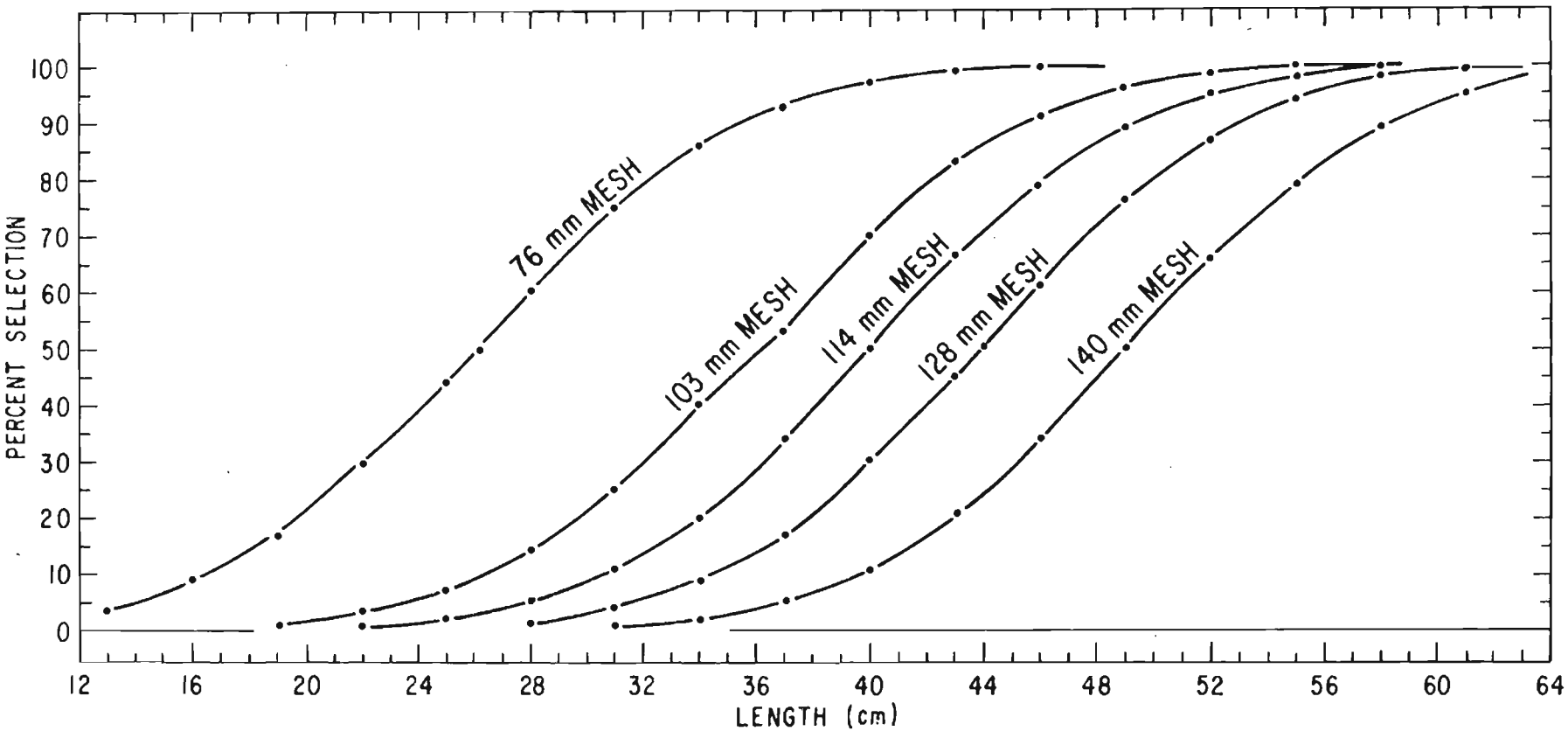

Fig. 17. Length selections curves from experimental studies with otter trawl (from Hodder 1964).

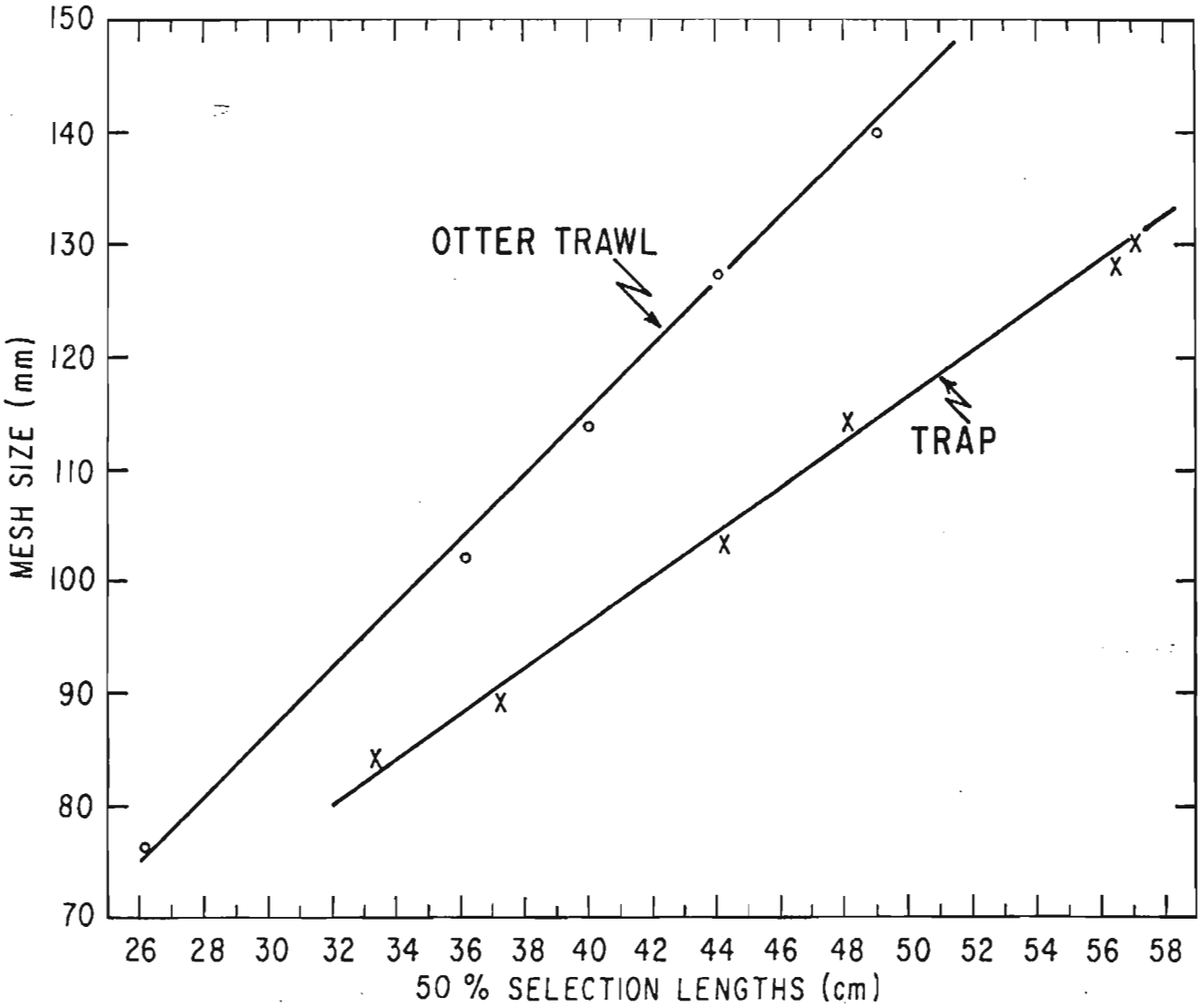

Fig. 18. Comparison of 50% selection lengths with mesh size for cod trap from the present study and that of Boulanger and otter trawl from studies by Hodder (1964).

APPENDIX 1: CONVERSION TABLES

Pounds to kilograms (1 lb = 0.453 592 kg)
Livres en kilogrammes

Pounds *Livres*	0	1	2	3	4	5	6	7	8	9
	kilograms — *kilogrammes* (kg)									
0	—	0.45	0.91	1.36	1.81	2.27	2.72	3.18	3.63	4.08
10	4.54	4.99	5.44	5.90	6.35	6.80	7.26	7.71	8.16	8.62
20	9.07	9.53	9.98	10.43	10.89	11.34	11.79	12.25	12.70	13.15
30	13.61	14.06	14.52	14.97	15.42	15.88	16.33	16.78	17.24	17.69
40	18.14	18.60	19.05	19.50	19.96	20.41	20.87	21.32	21.77	22.23
50	22.68	23.13	23.59	24.04	24.49	24.95	25.40	25.85	26.31	26.76
60	27.22	27.67	28.12	28.58	29.03	29.48	29.94	30.39	30.84	31.30
70	31.75	32.21	32.66	33.11	33.57	34.02	34.47	34.93	35.38	35.83
80	36.29	36.74	37.19	37.65	38.10	38.56	39.01	39.46	39.92	40.37
90	40.82	41.28	41.73	42.18	42.64	43.09	43.54	44.00	44.45	44.91
100	45.36	45.81	46.27	46.72	47.17	47.63	48.08	48.53	48.99	49.44
110	49.90	50.35	50.80	51.26	51.71	52.16	52.62	53.07	53.52	53.98
120	54.43	54.88	55.34	55.79	56.25	56.70	57.15	57.61	58.06	58.51
130	58.97	59.42	59.87	60.33	60.78	61.24	61.69	62.14	62.60	63.05
140	63.50	63.96	64.41	64.86	65.32	65.77	66.22	66.68	67.13	67.59
150	68.04	68.49	68.95	69.40	69.85	70.31	70.76	71.21	71.67	72.12
160	72.57	73.03	73.48	73.94	74.39	74.84	75.30	75.75	76.20	76.66
170	77.11	77.56	78.02	78.47	78.93	79.38	79.83	80.29	80.74	81.19
180	81.65	82.10	82.55	83.01	83.46	83.91	84.37	84.82	85.28	85.73
190	86.18	86.64	87.09	87.54	88.00	88.45	88.90	89.36	89.81	90.26
200	90.72	91.17	91.63	92.08	92.53	92.99	93.44	93.89	94.35	94.80
210	95.25	95.71	96.16	96.62	97.07	97.52	97.98	98.43	98.88	99.34
220	99.79	100.24	100.70	101.15	101.61	102.06	102.51	102.97	103.42	103.37

Inches and fractions to millimetres (1" = 25.4 mm)
Pouces et fractions en millimètres

Inches *Pouces*	0	1	2	3	4	5	6	7	8	9	10	11
	millimetres — *millimètres* (mm)											
0	—	25.40	50.80	76.20	101.60	127.00	152.40	177.80	203.20	228.60	254.00	279.40
1/16	1.59	26.99	52.39	77.79	103.19	128.59	153.99	179.39	204.79	230.19	255.59	280.99
1/8	3.18	28.58	53.98	79.38	104.78	130.18	155.58	180.98	206.38	231.78	257.18	282.58
3/16	4.76	30.16	55.56	80.96	106.36	131.76	157.16	182.56	207.96	233.36	258.76	284.16
1/4	6.35	31.75	57.15	82.55	107.95	133.35	158.75	184.15	209.55	234.95	260.35	285.75
5/16	7.94	33.34	58.74	84.14	109.54	134.94	160.34	185.74	211.14	236.54	261.94	287.34
3/8	9.53	34.93	60.33	85.73	111.13	136.53	161.93	187.33	212.73	238.13	263.53	288.93
7/16	11.11	36.51	61.91	87.31	112.71	138.11	163.51	188.91	214.31	239.71	265.11	290.51
1/2	12.70	38.10	63.50	88.90	114.30	139.70	165.10	190.50	215.90	241.30	266.70	292.10
9/16	14.29	39.69	65.09	90.49	115.89	141.29	166.69	192.09	217.49	242.89	268.29	293.69
5/8	15.88	41.28	66.68	92.08	117.48	142.88	168.28	193.68	219.08	244.48	269.88	295.28
11/16	17.46	42.86	68.26	93.66	119.06	144.46	169.86	195.26	220.66	246.06	271.46	296.86
3/4	19.05	44.45	69.85	95.25	120.65	146.05	171.45	196.85	222.25	247.65	273.05	298.45
13/16	20.64	46.04	71.44	96.84	122.24	147.64	173.04	198.44	223.84	249.24	274.64	300.04
7/8	22.23	47.63	73.03	98.43	123.83	149.23	174.63	200.03	225.43	250.83	276.23	301.63
15/16	23.81	49.21	74.61	100.01	125.41	150.81	176.21	201.61	227.01	252.41	277.81	303.21

Feet to metres (1' = 0.304 8 m)
Pieds en mètres

Feet *Pieds*	0	1	2	3	4	5	6	7	8	9
	metres — *mètres* (m)									
0	—	0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100	30.480	30.785	31.090	31.394	31.699	32.004	32.309	32.614	32.918	33.223
110	33.528	33.833	34.138	34.442	34.747	35.052	35.357	35.662	35.966	36.271
120	36.576	36.881	37.186	37.490	37.795	38.100	38.405	38.710	39.014	39.319
130	39.624	39.929	40.234	40.538	40.843	41.148	41.453	41.758	42.062	42.367
140	42.672	42.977	43.282	43.586	43.891	44.196	44.501	44.806	45.110	45.415
150	45.720	46.025	46.330	46.634	46.939	47.244	47.549	47.854	48.158	48.463
160	48.768	49.073	49.378	49.682	49.987	50.292	50.597	50.902	51.206	51.511
170	51.816	52.121	52.426	52.730	53.035	53.340	53.645	53.950	54.254	54.559
180	54.864	55.169	55.474	55.778	56.083	56.388	56.693	56.998	57.302	57.607
190	57.912	58.217	58.522	58.826	59.131	59.436	59.741	60.046	60.350	60.655
200	60.960									

Depth Conversion Table — Fathoms to Meters (1 fathom = 1.8285 meters)

Fathoms	0	1	2	3	4	5	6	7	8	9
0	0000	0002	0004	0006	0007	0009	0011	0013	0015	0016
10	0018	0020	0022	0024	0026	0027	0029	0031	0033	0035
20	0037	0038	0040	0042	0044	0046	0048	0049	0051	0053
30	0055	0057	0058	0060	0062	0064	0066	0068	0070	0071
40	0073	0075	0077	0079	0080	0082	0084	0086	0088	0090
50	0091	0093	0095	0097	0099	0101	0102	0104	0106	0108
60	0111	0112	0113	0115	0117	0119	0121	0122	0124	0126
70	0128	0130	0132	0134	0135	0137	0139	0141	0143	0144
80	0146	0148	0150	0152	0154	0155	0157	0159	0161	0163
90	0165	0166	0168	0170	0172	0174	0176	0177	0179	0181
100	0183	0185	0186	0188	0190	0192	0194	0196	0198	0199
110	0201	0203	0205	0207	0208	0210	0212	0214	0216	0218
120	0220	0221	0223	0225	0227	0229	0230	0232	0234	0236
130	0238	0240	0241	0243	0245	0247	0249	0250	0252	0254
140	0256	0258	0260	0262	0263	0265	0267	0269	0271	0272
150	0274	0276	0278	0280	0282	0284	0285	0287	0289	0291
160	0293	0294	0296	0298	0300	0302	0304	0305	0307	0309
170	0311	0313	0314	0316	0318	0320	0322	0324	0326	0327
180	0329	0331	0333	0335	0336	0338	0340	0342	0344	0346
190	0348	0349	0351	0353	0355	0357	0358	0360	0362	0364
200	0366	0368	0369	0371	0373	0375	0377	0379	0380	0382
210	0384	0386	0388	0390	0391	0393	0395	0397	0399	0400
220	0402	0404	0406	0408	0410	0412	0413	0415	0417	0419
230	0421	0422	0424	0426	0428	0430	0432	0433	0435	0437
240	0439	0441	0443	0444	0446	0448	0450	0452	0454	0455
250	0457	0459	0460	0463	0464	0466	0468	0470	0472	0474
260	0476	0477	0479	0481	0483	0485	0486	0488	0490	0492
270	0494	0496	0497	0499	0501	0503	0505	0507	0508	0510
280	0512	0514	0516	0518	0519	0521	0523	0525	0527	0528
290	0530	0532	0534	0536	0538	0540	0541	0543	0545	0547