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FOR THE

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REDBOOK 1967

PART III SELECTED PAPERS FROM THE 1967 ANNUAL MEETING

Issued from the Headquarters of the Commission
Dartmouth, N.S., Canada

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prepared by Vivian C. Kerr and Jean S. Maclellan

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PART III. SELECTED PAPERS FROM THE 1967 ANNUAL MEETING

SECTION A
GREENLAND AND LABRADOR COD

1. The estimation of efficient use of West Greenland cod stocks, a simple method of showing how a fishery should be carried out to get the highest output from the fish stocks[1]

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From 1 June 1967, or the date on which the 1961 ICNAF recommendation for Subareas 1, 2 and 3 comes into effect for Subarea 1 (West Greenland), whichever date is later, codends of trawl nets of at least 130 mm manila (120 mm nylon) mesh size must be used. This resolution was passed at the 1966 ICNAF meeting in Madrid. Thus, for the first time, a legal mesh regulation will be in force for the trawl fishery in Subarea 1. What developments led to this regulation, and what does it achieve?

1. Recent development of the cod fishery in ICNAF Subarea 1

In the last few years, the cod fishery off West Greenland has increased considerably. During the years 1952-1960, the average annual nominal catch was 277,000 metric tons, whereas, in the 5-year period from 1961-1965 the average annual catch was 382,000 tons (an increase of 38%) with a maximum of 451,000 tons in 1962. The increase in yield was, to a large extent, due to increased trawler activity and to the intensification of the Greenland fishery by the Federal Republic of Germany which, since 1961, has been the leading fishing nation in Subarea 1. In spite of the use (input) of more and more efficient fishing vessels, the catch per unit has declined since 1962 (1966 German Research Report, ICNAF Res. Doc. 67/14).

The intensive fishery first reduced the stock of big cod, thus affecting especially the salt fish production dependent upon big cod. The decrease in yield of big cod was compensated by an enforced fishing of the young cod stocks. This resulted in a more rapid reduction of the year-classes entering the fishery and, having regard to the high rate of growth of West Greenland cod, a very unprofitable utilization of this stock. The stock of young cod was reduced primarily in recent years by the increasing activity of the factory trawlers (especially when these converted from the Baader filleting machines type 99 to the Baader 338 for small cod). The factory trawlers were also able to process in their big fish meal plants the big catches of small cod which occurred frequently and which could not be filleted even by the Baader 338.

[1]submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/55

In order to reduce, in the interest of all nations participating in the Greenland fishery, the uneconomical catching of young fish by trawlers, the Danish delegation at the 1965 ICNAF meeting in Halifax proposed closing Great Halibut Bank, one of the main growth areas for young West Greenland cod, to fishing by trawlers. The ICNAF Greenland Cod Working Group, composed of fishery biologists from Denmark, United Kingdom, Portugal, USSR and the Federal Republic of Germany, was asked to study the effects on the international Greenland fishery of a regulation of this type. The resulting investigations showed that closing Great Halibut Bank (Div. 1B) could produce a beneficial effect on all methods of fishing (trawl, longline and handline). The Working Group also showed that greater profits could eventually result for all fishing nations if, at the same time, a mesh size of 150 mm manila were introduced. After long discussions at its 1966 meeting, the Commission adopted a proposal of the biologists to introduce for Greenland a mesh size of 130 mm manila (120 mm nylon).

The following investigations will show to what extent Greenland cod had been used, to what extent they could be used, and what will be achieved by using a mesh size of 130 mm.

2. Growth and rate of growth

In contrast to Labrador cod, which are slow growing, West Greenland cod grow extremely fast, especially in the years before maturity. Since 1960-61, Greenland cod have had a faster growth rate (Table 1). The faster rate

Table 1. Mean length and mean weight of gutted West Greenland cod at the end of December in the years 1953-1960 and 1961-1965.

Age (years)	Feeding periods	1953-1960 cm	1953-1960 g	1961-1965 cm	1961-1965 g	Percentage increase in weight 1953-60 to 1961-65
2	3	?	-	32	250	-
3	4	40	510	44	670	31
4	5	49	915	54	1,260	38
5	6	58	1,555	64.5	2,035	31
6	7	67	2,250	71.5	2,705	20
7	8	70	2,540	76.5	3,290	30
8	9	73.5	2,930	80.5	3,820	30
9	10	75	3,100	84.0	4,360	41
10	11	77	3,475	86.0	4,680	35
						32

of growth has resulted in an increased average weight of 32% for the individual age-groups. Since there has been no decisive improvement of the climate off Greenland in the last few years and, on the contrary, many facts indicate rather a deterioration of the climatic conditions, it can be supposed that the abrupt increase in growth in 1961 is intrinsically related to the increased intensity of the Greenland fishery since that time. As a result more food is available today for the highly reduced stock than in previous years with higher stock density. The existence of a causal relationship between stock density and growth off Greenland is suggested from the fact that the very strong 1947 year-class showed a much reduced growth rate due to competition for food.

3. Weight and natural mortality

Table 2 shows that 1,000 2-year-old cod at the end of their third feeding period weigh 250 kg (fresh gutted weight). Knowing that the natural rate of mortality of West Greenland cod is 15 to 20%, let us assume that the annual reduction by natural causes is 20%. Therefore, 200 are eliminated by death, predation by bigger animals, illness, etc., one year later at the end of their fourth feeding period. The individual weights of the remaining 800 animals, however, have increased from 250 g to 670 g, that is more than 1 1/2 fold, giving a total weight of 536 kg. At the end of the fifth feeding period, only 650 of the 1,000 2-year-old cod are still alive. Their individual weights have now increased by 590 g to 1,260 g, and their total weight is now 806 kg. Table 2 shows that the total weight, based on an annual mortality rate of 20%, increases to 1,109 kg at the end of the seventh feeding period.

Table 2. Gutted weight of the stock of West Greenland cod with age and with a natural mortality of 20%.

Age (years)	Feeding periods	Individual fish weight(g)	Fish stock		Percentage of maximum weight
			Number	Weight(kg)	
2	3	250	1,000	250	23
3	4	670	800	536	48
4	5	1,260	640	806	72
5	6	2,035	512	1,042	94
6	7	2,705	410	1,109	100
7	8	3,290	328	1,079	97
8	9	3,820	262	1,001	90
9	10	4,360	210	916	83
10	11	4,680	168	786	71
11	12	4,920	134	659	59
12	13	5,155	107	552	50
13	14	5,350	86	460	41

After the sixth and seventh feeding periods, West Greenland cod start spawning for the first time. The annual weight increment of individual mature cod is still considerable, but it is less than that during the immature stage, because much of the food intake is now needed for maturation of the gonads, for the spawning migration, and for the spawning process and only the remaining small part can be used for body growth. After the ninth feeding period, the total weight of the remaining 262 cod is still over 1,000 kg which is 90% of the greatest total weight. With progressing age, however, the total weight decreases rapidly as is shown in Table 2 and by the hatched curve in Fig. 1.

From calculations of population dynamics, it is known that natural mortality decreases with age since the number of predators decreases with increase in body size of the cod. For this reason, the calculations used in Table 2, were also carried out using other rates of natural mortality. Table 3 shows the changes in total weight when natural mortality is 25% to start with, then 20%, and from the sixth feeding period on is 15%. The dotted line in Fig. 1 shows that, in principle, the same growth curve is obtained. In this case, the maximum weight of 1,214 kg is reached one year later.

Table 3. Gutted weight of the stock of West Greenland cod with age and with natural mortality decreasing from 25 and 20 to 15%.

Age (years)	Feeding periods	Individual fish weight(g)	Mortality rate(%)	Fish stock Number	Fish stock Weight(kg)	Percentage of maximum weight
2	3	250		1,000	250	21
			25			
3	4	670		750	503	41
			20			
4	5	1,260		600	756	62
			15			
5	6	2,035		510	1,038	86
			15			
6	7	2,705		434	1,174	97
			15			
7	8	3,290		369	1,214	100
			15			
8	9	3,820		314	1,199	99
			15			
9	10	4,360		267	1,164	96
			15			
10	11	4,680		227	1,062	87
			15			
11	12	4,920		193	950	78
			15			
12	13	5,155		164	845	70
			15			
13	14	5,350		139	744	61

Table 4 and the solid line in Fig. 1 show what is probably closest to the true natural mortality. In this case, as in Table 3, for the first two years a natural mortality of 25% and 20% was chosen. For the following years, however, a mortality which decreases by 1% a year from 18% to 10% was chosen as a base. The resulting growth curve (solid line in Fig. 1) lies about midway between the two curves already described.

Table 4. Gutted weight of the stock of West Greenland cod with age and with natural mortality decreasing from 25 and 20 to 18 - 10%.

Age (years)	Feeding periods	Individual fish weight(g)	Mortality rate(%)	Fish stock Number	Fish stock Weight(kg)	Percentage of maximum weight
2	3	250		1,000	250	22
			25			
3	4	670		750	503	45
			20			
4	5	1,260		600	756	67
			18			
5	6	2,035		492	1,001	89
			17			
6	7	2,705		408	1,104	98
			16			
7	8	3,290		343	1,128	100
			15			
8	9	3,820		292	1,115	99
			14			
9	10	4,360		251	1,094	97
			13			
10	11	4,680		218	1,020	90
			12			
11	12	4,920		192	945	84
			11			
12	13	5,155		171	882	78
			10			
13	14	5,350		154	824	73

4. Efficient use and the "Ideal fishery"

In spite of the different natural mortality rates, all three curves in Fig. 1 show a surprisingly similar trend. Each has a very steep ascent and, after the end of the sixth feeding period when maturity begins, shows a more or less flat peak. This total weight curve is of essential importance in determining how to exploit the West Greenland cod stock most profitably. It shows quite clearly that, in determining the greatest total weight which a cod year-class can contribute during its life-span to the Greenland fishery, growth rate is much more important than natural mortality rate. The value of the conclusions which can be derived for the fishery from this curve are, however, of fundamental importance. The natural mortality rate - less important in this case - can only be determined *approximately* by indirect mathematical calculation. The growth rate - more important in this case - can be determined with *high precision* from length measurements and age determinations (there is no difficulty in ageing West Greenland cod). Therefore, the following well-founded statements can be made regarding the rational and economic management of the West Greenland cod fishery:

1. The highest possible fishing yield would be obtained if the cod were caught in their eighth year of life as 7-year-old fish.

2. Catching the cod before and after their eighth year of life will reduce the efficient use of the stock.

3. The utilization of this natural source of protein is especially low if the cod are caught as 2-, 3-, and 4-year-old fish.

4. A highly efficient use of the stock (more than 90%) is obtained if the cod are caught at 6 to 9 years of age.

5. *The "ideal fishery", the one with the highest total weight yield, prohibits the taking of cod less than 6 years of age, yet is so intensive that no cod reaches 11 or more years of age.*

To express these ideal postulates as body length in cm, it is necessary to convert the ages into length measurements. If the values for the respective efficiency of use (% of maximum weight) obtained from Table 4 are related to the mean lengths for the different ages as given in Table 1, the curve for the efficiency of use in relation to body length is obtained (Fig. 2). Table 5 shows the corresponding figures for the efficient use of the stock for each 3-cm length-group, which can be deduced from the curve in Fig. 2. The values exceeding 90% for efficient use of the fish stock - as Fig. 2 indicates quite clearly - are reached by taking cod between 65 and 86 cm of length. The fifth statement above can, therefore, be expressed in terms of fish length and read as follows:

The fishery off West Greenland would yield more than 90% of the maximum weight produced if no cod less than 65 cm long were caught and if the fishing effort of trawls and lines were so intensive that all big cod were caught before they reached a length of 87 cm.

International efforts to regulate the fishery off West Greenland should, therefore, aim at this "ideal" of a cod fishery.

Table 5. Efficiency of stock use in relation to body length (3-cm groups).

Body length(cm)	Efficiency(%)
24 - 26	13
27 - 29	17
30 - 32	21
33 - 35	26
36 - 38	31
39 - 41	37
42 - 44	43
45 - 47	50
48 - 50	57
51 - 53	63
54 - 56	70
57 - 59	77
60 - 62	83
63 - 65	89
66 - 68	93
69 - 71	97
72 - 74	99
75 - 77	100
78 - 80	100
81 - 83	98
84 - 86	92
87 - 89	80
90 - 92	67
> 92	50

5. The efficiency of stock use, to the present, in the Greenland cod fishery

Table 5 makes it possible, by a simple combination of its percentage efficiency figures with a per-mille row of length measurements of a catch made off Greenland, to establish the degree to which a certain method of fishing, either by trawl or by longlines and handlines, utilizes the stock with regard to the quantity of meat it offers for human consumption. Some examples taken from the German trawl fishery will give the details.

(a) Fishery for pre-spawning concentrations

In January 1967, the German fleet after a long period of very poor catches, fished with very good results in the area of Banana and Fyllas Banks. Determinations of age and maturity showed that the concentrations consisted mainly of shoals of pre-spawners and some bigger immature cod. Table 6 shows that about 60% of the cod fished in this area belonged to the rich 1961 year-class (age 6 years), 65% of which were preparing for spawning for the first time. Over 20% of these fish were from the 1960 year-class (age 7 years) and were first- and second-time spawners. The older year-classes, all of which had spawned several times, contributed another 7%. The remainder was made up of 5-year-old cod of the 1962 year-class and was almost exclusively immature cod. No 2- and 3-year-old cod were found in these winter concentrations. The average length was 66.1 cm. Range in length was 47 to 104 cm. The average weight of the fresh gutted fish was 2,260 g with 77% of the catch in market class II (medium). All cod caught were utilized; none had to be turned into fish meal. Calculating the value for the efficiency of stock use from the figures in Table 5 and from the length composition in Table 6, the result is 88.0%. This means that, for this catch composition, 88% of the possible maximum weight for West Greenland cod were obtained. From the point of view of gaining cod flesh (protein production from the sea), this fishery on concentrations of pre-spawners mixed with a quantity of older juvenile cod readily qualifies.

Table 6. Length and age composition(‰) of samples from West Greenland.

	Banana Fyllas Banks	Banana Bank	Holsteinsborg	Nanortalik	Thorvaldsen *A. Dohrn*	Thorvaldsen Fact. Traw.
Mesh	Jan 67	Mar 66	Nov 65	Nov 64	Oct 66	Oct 66
size(mm)	110	110	60	110	60	≈80
Length groups(cm)						
24 - 26	-	-	2	-	5	3
27 - 29	-	-	15	2	14	5
30 - 32	-	-	42	5	17	12
33 - 35	-	-	54	13	45	37
36 - 38	-	-	87	50	111	103
39 - 41	-	-	116	134	133	125
42 - 44	-	-	118	218	124	136
45 - 47	1	-	97	204	119	146
48 - 50	8	3	79	89	101	108
51 - 53	35	16	62	24	82	87
54 - 56	45	34	52	15	78	74
57 - 59	109	103	53	21	70	56
60 - 62	128	127	52	30	53	41
63 - 65	192	117	49	33	26	25
66 - 68	178	151	40	34	12	21
69 - 71	116	108	25	27	6	5
72 - 74	87	104	17	35	1	6
75 - 77	44	69	14	19	1	4
78 - 80	24	56	11	18	1	2
81 - 83	12	25	7	13	1	-
84 - 86	10	25	5	10	-	1
87 - 89	4	18	2	3	-	2
90 - 92	4	14	1	1	-	1

Table 6. (cont'd)

Mesh size (mm)	Banana Fyllas Banks Jan 67 110	Banana Bank Mar 66 110	Holsteinsborg Nov 65 60	Nanortalik Nov 64 110	Thorvaldsen *A. Dohrn* Oct 66 60	Thorvaldsen Fact. Traw. Oct 66 ≈80
Length groups (cm)						
93 - 95	2	8	-	1	-	-
96 - 98	1	5	-	-	-	-
99 - 101	-	6	-	-	-	-
102 - 104	-	5	-	-	-	-
105 - 107	-	3	-	-	-	-
108 - 110	-	2	-	-	-	-
111 - 113	-	1	-	-	-	-
Average length (cm)	66.1	69.5	49.7	50.8	46.8	48.0
Age (year-class in parentheses)						
2	-	-	78 (63)	4 (62)	27 (64)	13 (64)
3	-	-	335 (62)	697 (61)	241 (63)	223 (63)
4	4 (63)	-	267 (61)	39 (60)	318 (62)	343 (62)
5	137 (62)	49 (61)	216 (60)	39 (59)	407 (61)	404 (61)
6	590 (61)	501 (60)	32 (59)	130 (58)	3 (60)	3 (60)
7	206 (60)	123 (59)	10 (58)	33 (57)	1 (59)	3 (59)
8	21 (59)	66 (58)	61 (57)	50 (56)	3 (58)	8 (58)
9	0	179 (57)	-	-	0	0 (57)
10	34 (57)	14 (56)	-	-	0	2 (56)
11	1 (56)	6 (55)	-	4 (53)	-	-
12	0	2 (54)	1 (53)	-	-	-
13	4 (54)	45 (53)	-	-	0	0
14	3 (53)	6 (52)	-	-	-	-
15	0	8 (51)	-	2 (49)	-	1 (51)
16	-	-	-	-	-	-
17	-	-	-	2 (47)	0	0
18	-	-	-	-	-	-
19	-	1 (47)	-	-	-	-

(b) Fishery for spawning concentrations

The question now arises: is there a fishery in which a still higher utilization of the stocks can be attained? One might think that catches of concentrations of cod consisting exclusively of spawners ought to give the highest efficiency of stock use.

To the present, a fishery for cod spawners could only be carried out off Greenland in very rare cases. Off West Greenland cod spawn mainly below 500 m because, at depths of 600 - 800 m, the water is warmest due to the warm Atlantic component of the West Greenland Current. It has been impossible, up to the present time, to fish along the steep slope of the shelf between Fyllas and Frederikshaab Banks below 500 m. However, to the west of Banana Bank, the slope is less steep. Here, west of Little and Great Halibut Banks, the Baffinland Ridge separates the deep waters of Baffin Bay and the Labrador Sea and fishing can be carried out on the gentle slopes even below 500 m. In March/April 1961, for the first time, shoals of spawning cod were discovered here. Here, too, in March 1966, along the southern slope of Baffinland Ridge, pure shoals of spawners provided very profitable fishing down to 600 - 750 m. About 50% of the spawning cod were of the good 1960 year-class which spawned for the first time in 1966 (Table 6). The rich 1957 year-class still contributed 18% and the previously rich 1953 year-class, 4.5%. The average length of the spawning cod was 69.5 cm (50 - 130 cm long). The average weight was 2,680 g, and 23% of the landings consisted of market class I and "giants".

In spite of the fact that only mature fish were caught, the efficiency of stock use in this fishery was only 88.3% - the same as in the fishery for the pre-spawning concentrations. The explanation is that there was a certain proportion of cod 11 and more years of age in the fishery. From the point of view of maximum and rational exploitation, these fish were caught too late in life.

(c) Fishery in growth areas for young fish

A typical fishery in an area with a high proportion of juvenile cod is in Holsteinsborg Deep at the southern end of Great Halibut Bank. From the mesh selection experiments of the R/V *Walther Herwig* in November 1965 in this area, the composition of the stock can be determined with accuracy. From the selection values (selection factor 3.3, selection range 9 cm), the effect of fishing with different mesh sizes can be calculated with precision. In November in the Holsteinsborg Deep, a trawler using a codend with a mesh size of 110 mm and with no chafer to affect the selectivity could only attain an efficiency of stock use of 61%. However, great quantities of cod, much smaller than 40 cm, would be caught (selection range for 110 mm is from 32 to 41 cm). Thus, even factory ships fitted with filleting machines for small cod (Baader 338) could fillet only 68% of the fish caught. The remaining 32% would be converted directly to fish meal. In practice, however, because of the effect of chafers and of nets with mesh sizes smaller than 110 mm, the percentage of smaller cod is higher and the efficiency of stock use accordingly lower. To the present, no mesh regulations have been in force for West Greenland and, as has been confirmed by the many very small-meshed codends of at best 80 mm which have been recovered from the bottom, it is almost impossible for the smallest cod to escape capture. For the 80 mm mesh size of codend, an efficiency of stock use of only 57% was calculated, and for factory ships provided with Baader 338 filleting machines, the proportion of cod turned directly into fish meal accordingly rises to more than 40%.

Results of the age investigations (Table 6) show why the efficiency of stock use in the fishery off Holsteinsborg is so low while, at the same time, the proportion of so-called "industrial" cod is so high. In November 1965, only 10.4% of the cod were older than 5 years. Even if the fishery were carried out with a mesh size of 110 mm and without any chafer, at best no more than 11% of the smallest cod could escape.

However, juvenile cod are not only caught too early (from the point of view of best use and most profit) on the Great Halibut Bank but on all of the fishing grounds along the coast of West Greenland. Thus, the efficiency of stock use on Fyllas Bank at the end of 1964, when the 1961 year-class reached catchable sizes for the first time, only amounted to 58%. Here, 62% of the fishes caught by the 110 mm size of mesh (without chafer) were only 3 years old. In the area of Nanortalik Bank, the proportion of this year-class caught reached 70% (Table 6). However, 22% of the cod caught were more than 5 years old, resulting in an efficiency of stock use of only 57%.

Selection experiments made in October 1966 from R/V *Anton Dohrn* and catch studies on board a factory ship operating on the same fishing grounds confirm *that because of the blockage of meshes by chafers and the use of very small mesh sizes, etc., there is little effective selection.* This is shown clearly in Fig. 3. The solid line in Fig. 3 shows the length distribution of the cod caught by *Anton Dohrn* in October 1966 off Thorvaldsen using a 60 mm mesh size of net over the codend. Since at best only 0- and 1-year-old cod can escape through meshes of 60 mm (selection range 15.3 - 24.3 cm) and these fish are found mainly in the shallow coastal waters at that time of the year, the *Anton Dohrn* length curve shows the length composition of approximately the total stock of cod living off Thorvaldsen. The average length was 46.8 cm (Table 6). The broken line in Fig. 3 shows the length composition of cod measured at the same time on board the factory ship. It is obvious, from a comparison of the left sides of the *Anton Dohrn* curve (solid line) and of the factory trawler curve (broken line) with the 110 mm mesh-size curve (dotted line), that the ≈80 mm factory trawler net was much less selective than the 110 mm net. The average length of the fish caught by the factory trawler was 48.0 cm, only a little greater than the size of the cod caught by *Anton Dohrn*. About 38% of the cod caught by the factory trawler (19.8% of the total catch by weight) was too small for the Baader 338 and was processed as fish meal. The average length of the cod going to fish meal was 39.5 cm. This corresponds to an average weight of 500 g per cod. The filleted cod had an average weight of 1,255 g. The proportion of the fish meal cod is, according to the fishmaster on the factory trawler, much higher still, since many of the small cod destined for the Baader 338 are torn when passing through the machine because of their small size. Unfortunately, our expert, for lack of time, was not able to give figures on quantity and length composition of this additional industrial cod. According to the statement of the fishmaster, off Thorvaldsen 6 baskets of assorted fish meal cod as well as 2 1/2 baskets of cod which did not give usable fillets went for fish meal. If most of the smaller cod tear in the filleting machine, the proportion of the cod for fish meal is increased by another 12%. This means that, off Thorvaldsen, only 50% of the cod caught were suitable for fillet production! This is not an extreme maximum figure but confirms the results of calculations of the quantities of landed fish meal and the corresponding reports by the captains on "discards" (cod thrown overboard) and "industrial cod" (cod processed into fish meal). Also, other methods of calculation used by the Greenland Cod Working Group showed that, in recent years, often more than 40% of the cod caught by trawl off Greenland (especially on board wet fish trawlers) were not used for direct human consumption because fishing was carried out using trawl nets with mesh sizes which were far too small.

The catches of the factory ship off Thorvaldsen in October 1966 (Table 6) consisted almost exclusively of three year-classes (1963 - 22%, 1962 - 34%, 1961 - 40%). Only 1.7% of the cod were older than 5 years! Only the 5-year-old and the biggest of the 4-year-old cod could be filleted. The efficiency of stock use for this fishery was only 53%! Such a fishery can only be wasteful, uneconomic and short-sighted!

6. <u>130 mm mesh size</u>

Whether introduction of a minimum mesh size of 130 mm manila (120 mm nylon) can give a higher and more rational utilization of the cod stock off Greenland is dubious. *Even when 130 mm meshes are fully effective (no chafer etc.), the effect is only very small because the 50% selection point lies at only 42.9 cm, i.e.,* at this small length and at an individual weight of only 625 g (one single fillet weighing 100 g), 50% of the cod of this size are retained in the codend of the net; at a length of 38.4 cm, 25%; and at 47.4 cm, 75%. As Table 1 indicates, the 130 mm selection runs just through the 3-year-old cod. This means that only the 2-year-old and the 3-year-old cod of smaller size can escape through the meshes. And it must be re-emphasized that this happens when the 130 mm net is *fully* effective. The rather low efficiency of a 130 mm mesh size is obvious from Fig. 3 and Table 5. Cod which are caught at a length of 42.9 cm give only an efficiency of stock use of 42%!

On board factory trawlers, the proportion of the cod for industrial purposes will therefore continue to be high as long as these ships fish on grounds with mainly a young fish population since the range of overlap of sizes of cod for fish meal and for the Baader 338 lies between 43 and 47 cm. In the Holsteinsborg fishery in 1965, if a 130 mm net had been used, the amount of fish meal cod would have been reduced from 32% to 20%. Thus, 12% of the fish caught with 110 mm mesh size could have escaped. The efficiency of stock use in this fishery would have been increased by 6% to 67%. In the case of the fishery with factory trawlers off Thorvaldsen in October 1966, by using 130 mm nets an efficiency of stock use of 61% instead of 53% would have resulted.

In the fishery for pre-spawning and spawning concentrations, 130 mm meshes have no effect because the smallest fish are too big for these meshes. However, the larger meshes guarantee a better flow of water through the codend and there is less piling of water in front of the mouth of the net. This will increase the catchability of the net and thus the catch.

7. Mesh sizes larger than 130 mm

No captain, fisherman or fishing industry is interested in a fishery off West Greenland for small cod of sizes between 25 and 50 cm only. All would like to catch cod larger than 50 cm in length. With this in mind and being aware of the very small benefit of an increase in mesh size to 130 mm, the Greenland Cod Working Group not only proposed closing Great Halibut Bank but increasing the mesh size *to at least 150 mm.* For 150 mm (manila) the 50% selection point lies at 49.5 cm. This corresponds to a cod weight of 950 g. The efficiency of stock use for this length is 57%. Trawling with codends of 150 mm would mean complete protection of the 2- and 3-year-old cod and furthermore, would give a chance of survival to a certain number of the 4-year-old cod at least in the first half of the year.

In the fishery in the growth areas for young fish, the introduction of a 150 mm net would mean an essential reduction of "discards" and "industrial fish" because only fish of 40 to 50 cm in length would constitute the main part of the catches. Thus, not only a large proportion of the fast-growing young cod would remain alive and could grow and produce a greater weight of fish flesh for a higher efficiency of stock use, but there would also be a great saving of labour and increase in productivity of the ships from utilization of the larger fish sizes.

For ships without fish meal plants which catch small cod and must discard them, there is no economic gain. And because cod thrown back into the sea are dead, there is less income in the future for fishermen and fishing companies working off West Greenland.

The following statements can now be made about the previously discussed Holsteinsborg fishery in November 1965, if it were using a 150 mm mesh size of net instead of a 110 mm mesh size of net:

(1) The efficiency of stock use would increase from 61% to 76%.

(2) The average length of the cod caught would increase from 52.4 cm to 59.8 cm, and the average weight from 1,286 g to 1,782 g with the bigger fish bringing a higher price.

(3) The proportion of industrial cod taken by factory trawlers would be reduced from 32% to 7%!

(4) Of all those cod retained by a 110 mm net, 44% could now slip through the meshes of the 150 mm net. They would survive and improve the weight yield in the future by their rapid growth. If they had been caught by a 110 mm net, 66% (that are the very small cod) of these 44% now surviving would have been turned into fish meal and only the remaining 34% (that are the larger cod) would have been filleted.

(5) For the factory trawler fishing with 150 mm mesh size instead of 110 mm, the above-mentioned 34% of small but just filletable cod would mean, of course, a diminution in the quantity of filletable cod. This 34% would constitute a reduction of 13.5% by weight of the filletable cod. This does not mean, however, that there would be an identical loss in fillet production by the ship. The reasons are:

(a) The bigger cod produce a higher percentage output of fillets (the filletable cod is on the average 216 g per fish heavier).

(b) There is less tearing and, therefore, less loss of cod in the filleting machine.

(c) There is less loss when dressing the fillets.

(d) There is less loss in V-cutting of boneless fillets).

(6) By catching bigger and heavier cod, a considerable amount of labour would be reduced (economized) and the daily output of the ship increased.

(7) The number of larger cod caught by a 150 mm net would be greater than the number caught with a 110 mm net.

Unfortunately, no exact figures can be given for (6) and (7) above. The losses indicated under (3) and (5) might, to a high degree, be compensated (in weight and money) by the gains mentioned under (2), (6) and (7).

Even if, during the first year after international adoption of a 150 mm mesh size, the fishery in areas with young fish suffers certain economic losses, these would be short-term losses and out of all proportion to the economic gains resulting from the extremely high growth rate of the West Greenland cod during its juvenile phase of life.

If the same calculations are made for the previously-mentioned winter fishery in the beginning of 1967 in the area of Banana and Fyllas Banks, it becomes obvious that the efficiency of stock use in this fishery would increase from 88% to 90% with the adoption of the 150 mm mesh size as 3.3% of the cod would have escaped through the meshes. However, only the smaller cod would be lost and the loss in weight only 1.9%. With nets of bigger meshes giving higher yield practically, this calculated loss would be compensated by a much greater catch. For the Georges Bank haddock fishery, it is known that the drastic increase of the mesh size to 114 mm brought about an average increase in catches of up to 10%. First of all, a greater number of bigger fish are caught.

If pure shoals of spawners were fished with 150 mm meshes, there would be no losses as all spawning cod are too big even for these meshes. In this case, fishing with 150 mm mesh size could only produce a beneficial effect.

Concluding considerations

An essential task for the fishery biologist is to help secure the greatest possible long-term use of the fish stocks in the oceans to supply protein to mankind. This requires close cooperation with the fishery. If the practical people in the industry are to understand the arguments of the biologists about the way a certain fishery should be carried out to obtain the highest possible yield, and thus the highest earnings (economic output), *science must speak a language which is understood by the practical people.* The simple method of calculating the efficiency of stock use which has been demonstrated in this study for the first time would seem to contribute to a better understanding, on the part of the fishery people and administrators, of the effect produced by present day fisheries upon the fish stocks.

Having ascertained with the help of the curve for the efficiency of stock use how the cod fishery off West Greenland should be managed, identical studies should now be made for the other important fish stocks of the North Atlantic. In areas where only one fish stock is exploited, it would not be difficult to attain rational use by regulation. Difficulties with regard to the realization of appropriate measures of regulation do exist, however, in areas with mixed fisheries. In these areas, certain regulatory measures should be applied so that, in the end, the highest yield by weight (protein for mankind) and/or money is attained. This means that in a fishery for a species of minor importance there must be certain losses. The fishery off West Greenland in the past few years has become almost an exclusive fishery for cod due to the heavy decimation of the redfish shoals, which are only immigrants from the waters to the east of Greenland. It would, therefore, not be very reasonable or economical to give up the possibility of increasing the yield of the cod fishery because of insignificant losses in the redfish fishery.

Since the existence of redfish in many areas where there are mainly gadoid stocks could become an obstacle to future rational measures of regulation for the fast growing gadoids, intensification of the studies of redfish selection in relation to large mesh sizes would seem to be an urgent necessity. Further, these studies should be investigated separately for both the *marinus*-

type and *mentella*-type redfish since they show a different behaviour and reaction to trawl nets.

It is understandable that, following the announcement of an increase in mesh sizes, fishermen and trawler companies are afraid of losing fish and money, even though they realize that the present day excessive fishing of young fish stocks is not wise when considering the future of the fishery. In order to prove to the industry that, in spite of certain initial losses, bigger mesh sizes will protect the young fast-growing fish and produce immediate beneficial effects in respect of catch and financial gain, two questions must soon be investigated thoroughly:

(1) the effect of different mesh sizes on the flow of water through the net, the piling-up of water in front of the net and its effect on the reactions of the fish;

(2) studies of operational costs on board trawlers while at sea, especially on board factory trawlers.

Ad 1: There should be no doubts in industry about a direct connection between the flow of water through the net, on the one hand, and the amount of pile-up of water before the opening of the net on the other hand. Better water flow means greater trawling speed. Even the slightest increase in trawling speed results in a larger area being fished and in an increased quantity of water being filtered. An alteration of the mesh size would produce a more decisive effect on the piling-up of water in front of the net and, at the same time, upon the behaviour and reaction of the fish. A smaller pile-up of water before the net increases the efficiency of the net for catching bigger fish. This has been demonstrated clearly for the haddock fishery on Georges Bank.

Unfortunately, very little is known about these matters. Therefore, there is an urgent need for nets of different materials and mesh sizes to be tested in towing tanks and wind tunnels and for continuous comparative fishing trials on grounds where fish are rather evenly distributed.

Ad 2: More essential, however, are studies of operational costs at sea especially on board processing ships. Captains repeatedly report great variation in daily production due to catching and/or processing small or big fish. As every fish has to be handled several times, *the daily production* especially on board factory trawlers and salters *is essentially dependent on the numbers of fish.* To produce 1 ton of cod fillets requires 1,100 cod of 70 cm length but 2,800 cod of 50 cm length (at a fillet yield of 35%). For small fish, the fillet yield is smaller, especially when the V-cut is used to produce boneless fillets. Thus, for the same production, about three times the labour effort is required. In addition, in the case of salting cod, the small salted cod commands a far lower price.

In view of the high cost of labour, especially at sea, a study of the relation between labour and machine costs and the final proceeds, when small cod are processed into fish meal, would be of great interest. For instance, about 10,000 small cod of an average length of 39 cm are required for the production of one single ton of fish meal. On factory ships, salters and wet-fish fishing boats, the catch of small fish always results in an unfavourable relation between labour and other invested costs and the final proceeds. Furthermore, only during periods of favourable catching conditions are the amounts of daily production also determined to a high degree by the size of the fish caught. And it should also be borne in mind that these unfortunately infrequent periods, when the total potential of the labour and the very expensive technical installations of the ship can be fully utilized, are often very important in determining the annual proceeds of the ship and of its owners.

It is certain that studies of rational use of labour on board fishing craft such as are suggested in this paper - and certainly these studies also will have to deal with the problem of how to avoid catching too many small and therefore "labour-intensive" fish - will give interesting results. *Surely, studies of operational costs can contribute much to the removal of objections within fisheries circles to all economical systems*; objections, which still exist today against regulations, which have no other purpose than to guarantee, through the conservation of young fish, the highest possible yields in protein and/or money from the sea and by so doing, guarantee the livelihood of many fishermen and the survival of many renowned fishing companies.

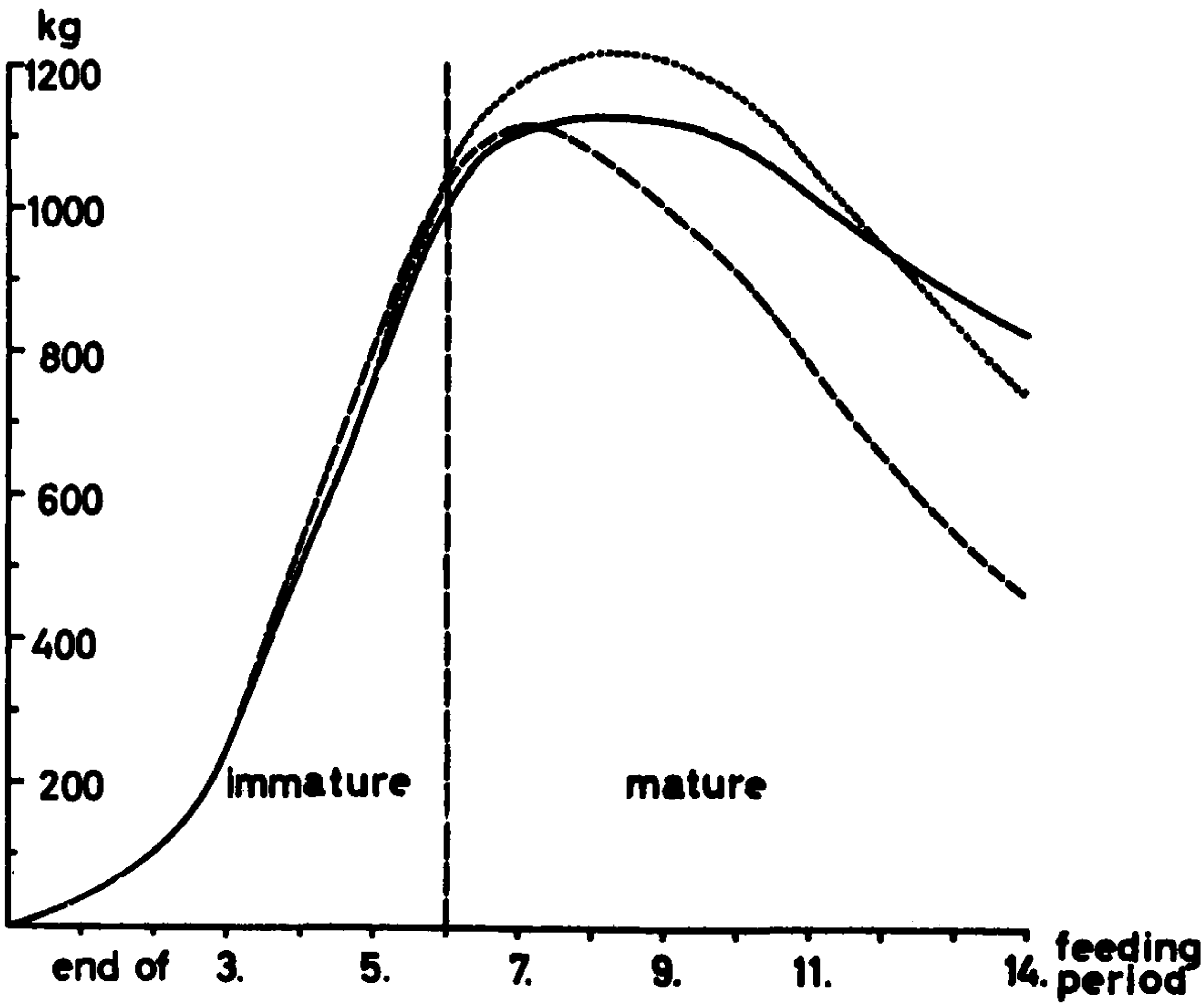
kg
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Fig. 1

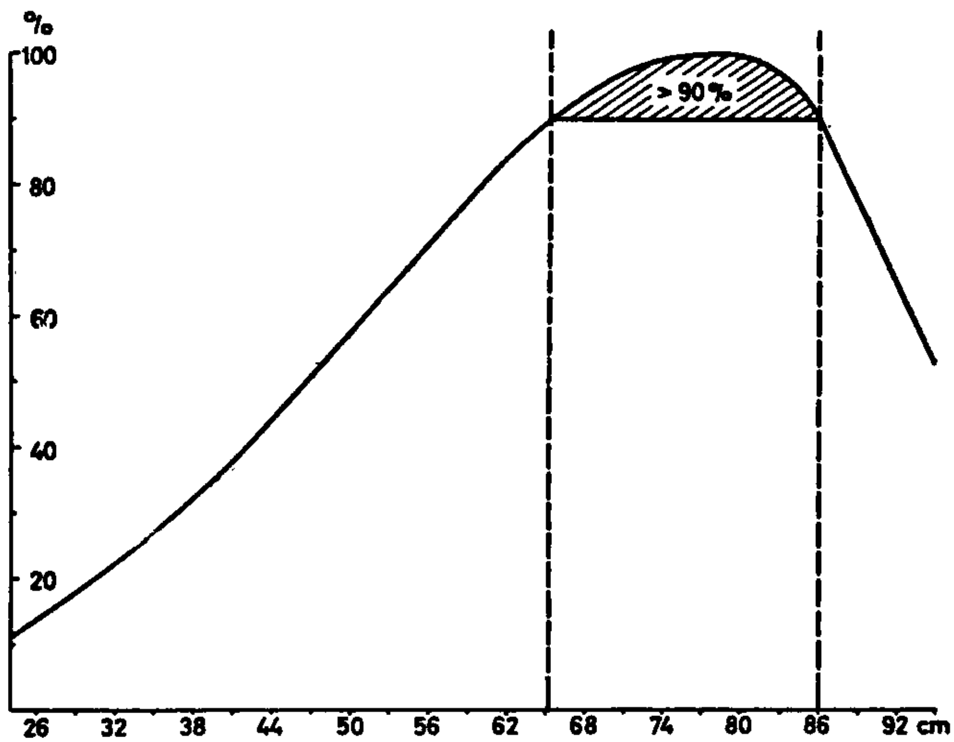
%
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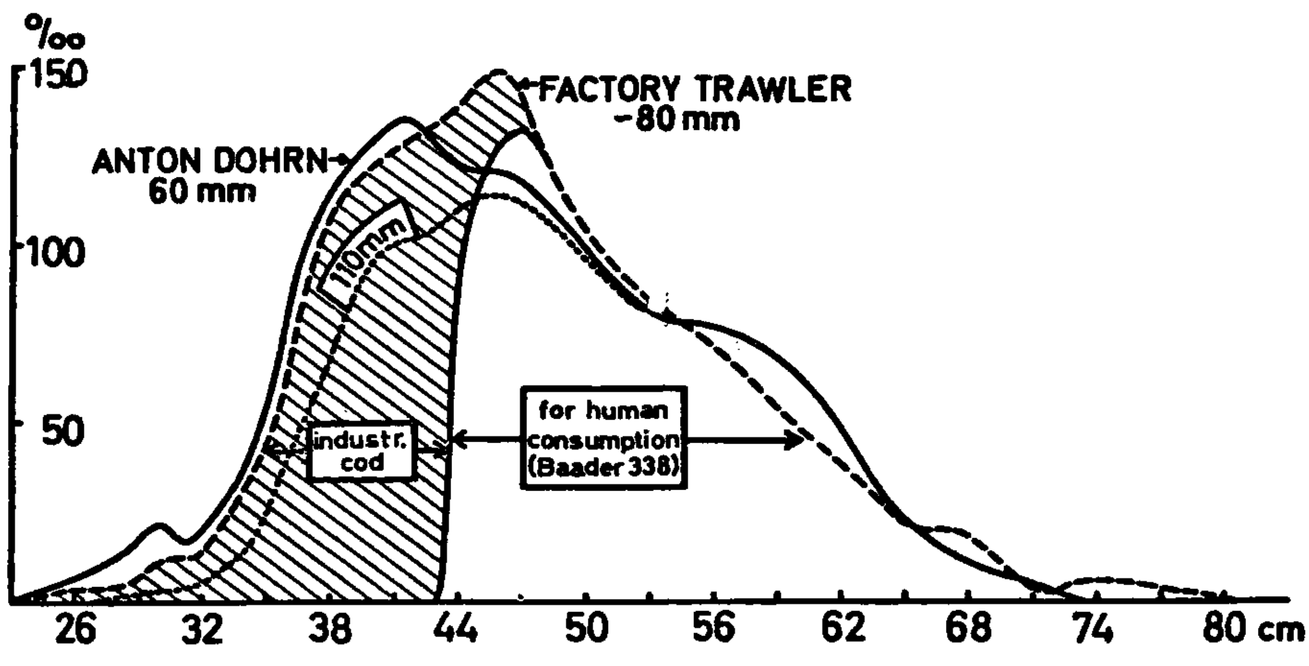
Fig. 2


‰
150
100
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FACTORY TRAWLER
-80 mm
ANTON DOHRN
60 mm
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industr.
cod
for human
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(Baader 338)
26
32
38
44
50
56
62
68
74
80 cm

Fig. 3

2. On the growth of the Labrador cod[1]

by A.I. Postolaky
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The growth of fish depends greatly on the feeding conditions. The feeding conditions include not only the availability of food organisms but also the intensity of food digestion. The rise of temperature within the optimum norm results in a higher intensity of food digestion, and consequently, in an increase of food consumption (Nikolsky, 1963). In other words, the temperature conditions influence the intensity of metabolism which accelerates or decelerates the growth of fish.

Ancellin (1954) was the first to pay attention to the fact that in 1935 the mean length of the southern Labrador cod at the same age was higher than that in 1952. May (1966) studying the growth of cod in Subarea 2, came to the conclusion that in Div. 2G and 2H the growth rate of cod did not change from 1959 to 1964. In Div. 2J the growth rate of cod in 1964 (particularly for ages above 7) was higher than that in previous years. Changes in the growth rate are explained by a higher intensity of fishing.

The present paper shows the growth of the Labrador cod from 1961 to 1966.

The age and growth of cod were studied from otoliths. Samples for for ageing were collected by scouting and research vessels in areas of southern Labrador, nearer to the Continental Slope (depths from 250 to 320 m). The gear (bottom trawl) used by the vessels were analogous to those used by the commercial trawlers.

The rate of growth of Labrador cod was studied using actual mean lengths for age-groups of cod taken from the offshore waters of southern Labrador (Div. 2J) during April-May. Those data are representative of the whole Labrador cod, because in that period the cod spawning in southern Labrador mix with that part of the commercial stock which winters and spawns in southern Labrador (Postolaky, 1964, 1966).

As seen from Fig. 1 the mean length of cod of the same age changes each year. In April-May, 1963 the mean length for ages 4-10 was less than that in 1962. On the contrary, in 1966 the mean length for the same age increased as compared to that in 1964, 1965, but the length for ages above 6 did not reach the values of 1962. The data cited above point out the asynchronous changes in the growth of different age-groups. In 1962, the length

[1] Submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/97

for ages below 7 was less than and for ages 7-10 was higher than that in 1961. On the other hand, in 1964 the mean length for ages 4-7 increased and for ages 8-10 declined compared to that in 1963.

The differences in changes of growth of different age-groups can be explained by the fact that in the summer period older age-groups (7 or above) feed on the east coast of Newfoundland and south coast of Labrador, and ages below 7 remain in the offshore areas of southern Labrador and the northern Newfoundland Bank (Postolaky, 1966). The feeding conditions in these areas were apparently different.

Comparing the growth of cod with the temperature conditions in the coastal and main streams of the Labrador Current shows that growth was the best in coastal and offshore waters of fattening area of cod.

The increases and decreases in the mean length of cod caught in April-May are caused by growth in the previous feeding season (Table 1). The characteristic of growth of cod in different years and the data on the thermal regime of the Labrador Current for July are given in Table 2.

Table 1. Comparison of the mean length (cm) of cod for April-May, 1961-1966.

Year	1961		1962		1963		1964		1965		1966	
Age	M	n	M	n	M	n	M	n	M	n	M	n
4	36.00	6	31.96	43	31.37	81	36.49	23	34.15	30	39.55	106
5	45.00	17	42.91	282	36.10	95	38.03	140	38.67	34	44.83	185
6	48.20	54	47.21	326	44.62	207	45.75	150	45.30	82	47.89	119
7	49.70	66	53.91	163	48.37	577	50.74	380	50.15	77	52.12	101
8	52.90	31	55.94	104	53.40	292	52.61	327	53.75	162	54.01	39
9	54.90	32	59.30	76	56.62	144	55.12	75	55.90	140	57.40	20
10	57.40	7	61.20	77	59.73	111	58.40	32	59.70	48	58.84	18

As seen from the data cited, growth of cod is in full agreement with the temperature regime.

Table 2. Growth of cod and the temperature regime.

	1961	1962	1963	1964	1965
Main stream	cold	cold	warm	cold	warm
Characteristic of growth of 4-6(7)-year-olds	bad growth	bad growth	good growth	bad growth	good growth
Coastal stream	warm	cold	cold	warm	warm
Characteristic of growth of 7(8)-10-year-olds	good growth	bad growth	bad growth	good growth	good growth

Thus, it can be noted that the temperature conditions during the feeding period which result in the increase or reduction of metabolism are the main reason for the increase and decrease in growth of the Labrador cod.

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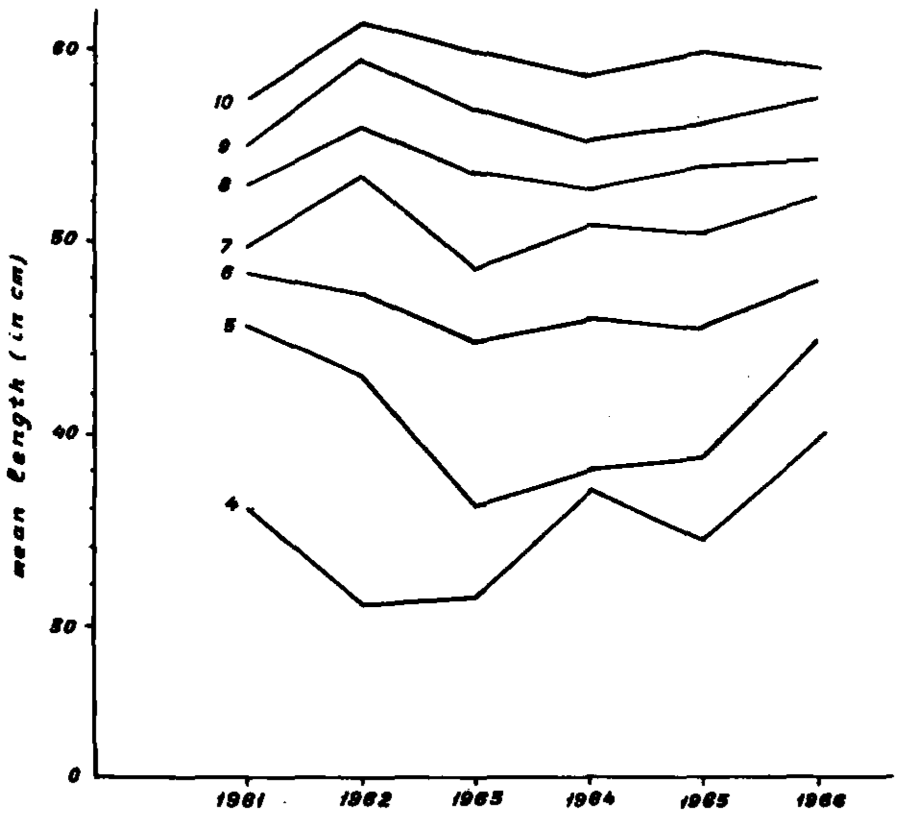

Fig. 1. Growth of Labrador cod, 1961-1966.

3. Some observations on year-class fluctuations in the West Greenland cod stocks[1]

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At the meetings of the Bio-Economics Working Group in 1966-67, various regulatory measures for the North Atlantic fisheries were discussed. The Working Group found that a catch quota was perhaps the most appropriate measure but stressed that when setting catch quotas one has to take into account the fluctuations in year-class strength in the various fish stocks. The present paper deals with the year-class fluctuations observed in the Greenland cod stocks. The material hitherto available (*Sampling Yearbook*, Research Reports) is, however, in many cases far from sufficient for a real judgment of the year-class strength. This, and the rather poor information on discards, means that the actual figures on year-class strength given in this paper must be taken with some reservation. However, the author believes that the figures give a fair idea of the magnitude of the year-class fluctuations and the magnitude of the fluctuations in future annual landings due to these year-class fluctuations.

Year-class fluctuations in the Greenland cod stocks are of major importance to the fishery on these stocks. This has been known since regular fisheries investigations started in West Greenland in 1924. Since then several papers have been published dealing with these year-class fluctuations. Also annual reports on fisheries and research carried out published in ICNAF and ICES series deal with year-class fluctuations. Summaries and discussion of the fluctuations are published by Hansen (1949 and 1953) and by Hermann, Hansen and Horsted (1965) covering year-classes 1924-47 and 1924-51 respectively.

Hansen (*loc. cit.*) and Hermann *et al.*(*loc. cit.*) have given the relative strength of the year-classes based on the importance of the year-classes in the fishery of the Greenlanders (an inshore fishery). Table 1 shows the relative year-class strengths found and published by these authors.

An attempt was made to bring this table up to date but it was so difficult to get a usable weighting factor for the Greenlanders' effort in recent years that the attempt was given up and another method had to be used.

In the present paper, the author has tried to measure the strength of the year-classes since 1947 in terms of number of recruits in the West

[1]Submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/104

Greenland area. The following procedure has been followed:

1. Landings from Div. 1NK were allocated to known divisions according to Horsted (1965).

2. Within each division, annual landings were grouped as follows (a) for otter trawlers, (b) for dory vessels, (c) for liners, (d) for the Greenlanders.

3. Existing age-frequency samples were pooled for each year by division and group mentioned under Item 2 above.

4. The weight of the pooled samples was calculated from the age-weight key given in Fig. 1 and Table 2.

5. The annual numbers landed of each year-class were calculated by raising the weight of pooled samples to weight landed.

6. The 1947-54 year-classes were regarded as recruited when 5 years old, while the 1955-61 year-classes were regarded as recruited when 4 years old due to the increased growth rate in recent years. Fishing mortality in the year of recruitment was regarded as being only 25% of the overall fishing mortality in that year and fishing mortality on younger age-groups was not taken into account.

7. The mean fishing mortality (F) in Subarea 1 is given in Table 3. Natural mortality (M) is taken as being 0.20.

Following the items mentioned above the numbers of recruits in each year-class since 1947 were calculated as shown in the example below. The final figures for numbers of recruits are given in Table 4, which also gives the theoretical number of age-group I supposing M = 0.20 for age-groups I-IV.

Example of calculating the number of recruits. 1955 year-class. 1000 recruits (age-group IV) would be reduced as follows according to F in Table 3 and M = 0.20.

Age-group	IV	V	VI	VII	VIII	IX +
No. of fish present	1000	741	391	192	97	46
No. of fish dying	259	350	199	95	51	46
No. of fish caught $\left(\frac{F}{F + M}\right)$	86	241	143	67	37	34

No. landed of age-groups IV - VIII = 574

Actual number landed of age-groups IV - VIII
according to samples = $38,569 \times 10^3$

$$\text{Actual number of recruits (IV-group)} = \frac{38,569 \times 10^3 \times 1,000}{574}$$

$$= 67.2 \times 10^6$$

Taking the number of recruits as the best measure of year-class strength and regarding only the year-classes since 1947, it follows that

(a) Maximum relative difference between successive year-classes is 5:1 (year-class 1953:54)

(b) Greatest difference between year-classes is 8.3:1 (year-class 1961:54)

(c) Average divergence of single year-classes from long-term mean is about 61% of mean year-class strength.

Supposing that the year-class variation as given by the year-classes since 1947 can be regarded as typical for Subarea 1 (subject to the necessary distinction between the northern and the southern region) the author has tried to evaluate the influence of such a variation on the annual landings using a fishing intensity as in most recent years (F likely to be about 0.65) as well as a 30% reduction in effort. The results are given in Table 5. The landings given in this table are generally below the actual landings obtained, and it is hence most likely, that the figures in Table 4 are biassed with a tendency toward being underestimated. The reason for this may be that some of the assumptions made do not hold, especially Item 6 above which may be too simple an assumption. A much better knowledge of discards is required in this connection.

Therefore, although the figures given in Table 4 and hence also in Table 5 may be biassed, the relation between the figures may nevertheless give a valuable indication of the year-class variation and the influence of this variation on the fisheries.

The general picture obtained from Table 5 is that with a high fishing mortality the output of the fisheries will follow the year-class variation more directly than with a reduced fishing mortality (effort). If effort is still increasing we may expect great fluctuations in annual landings, and in this connection it may be necessary to point out, that the relative good landings obtained with a high effort in recent years are based on the favourable recruitment in these years with the 1957, 1960 and 1961 year-classes being well above average, the 1956 year-class close to average and the 1958 year-class being of some importance although below average.

Possibility of predicting year-class strength

Hansen (*loc. cit.*) and Hermann *et al* (*loc. cit.*) have pointed out, that the relative year-class strength may be predicted with some accuracy from observations of cod of age-groups I, II, and III, from larval abundance and even from hydrographical conditions. Time has not permitted the author to try to make any analysis of this rather important problem, but, from some of the samples taken by research vessels fishing with commercial trawls with covered codend, the author has the impression, that it is worth while trying to study this problem, as the chance of making successful predictions seems rather good.

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Table 1. West Greenland cod. Relative year-class strength (from Hermann, Hansen and Horsted, 1965).

Year-class:	1924	25	26	27	28	29	30	31	32	
Relative strength:	100	3	74	12	9	24	18	43	36	
Year-class:	1933	34	35	36	37	38	39	40	41	
Relative strength:	18	109	33	81	16	13	28	28	32	
Year-class:	1942	43	44	45	46	47	48	49	50	51
Relative strength:	86	28	23	59	13	148	21	11	52	17

Table 2. Age-weight relationship for cod (see also Fig. 1).

Age-group	Mean weight (round fresh) of year-classes 1947-1954 (kg)	1955-1961 (kg)
III	0.550	0.620
IV	0.890	1.180
V	1.540	2.100
VI	2.330	3.080
VII	2.870	3.810
VIII	3.470	4.540
IX +	5.000	5.550

Table 3. Fishing mortality coefficient (F). Subarea 1 cod. The figures for the years 1952-58 follow those given by the Greenland Cod Working Group (Anon., 1966), while the figures for 1959-65 correspond with those given by Gulland (MS for the Bio-Economics Working Group, 1967).

Year	1952	53	54	55	56	57	58	59	60	61	62	63	64	65
F	.21	.21	.28	.28	.30	.30	.38	.41	.44	.51	.48	.54	.59	.65

Table 4. Number of recruits in the 1947-61 year-classes. Age at recruitment being 5 for the 1947-54 year-classes and 4 for the 1955-60 year-classes. Theoretical corresponding number in age-group I given supposing M = 0.20 for all age-groups.

Year-class:	1947	48	49	50	51	52	53	54	55	56	57	58	59	60	61
No x 10^6 of age-group I:	722	166	127	432	164	176	528	105	122	294	678	204	112	422	715
No x 10^6 of recruits in															
Div.1A-1D	305.9	71.4	38.9	145.4	58.7	62.3	200.4	40.0	58.1	96.8	335.3	72.1	56.2	224.5	363.8
Div.1E-1F	18.4	3.2	18.3	48.7	15.1	16.7	36.6	7.3	9.1	64.5	36.9	39.6	5.3	6.9	28.5
Subarea 1	324.3	74.6	57.2	194.1	73.8	79.0	237.0	47.3	67.2	161.3	372.2	111.7	61.5	231.4	392.3
Index	100.0	23.0	17.6	59.9	22.8	24.4	73.1	14.6	20.7	49.8	114.8	34.5	19.0	71.4	121.0

Table 5. Theoretical landings of Subarea 1 cod with recruitment change as in the 1947-60 year-classes. Growth rate is considered steady as in the years since 1960 (Table 2). F in year of recruitment is only considered as 25% of the F given in the table.

Year	F = 0.65	$\frac{F}{Z}$ = 0.76	F = 0.46	$\frac{F}{Z}$ = 0.70
	landings in		landings in	
	tons x 10^3	No x 10^6	tons x 10^3	No x 10^6
1	293.8	132	289.3	117
2	356.6	147	341.7	131
3	259.3	90	266.7	86
4	202.7	79	228.2	78
5	228.6	92	227.5	83
6	186.5	69	186.7	60
7	181.1	81	176.4	72
8	235.7	99	214.9	86
9	187.9	66	190.7	62
10	158.3	66	161.7	61
11	232.5	117	217.9	100
12	368.3	160	335.6	137
13	276.9	102	265.8	94
14	232.0	92	232.7	85
15	310.0	148	344.0	138
16	434.5	185	412.0	162
17	353.9	139	343.4	127

Landings from a mean year-class

F = 0.65	F = 0.46
268 x 10^3 tons 110 x 10^6 specimens	270 x 10^3 tons 101 x 10^6 specimens
mean weight 2.44 kg	mean weight 2.67 kg

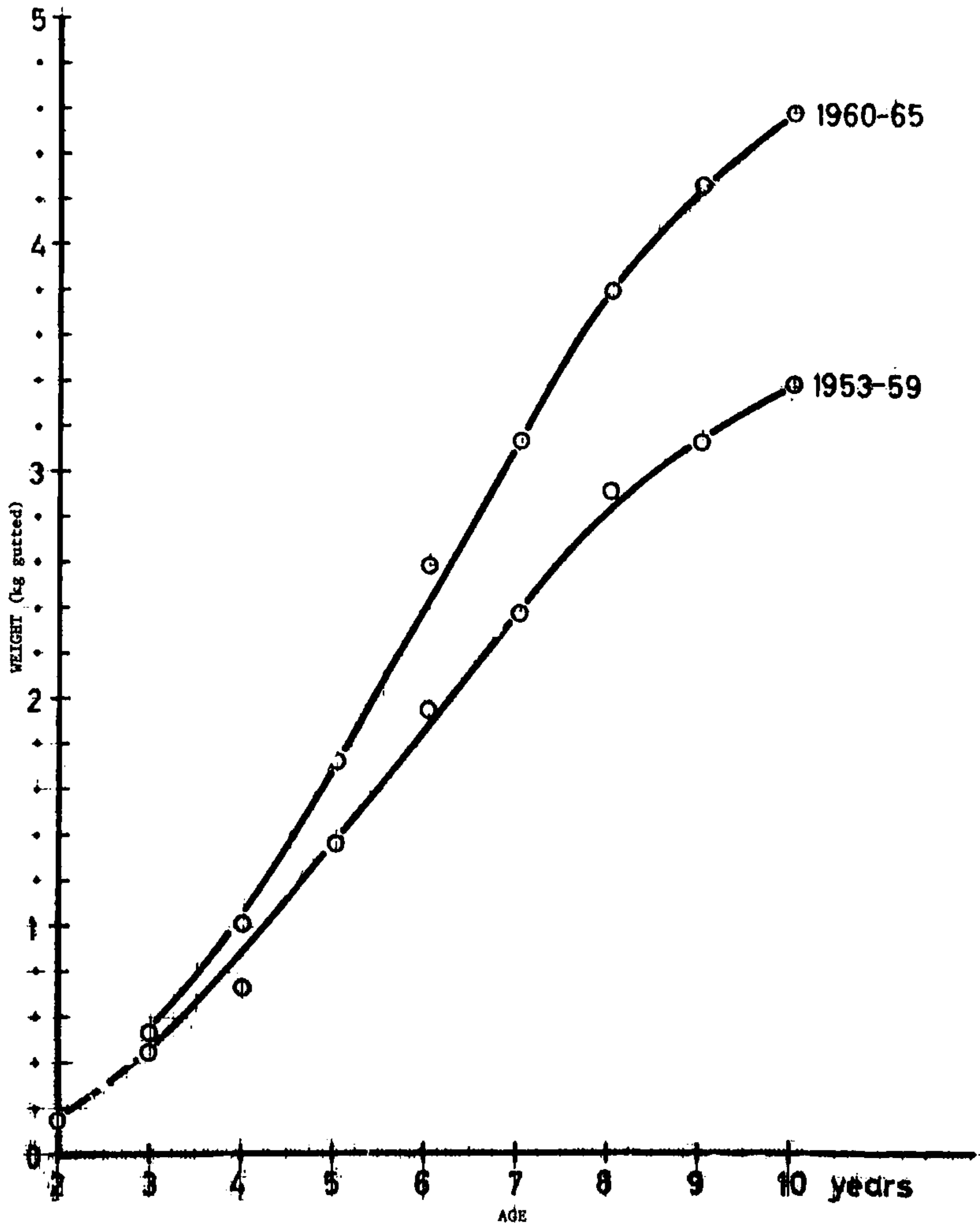

Fig. 1. Age-weight growth curves for cod from West Greenland. Div.1A-1D. Offshore during the July quarters of 1953-59 and 1960-65.

SECTION B
DESIGNATION OF HAKES

1. Designation of the hakes, (*Urophycis chuss* and *Urophycis tenuis*) in ICNAF statistics[1]

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The specific status of the hakes, *Urophycis chuss* and *U. tenuis* has been a subject for debate during the last several years, particularly among Canadian workers (Leim and Scott, 1966). The confusion that has surrounded these two species quite naturally has been reflected in the ICNAF landing statistics (McCracken, 1966). For example, in 1964 (ICNAF Statistical Bulletin Vol. 14 for 1964) the USA, USSR, and Canada (Newfoundland) reported catches of *Urophycis* by species while Canada (Mainland), France (St. Pierre), Germany and the United Kingdom preferred to report their catches simply as *Urophycis* (not specified). In the ICNAF statistics for 1965 (ICNAF *Statistical Bulletin* Vol. 15 for the year 1965) the USA is the only country that reported landings for both species of hake. Canada (Newfoundland) and Spain reported their entire catch of *Urophycis* as "white hake" (*U. tenuis*) while Canada (Mainland) and the USSR reported only "red hake" (*U. chuss*) in their catch statistics.

There can be no doubt as to the validity of the existence of both *Urophycis chuss* or *Urophycis tenuis*. Biologically, the two species are quite different. For instance, *U. chuss* normally grows to a maximum of 55 cm in total length and attains a weight of perhaps 2 kg while *U. tenuis* grows to lengths in excess of 125 cm and may weigh more than 22 kg. *U. chuss* matures when at a total length of 28 to 30 cm. *U. tenuis* does not mature till it is more than about 55 cm in total length.

The early life histories of the two species also differ remarkably. *U. chuss* migrates to the bottom and abandons its post larval existence in the plankton when about 30 mm long. *U. tenuis* on the other hand, remains at the surface till it attains a length of about 80 mm. (Descent may occur at a smaller size in shallow inshore areas). *U. chuss* instinctively enters the mantle cavity of the sea scallop, *Placopecten magellanicus*, where it lives inquilinistically until it literally grows too large to enter the host animal (110-140 mm total length). *U. tenuis* does not establish such a relationship with *Placopecten* or any other animal.

U. chuss is basically a temperate animal and finds its center of distribution off southern New England in the mid-Atlantic bight. *U. tenuis* is basically boreal and is most abundant in the Gulf of St. Lawrence and on the Grand Banks.

[1]submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/76

The general appearance is distinctive. Workers who have handled these two species of *Urophycis* can generally tell them apart simply by sight. Hence, most new England fishermen can identify which species of hake they have taken. In general, *U. chuss* is a dark reddish brown in color with white or yellowish undersides. *U. tenuis* is lighter being grey with purplish metallic overtones when fresh. It is also white on the underparts. *U. chuss* has a long filament on the first dorsal fin (the filament is more than two times the height of the fin). *U. tenuis* has a short filament on the first dorsal fin (the filament is less than two times the height of the fin). This character is a good one and is foolproof with the exception of specimens of *U. chuss* which may have broken fin filaments.

U. chuss always has three gill rakers on the upper bar of the first gill arch while *U. tenuis* always has two.

The character that has led to most of the confusion concerning the status of *Urophycis chuss* and *U. tenuis* in the past is the number of rows of scales along the lateral line. The literature for years has said that *U. chuss* has about 110 lateral line scales and *U. tenuis* has 140. Leim and Scott (*ibid*) have pointed out as has McCracken (*ibid*) that many hake are taken in Canadian waters with scale counts intermediate between those given for the two species. In actuality, when the situation is assessed, it is found that *U. chuss* may have from 98 to 117 lateral line scales (with a mean around 110) and that *U. tenuis* may have from 119 to 148 lateral line scales (with a mean around 130).

System for *Urophycis*

Examination of several thousand fish at Souris, P.E.I. during August of 1966 revealed the hake catch to be made up of only one species - *Urophycis tenuis*. Souris is the major port for Canadian (Mainland) hake landings from ICNAF Div. 4T. In New England waters this species, when mature, is found primarily in cold deep water, 80 fathoms (146 m) and greater or in areas where the water may be shallow but cool (such as at the mouth of the Bay of Fundy). On the other hand, *U. chuss* undergoes major seasonal migrations which seem primarily to be controlled by temperature. In the summer months *U. chuss* is found spawning over the Continental Shelf in water as shallow as 10-30 fathoms (18-55 m) off southern New England and as shallow as 3-4 fathoms (5-7 m) in the cooler Gulf of Maine. If *U. chuss* occurs in the Gulf of St. Lawrence at all it probably does so in very limited numbers because of adverse hydrographic conditions and most certainly does not contribute to the commercial landings from there to any measurable extent. The same may be said of the occurrence of this species on the Grand Banks. Templeman (personal communication) reports that he knows of no valid record of *U. chuss* from the Grand Banks and as he has pointed out (1966) all hake landed from Subarea 3 have been *U. tenuis*.

McCracken (1966) has suggested "(a) that the landings categories white hake, red hake, and hake (unspecified) become hake (common); and (b) that the scientific name designation become *Urophycis* sp." This suggestion when offered was a valid one because, as McCracken pointed out, by treating the two species as one no particularly pertinent information would be lost "since species designation in any case may be erroneous."

Our research has made it clear that the two species, *chuss* and *tenuis*, are valid and easily identified in most instances. There were inadequacies in the literature that lead to confusion - a case in point being the scale counts. These problems have been resolved.

We suggest that ICNAF consider the following protocol for maintaining separate statistics:

1. For statistical purposes any hake (*Urophycis*) taken in Subareas 1, 2, or 3 and Divisions 4S, 4R, 4T, 4Vn, and 4Vs should be designated as white hake (*Urophycis tenuis*).

2. In Divisions 4W, 4X and Subarea 5, hake designation is not as simple as it is for the remainder of the Convention Area. *U. chuss* begins to appear on the Scotian Shelf in small numbers in the area of the Sable Island Bank (ICNAF Div. 4W), but *U. tenuis* continues to be the more abundant of the two species. To the south and west, *U. chuss* becomes increasingly abundant until in the most southwestern of the Convention Divisions (5Z) it is far more abundant than *U. tenuis*. The hake in these areas may be separated as follows:

   Method of capture: Any hake taken by hook and line (longline, handline, troll line, and trawl line) should be designated as white hake (*U. tenuis*). *U. chuss* is a much smaller fish and is seldom amenable to capture by commercial hook and line methods.

   Size: As pointed out previously there is a substantial difference between the sizes attained by the two species. Any specimen of *Urophycis* larger than 55 cm standard length should be designated as white hake (*Urophycis tenuis*). (The relative numbers of *U. chuss* which attain or surpass 55 cm in total length are so few that the "contamination" in the catch statistics from that source would be insignificant.)

In Subarea 5 it is virtually impossible to make a significant catch of white hake with individuals averaging less than 45 cm. Any such catch may be arbitrarily designated as red hake (*chuss*). All shoal water (less than 60 m) catches from April to November in Subarea 5 may be classified as red hake. During the late winter red hake aggregate and are taken in quantity in depths of 80 to 150 m along the arc from Georges Bank to off Delaware. These catches may contain a few *tenuis* but they may also be quite safely listed as *chuss*, unless, as mentioned above, the average size is significantly greater than 45 cm.

In Divisions 4W and 4X, and within the Gulf of Maine in deeper waters, there will continue to be a problem if individuals do not learn to recognize the two species. Sufficient criteria for recognition have been included earlier in the present paper.

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SECTION C
GEORGES BANK HERRING

1. Further studies on herring caught on Georges Bank in November and December 1966[1]

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During the research cruise of R/V *Wieczno* 1,758 herring were analyzed in detail and 10,000 length measurements were made. The results of the measurements are given in Fig. 1.

In November and December the yield of herring averaged 1,100 kg per 1 hr trawling. This was considerably lower than the results obtained by Polish trawlers from August to October.

The length of analyzed fish varied between 17 to 36 cm, with individuals of 17-22 cm occurring in small number (0.5%). As in 1965 the curve of length composition has one peak. From a comparison of the size of herring captured in 1965 and 1966, it appears that the modal length-class increased by 1 cm from 29.0-29.9 cm in 1965 to 30.0-30.9 cm in 1966 (Fig. 1). The modal length-class increase of 1 cm shows that the same year-classes which were predominant in 1965 were also predominant in 1966.

The analyzed fish were from a post-spawning population and most of the individuals had gonads in Stage II of maturity. The condition of these fish was poor in comparison to full herring. The length/weight relationship of herring, as determined by the equation

$$W = k\ell^n$$

where:

W = the weight of fish in grams
ℓ = the length of fish in cm
k and n = constant coefficients,

is similar to the results obtained for spent herring captured in September 1965 (Fig. 2).

Age analyses showed that most of the fish belonged to the 1960, 1961 and 1959 year-classes; the same ones as found in 1965. Age composition of the analyzed herring is given in Fig. 3. The 1960 year-class was dominant

[1]Submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/53

(51 %). The 1961 year-class was next in importance (20.2%) but is considered poor. More attention is to be given to the 1963 year-class which, although it made up only 7.5% of the catches, still occurred in greater number than the fish of the 1962 year-class. It is expected that the 1963 year-class will become even more important in future years.

The investigations on age composition of herring were performed aboard the research vessel. The analyses also included the samples taken aboard commercial fishing vessels. The latter showed that in commercial catches in August and September herring belonging to the 1960 and 1959 year-classes were predominant (67% and 15% respectively). The 1963 and 1964 year-classes did not occur, though they were present in the catches made by the research vessel R/V *Wieczno*. It should be added that these young year-classes occurred on the fishing grounds at depths up to 80 m.

Mean lengths of fish of the same age-groups for the years 1965 and 1966 are compared in Table 1.

Table 1. The average length (cm) of herring in age-groups I-VIII.

	Age-group							
Year	I	II	III	IV	V	VI	VII	VIII
1965	-	26.0	27.6	29.0	30.5	31.8	32.8	33.5
1966	21.1	25.2	27.7	29.2	30.5	32.4	33.1	33.9

The table shows that in 1966 fish of the same age-groups were in general larger than in 1965, though it must be considered that in 1965 the measurements were performed in September, while in 1966 in November-December. An exception is noted for age-group II, in which the fish captured in 1966 were smaller.

The average lengths given in the table were determinations of the rate of growth of herring using the von Bertalanffy equation:

$$\ell_t = L\infty \, (1-e^{-K(t-t_o)}) \quad \text{(Beverton and Holt, 1957)}$$

where:

ℓ_t = length at age t
$L\infty$ = asymptote of curve of growth in length
K = one of the two main parameters of the von Bertalanffy growth equation
t_o = arbitrary origin of growth curve

The parameters of this equation computed on the basis of the 1966 data are: L_∞ = 35.6 cm; K = 0.297; t_0 = -1.9. The parameters obtained according to the 1965 data were: L_∞ = 37.6 cm; K = 0.195 and t_0 = -3.8 (Draganik, 1966). The curve of the growth rate of herring is presented in Fig. 4. Although mean lengths of fish of the same age-groups differ but slightly in the years 1965 and 1966, the parameters of the von Bertalanffy equation for the data from these years show some differences (K is different by 0.1).

In order to determine whether these differences are of essential character, the range of fluctuations of L_∞ and K values has been determined with the approximation up to 95% on the basis of the data collected in 1966. From the computations it appears that the values of these parameters are within: for L_∞ between 34.1 and 38.2 cm and for K between 0.195 and 0.403. The values for L_∞ and K obtained according to the 1965 data were found to range within the same limits.

The results of these investigations show that the rate of growth, as determined separately from material collected in 1965 and 1966, was approximately the same in both years.

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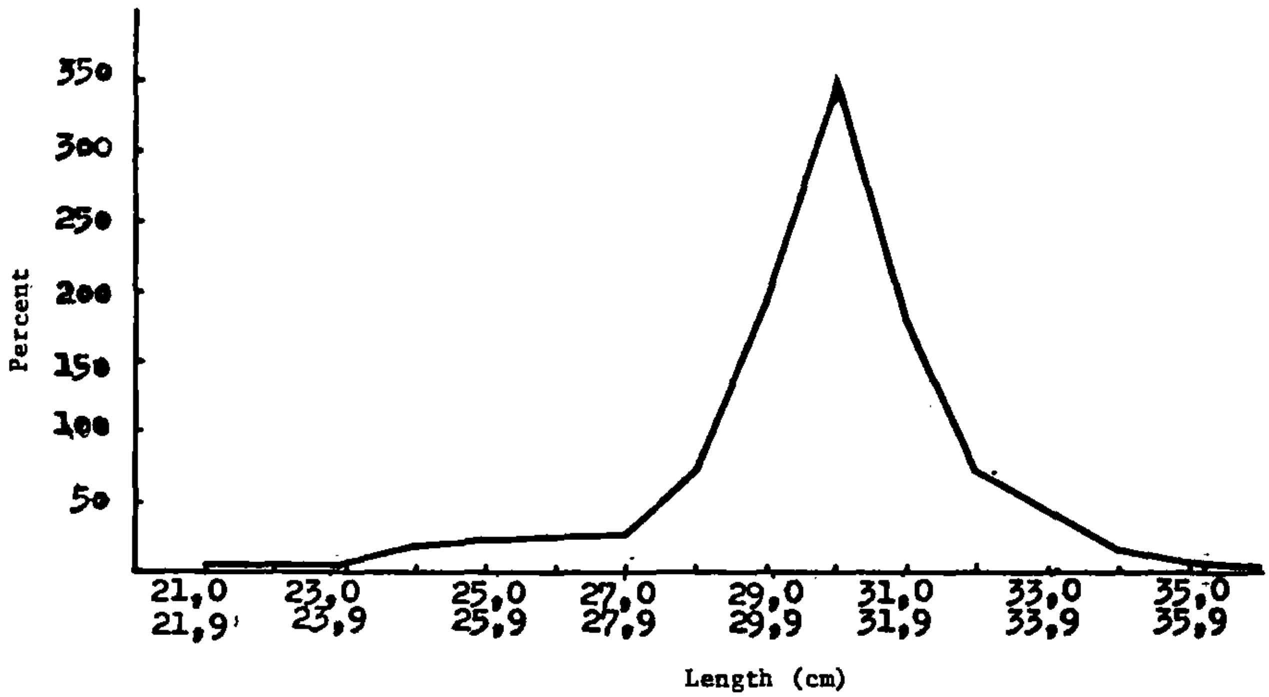

Fig. 1. Length composition of herring from Georges Bank, 1966.

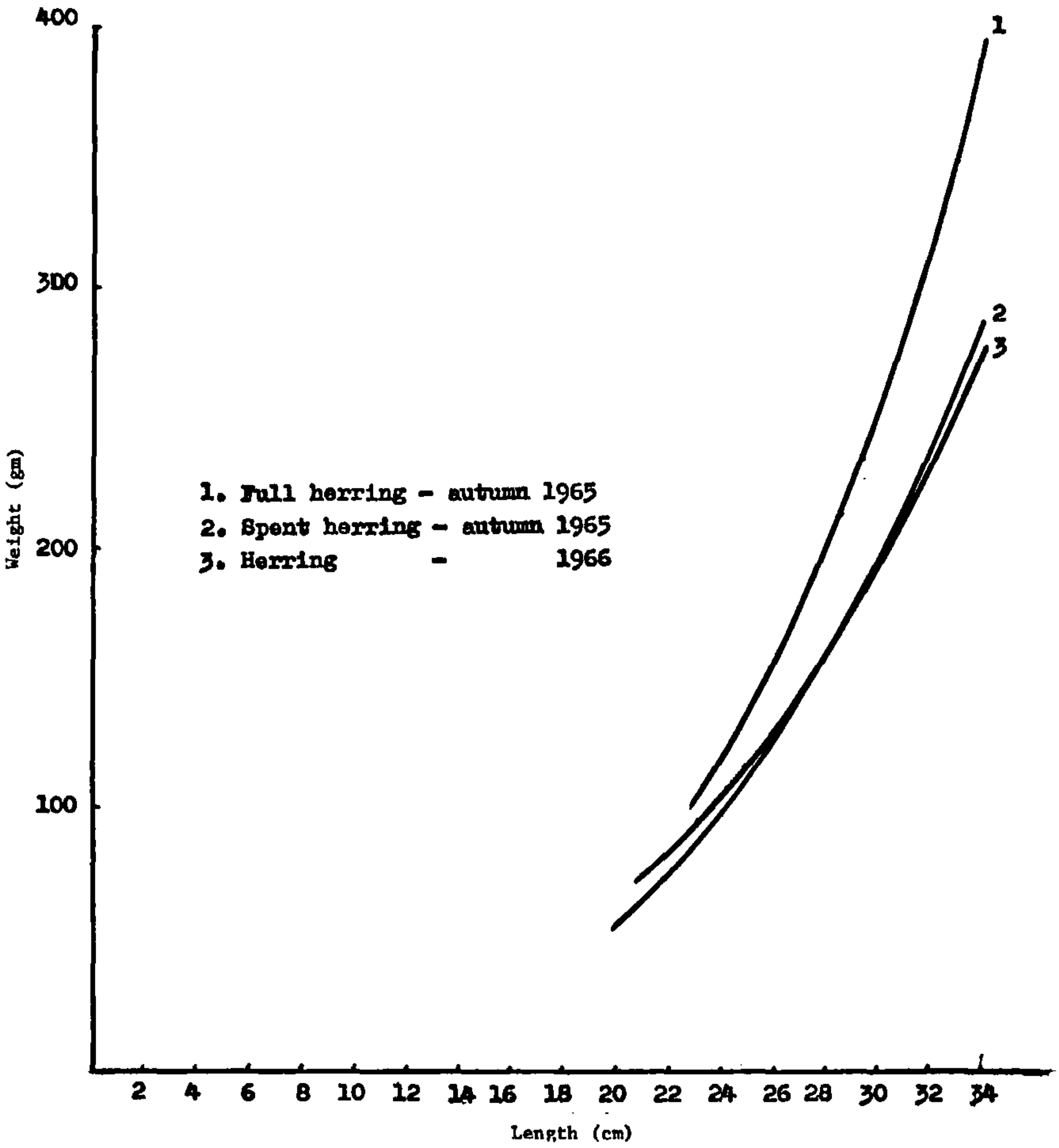

Fig. 2. Relation between length and weight of herring from Georges Bank.

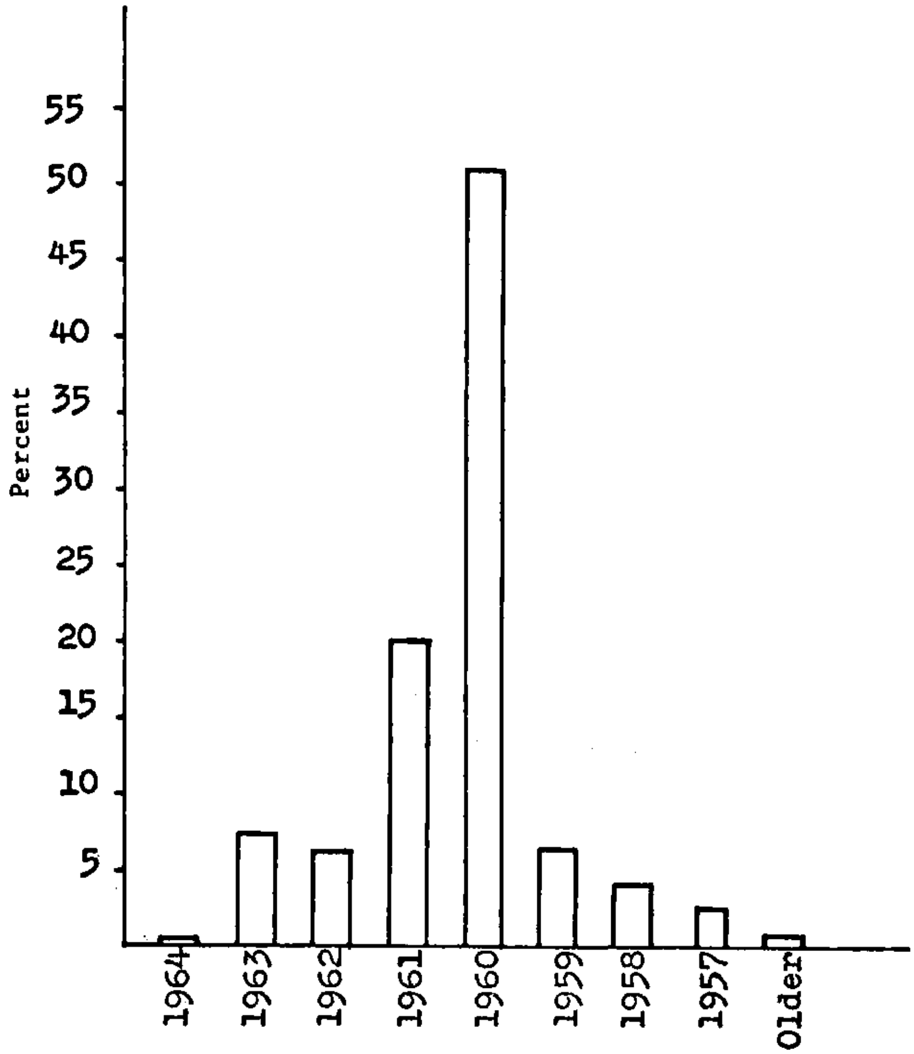

Fig. 3. Age composition of herring from Georges Bank.

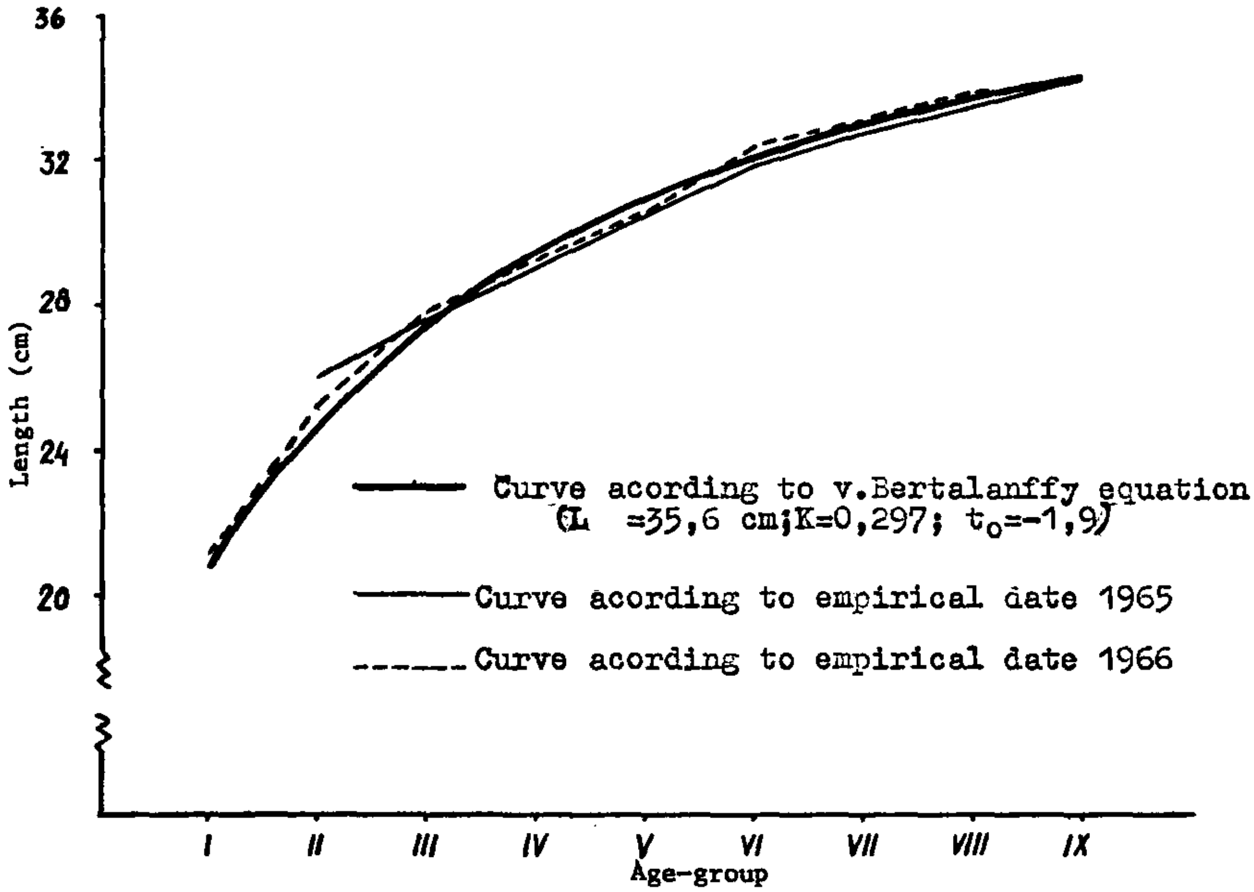

Fig. 4. Growth rate of herring.

SECTION D
MESH MEASURING GAUGES

1. Mesh measurement gauges and methods of applying pressure[1]

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Abstract

This experiment was done to show the significance of differences which exist in several methods of applying pressure using simple mesh measuring gauges. Several methods of applying pressure were tested: (1) spring-loaded; (2) dead weight; and (3) personal estimation. The amount of pressure in two instances was twelve pounds (5.4 kg), and in the third instance pressure was estimated.

The samples were taken from four codends. In the same codend there was greater variation between mesh sizes than between any of the three gauges. An overall analysis of each of two types of netting was made. In each instance, the difference between gauges was not significant.

Introduction

A working group was established at the Commission's Sixteenth Annual Meeting in Madrid in June 1966, with the following terms of reference: "to study the whole question of mesh definition and method of measurement in the light of further discussion in NEAFC of international inspection arrangements with a view to further consideration being given at the Seventeenth Annual Meeting to the question of adopting a single gauge of uniform application which would be simple and satisfy scientists, inspectors, the courts, and the fishermen."

This experiment was made in the interest of resolving these questions. Two United States fisheries inspectors each having considerable experience in the field of law enforcement made the measurements. The primary thought was on inspection and enforcement of regulations - not research.

In the past, numerous experiments have been conducted by scientists. The results, in about every instance, have been the same. In other words, the indications were that with careful use significant differences between average mesh measurement with each gauge are unlikely in spite of the difference in method of applying pressure to the gauges. It seems that great confusion has revolved about the precision of measurements taken from materials that are of questionable stability in the first instance. From the enforcement point of view, the prerequisite in a mesh measuring gauge is its legal acceptance, its ease of use and of transport.

[1] submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/114

The ICNAF regulations define the type gauge to be used in testing mesh size and the amount of pressure to be applied. How this pressure is to be applied is left open for decision by the various user nations due to their individual legal acceptance problems. The ICNAF gauge itself is a standardized blade, is inexpensive, is easy to use, read and to transport. When netting of questionable mesh size is found, a high degree of prudence is used in alleging that a punishable violation has been committed. Due to the variances in mesh size found in netting while in use, and the variation in taking measurements from one inspector to another, there has to be a margin of sound discretion on the part of the investigator. This does away with the precision required by the scientist and places the allegation in a more acceptable light in the court of law. In general, when meshes are measured under different tensions, provided a minimum tension is applied and a maximum tension is not exceeded, mesh size is proportional to the tension applied. Therefore, from the international enforcement point of view, a trained inspector could apply his nation's method of measuring pressure on the international blade and if the average of the measurements were below the minimum in the acceptable margin of discretion, the complaint by another nation would be valid and legal proceedings could be taken accordingly.

Experiment

It was decided that only persons with considerable previous experience, in using mesh measuring gauges, would take part in this experiment. These would be the men who would normally make investigations and who would make mesh measurements on the decks of trawlers at sea. They also are familiar with the types of codend twine being measured, in addition to being familiar with the gauge in use. The only instructions issued were that the gauges were to be used as precisely as possible, and each of the two persons would measure all of the meshes in the row selected, parallel with the long axis of the codend approximately midway between the lacings, using first the spring-loaded blade; second, the weighted blade; and third, the personal estimation. The measured pressures were 5.4 kg including the weight of the gauge except the last which was assumed. Measurements were made on four different codends fabricated from #2 braided nylon (polyamide) cord, tex. no. 12,760, and four others fabricated from 3 mm nylon twisted cord, double, tex. no. 9,330. Due to the high strength of the cord in the meshes, the six measurements made on each mesh using the relatively low pressure had little or no effect on irreversible stretching of the twine and no effect on the knots as these were tightened hard through use. The netting was wet, soft, and flexible during the taking of measurements.

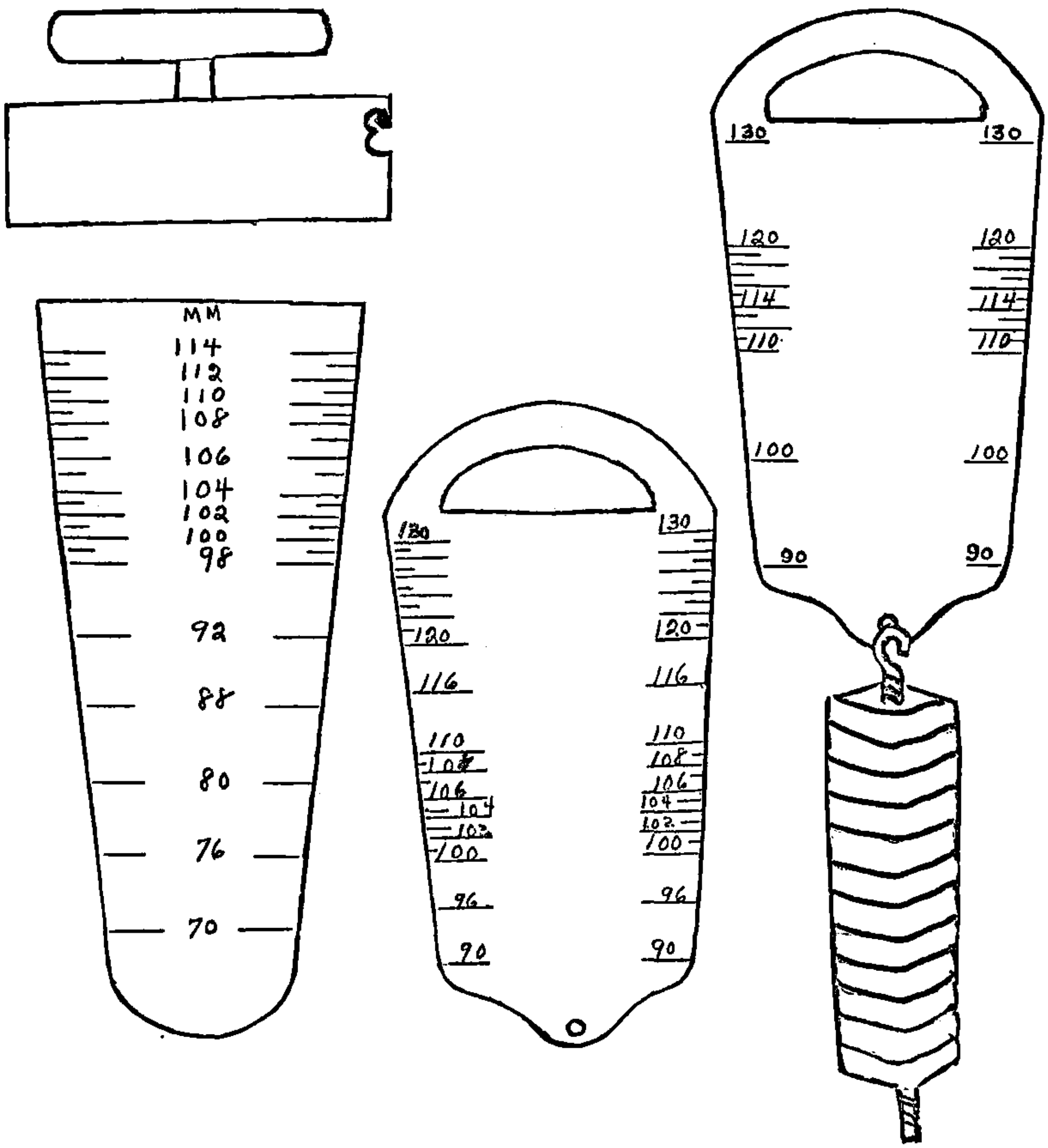
Measuring gauge

The gauges used were the simple plate type drawn to the specifications of the ICNAF Convention. The specifications being, flat wedge-shaped, having a taper of 2 cm in 8 cm and a thickness of 2.3 mm. This is the gauge that has been used in the United States for enforcement and research work (see diagram).

ICNAF Gauges

Methods of Applying Pressure

USA USSR

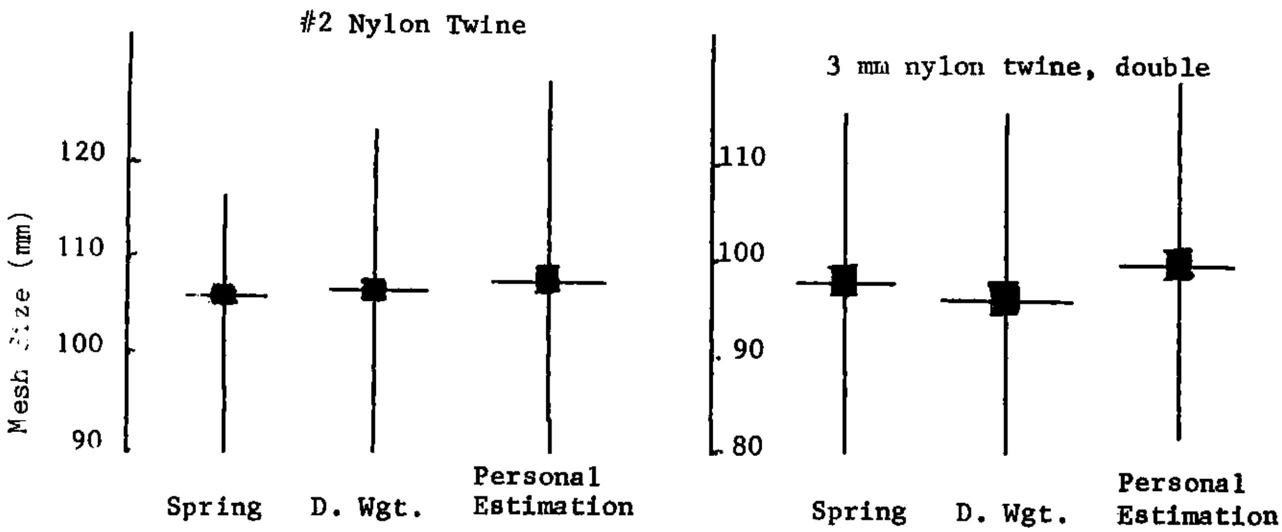


The method of applying measurable pressure is of individual choice. In this experiment the spring-load method approved by ICNAF was used, also the suspension of dead weight from the lower end of the blade, and simply personal estimation for testing.

The gauges used with measurable pressure were adjusted to include the weight of the blade.

Variances and S $\bar{X}$ of Pooled Samples by Method of Applying Pressure and Twine Type

	#2 Nylon Twine			3 mm Nylon Twine, double		
	Spring	D.Wgt.	P.E.	Spring	D.Wgt.	P.E.
N	186	186	186	196	196	196
$\bar{X}$	106.37	106.87	108.71	99.04	98.24	100.00
s^2	40.07	52.16	43.57	37.54	32.65	39.17
$S\bar{X}$	.469	.529	.480	.436	.412	.447
D*	± .938	± 1.058	± .959	± .872	± .824	± .894



*D = 2 $S\bar{X}$ (2 times the standard error of the mean). For example, a range about the mean of 2 $S\bar{X}$ for the spring-loaded gauge on #2 meshes will be 106.37 ± .94:L(+) = 107.31, L(-) = 105.43.

Conclusions

Numerous experiments have been made with several types of mesh measuring gauges by scientists from a number of nations throughout the world. The results of these experiments have been nearly the same, with the great emphasis on the lack of precision.

It would seem that for international enforcement purposes a high degree of precision is unnecessary. An inspector acting prudently would act within a margin of discretion. For legal purposes in this case the margin cannot be too narrow.

The problem should be approached with a philosophic point of view. All of the gauges that have been tested have inherent faults if they are not used cautiously. For purposes of international inspection the simple ICNAF gauge could be used for testing and when it is apparent that an infringement exists a more careful measuring of the meshes can be done the 5.4 kg weights attached. This method is slow and tedious, but there are no springs or mechanical devices, the equipment is inexpensive, and probably acceptable by all courts as a method of measurement. In addition, the blade and the weights can be certified for width and for weight. Consideration should be given to acceptance of the ICNAF blade and this method of applying pressure during the interim to find a more expedient method.

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SECTION E
NORTH ATLANTIC SALMON

1. A preliminary report of the composition of the spawning runs of Atlantic salmon (*Salmo salar*) in Maine rivers for the period 1962-1966[1]

by A. L. Meister and R. E. Cutting
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Preliminary investigations corroborated suspicions that creel census data provide an unrealistic approach to determining spawning run composition of Atlantic salmon (*Salmo salar*) in Maine. Consequently, trapping of the runs or a significant portion thereof, in the lower reaches of the river was considered a prerequisite and a trapping study was initiated in 1962 and continued through 1966. Age-class composition, sex ratios, and length-weight relationships of the trapped portions of the ascending runs are presented in this report.

A fishway trap was installed on the Narraguagus River in May, 1962. Located approximately one mile above tidewater, this structure provides an opportunity to check a significant portion of the ascending runs. Fish are able to negotiate the adjacent spillway of the dam during moderate to high flows, but studies indicate that we sample from 40 to 80% of the ascending runs depending upon water levels during the peak migration periods.

In the period 1962 through 1966 all ascending salmon were measured, weighed, sexed, and tagged. Lengths were recorded in tenths of inches and weights in pounds and ounces. Lengths are total lengths with tail relaxed. Scale samples were taken for later age determination from the region between the lateral line and the posterior edge of the dorsal fin.

In 1966, studies were expanded to include the Machias River. A fishway at Whitneyville, five miles above tidewater, was provided with a trap, and data from the 1966 season are incorporated in this report.

Fish of hatchery-origin are present in the ascending runs of the Narraguagus and Machias Rivers but they are of minor importance. The predominance of grilse among these fish precluded their being representative of the native spawning runs. Data presented in this report pertain strictly to native stock.

Composition of the ascending runs of salmon

Scale interpretation allowed ageing of each fish and assignment to age-class and component portion of the ascending run. Age at smolt migration as well as the number of years spent in the marine environment were recorded for each fish. Fish were divided into maiden (virgin) salmon, and salmon

[1]submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/42

showing one or more spawning marks on their scales. The latter are referred to as repeat spawners and are so listed in the age-class composition of the ascending runs by years as presented in Table 1.

Frequently, the maiden portion of a spawning run is divided into grilse (1-sea-year fish), small salmon, and large (3-sea-year) salmon. The relative scarcity of both grilse and large salmon in Maine waters make this an arbitrary division of little real significance. Grilse accounted for less than 2% of the fish throughout the study period with yearly fluctuations ranging from 0 to 4.6% of the salmon from the Narraguagus. The 1966 figure of 3.6% grilse for the Machias is within this range.

Table 1. Age-class composition of the spawning runs of Atlantic salmon in Maine rivers.

	NARRAGUAGUS RIVER							MACHIAS RIVER
Year	1962	1963	1964	1965	1966	Total	Percent of total	1966
No. of fish	253	173	249	227	193	1,095	100.0	531
MAIDEN FISH								
1-sea-year	-	8	-	2	3	13	1.2	19
2-sea-year	235	138	216	208	167	964	88.1	446
3-sea-year	5	4	3	4	3	19	1.7	15
Maiden fish (percent)	94.9	86.7	87.9	94.3	89.6		91.0	90.4
REPEAT SPAWNERS								
2nd Run	11	17	29	10	20	87	7.9	41
3rd Run	2	6	1	3	-	12	1.1	10
Repeaters (percent)	5.1	13.3	12.1	5.7	10.4		9.0	9.6
SMOLT AGES								
1-year	-	-	-	-	-	-	-	4
2-year	217	139	216	172	167	911	83.2	473
3-year	36	34	33	55	26	184	16.8	53
4-year	-	-	-	-	-	-	-	1
2-year smolt (percent)	85.8	80.4	86.8	75.8	86.5		83.2	89.1

Large salmon account for 1.2 to 2.3% of the ascending fish with an average of 1.7% for the Narraguagus (Table 1).

The repeat spawner portion of the runs range yearly from 5.1 to 13.3% with an average of 9.0% for the study period. Dominant in this portion of the run are fish returning on a second spawning migration (88% of the repeat spawners).

Dominant fish in the salmon streams of Maine are 2-sea-year fish (Table 1). They account for 88% of the fish handled during the study period on the Narraguagus and 84% of the fish from the Machias in 1966.

Smolt ages of the returning adults for the Narraguagus River were entirely 2- and 3-year-old fish. The 2-year smolt age-class was dominant with 76 to 86% of the returning adults in this group. Average for the study period was 83% for fish of 2-year smolt origin. Less than 1% of the fish from the Machias were from 1-year smolts and the 2-year smolt age-group was dominant.

Length-weight relationship of Narraguagus salmon

The length-weight relationship of Narraguagus River salmon is well within the established ranges for *Salmo salar* and Table 2 presents the lengths and weights of Narraguagus salmon by class. Part of the wide range for maiden fish can be attributed to dimorphism for no attempt is here made to separate sexes.

All lengths and weights of Narraguagus salmon, with the exception of grilse, are well within the ranges exploited by the Greenland fishery.

Sex ratios of the ascending adults

In the study period 1962 through 1966 ascending fish (901 salmon) have been sexed at the fishway trap. Sex ratios by class and year are presented in Table 3. The ratio of male to female has ranged from 1.0:1.29 to a low of 1.0:1.83 for the study period with an average of 1.0:1.49.

The low number of males can be attributed in part to the relative scarcity of grilse in the spawning runs of Maine streams. A more realistic approach to the sex composition of the spawning runs can perhaps be made by expressing the number of males in percent. Males throughout the study period have averaged 40% of the fish in each run (Table 3).

Age composition of the smolt migrations *vs* returning adults

A brief comparison of the age-class composition of smolt migrations and the determined smolt ages of the returning adults was undertaken. From Table 1 we find that the majority of the returning adults are 2-sea-year fish originating from 2-year-old smolts. Consequently, the returning maiden

Table 2. Length-weight relationship of Narraguagus River salmon, Maine, USA.

Class	Lengths[a] Range	Mean	Weights Range	Mean
Grilse	21.7 - 25.6	23.5 (59.7 cm)	2 lb 12 oz 4 lb 14 oz	3 lb 15 oz (1.786 kg)
Maiden fish				
2-sea-year	27.0 - 33.6	30.0 (76.1 cm)	6 lb 4 oz 12 lb 12 oz	8 lb 14 oz (3.926 kg)
3-sea-year	33.0 - 36.0	35.1 (89.1 cm)	14 lb 10 oz 17 lb 0 oz	15 lb 12 oz (7.144 kg)
Repeat spawners				
2nd Trip	32.5 - 41.0	35.0 (88.8 cm)	12 lb 4 oz 19 lb 2 oz	15 lb 8 oz (7.029 kg)
3rd Trip	35.7 - 42.0	38.5 (97.7 cm)	17 lb 2 oz 24 lb 2 oz	20 lb 4 oz (9.185 kg)

[a]Total lengths with tail relaxed expressed in 0.1 inches.
Figures in parentheses are metric equivalents.

Table 3. Sex ratio of the trap caught portion of the spawning runs of Atlantic salmon in the Narraguagus River, Maine, USA for the period 1962-1966.

Year	1962		1963		1964		1965		1966		Total	
Sex	M	F	M	F	M	F	M	F	M	F	M	F
Class												
Grilse	0	0	6	1	0	0	2	0	2	1	10	2
Maiden fish	70	123	46	67	88	101	65	97	60	89	329	477
Repeat spawners	2	9	4	13	7	22	3	7	6	10	22	61
Totals	72	132	56	81	95	123	70	104	68	100	361	540
Ratio Male:Female	1.0:1.83		1.0:1.45		1.0:1.29		1.0:1.48		1.0:1.47		1.0:1.49	
Total fish sexed	204		137		218		174		168		901	
Males (percent)	35.29		40.87		43.58		40.23		40.48		40.06	

adults have been compared with the smolt migrations occurring two years prior to their return.

The percentage of 2-year-old fish in the smolt migrations for the period 1960 through 1964 have ranged from 60 to 90%. Three-year-old smolts account for the remainder of the fish handled in our assessment studies on the Narraguagus River. Comparing these figures with the smolt ages of the ascending adults for the period 1962 through 1966, we find that 72 to 87% of the maiden fish originated from 2-year smolts.

The difference in the figures for smolt migrations as compared with the returning adults can perhaps be accounted for in two ways. Three-year smolts are usually larger and this may enhance survival. Secondly, the assessment figures may not be truly representative of the smolt migration for the entire watershed.

2. Marine migration of Atlantic salmon kelts tagged in Maine, USA[1]

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Introduction

Development of a fishery of significant proportions for Atlantic salmon (*Salmo salar*) off the West Greenland coast has given impetus to the study of marine salmon movements. Too little is known about the impact of the Greenland fishery on the salmon stocks of countries on both sides of the North Atlantic. Determination of the composition of the Greenland catch in terms of country of origin is only one phase of the assessment of that fishery. Knowledge of movements of tagged salmon will contribute to that assessment.

Biological statistics of the Greenland catch indicate that most of the salmon are taken during their second year of marine feeding (Hansen, 1965; Saunders, 1966). Few of the fish will spawn as grilse. The preponderance of second-sea-year fish might indicate serious exploitation of stocks from large Greenland catches for areas like Maine which has few grilse. Maine spawning runs of native fish average about 2% grilse. Of the remaining 98%, about 9% is composed of repeat spawners.

Tag returns

In 1962 the Maine Atlantic Salmon Commission began operating a trap in the Denil-type fishway at the Cherryfield Dam on the Narraguagus River in eastern Maine. Ascending adults are captured for tagging as they move through this fishway. Approximately 50-80% of the ascending run is captured, the remainder of the run bypasses the fishway via a spillway when water levels are suitable. During 1962-1965, a total of 788 spawning fish was tagged (Meister and Cutting, 1966). Based on estimated survival in the stream, we estimate the spawning survivors number no more than 580 fish. Percent tag recovery figures for tagged post-kelts in the sea and in the natal river are summarized in Table 1.

The total estimated survivors is at best a maximum figure. The percentage of tagged fish surviving the migration back into salt water is not known exactly. Furthermore, tagged fish returns to the river indicate that tag loss in some years may exceed 50%. On this basis, the known commercial exploitation of Maine-tagged post-kelts is at least 5% of the kelts returning to the marine environment, and quite likely the rate may fall in the range of 10-15%. In like manner, for each Convention Area tag return, there is about one tag return to the river. Commercial fisheries may be harvesting half of the post-kelts available in the ocean.

[1] submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/57

Table 1.

Year tagged	Number tagged and released	Estimated survivors[a]	Tag recoveries	Percent recovery[b]	River returns	Percent river returns[b]
1962	206	151	9	5.96	16	10.60
1963	166	123	4	3.25	7	5.69
1964	225	160	7	4.38	16	10.00
1965	191	146	10	6.85	-	-
Totals	788	580	30	$\overline{X}$ = 5.17		

[a]Estimated survival in stream ± 10%.
[b]Based on estimate survival figures.

Table 2.

Tagged		Recaptured	ICNAF Divisions 1B	1C	1F	3K	3L	3Ps	4X	Totals
1962	June	1963	-	-	-	-	-	2	1	3
	July		-	-	-	-	2	1	2	5
	October		1	-	-	-	-	-	-	1
1963	June	1964	-	-	-	-	-	2	-	2
	July		-	-	-	-	1	-	-	1
	November		1	-	-	-	-	-	-	1
1964	June	1965	-	-	-	-	-	-	1	1
	July		-	-	-	-	-	2	-	2
	August		-	-	-	-	1	-	-	1
	September		-	-	-	-	-	-	1	1
	October		-	-	-	1	-	-	-	1
	November		-	-	-	1	-	-	-	1
1965	June	1966	-	-	-	-	-	2	-	2
	July		-	-	-	-	-	3	1	4
	August		-	-	1	-	-	-	-	1
	November		-	1	-	-	1	-	-	2
	December		-	-	-	-	1	-	-	1
Totals			2	1	1	2	6	12	6	30

Table 3.

Geographic area	ICNAF Div.	Distance from tagging site in statute miles	Time at sea (days) from 1 May	Rate of movement (miles/day) from 1 May	Group mean days at large	Rate of travel (miles/day)
Bay of Fundy	4X					
		152	91	1.7)		
		144	79	1.8)	87	1.8
		165	90	1.8)		
Western Nova Scotia	4X					
		171	148	1.2)	148	1.2
Central Nova Scotia	4X					
		189	56	3.0)	52	4.2
		254	48	5.3)		
Southern Newfoundland	3Ps					
		697	58	12.0)		
		697	46	15.2)		
		705	62	11.4)		
		697	76	9.2)		
		697	51	13.7)		
		747	76	9.8)	62	11.7
		697	64	10.9)		
		699	46	15.2)		
		699	71	9.8)		
		705	62	11.4)		
		699	65	10.8)		
		699	61	11.5)		
Southeastern Newfoundland	3L					
		841	70	12.0)		
		830	73	11.4)	78	11.0
		830	64	13.0)		
		830	107	7.8)		
Northeastern Newfoundland	3K,L					
		1,070	165	6.5)		
		1,038	200	5.2)	200	5.1
		965	210	4.6)		(adjusted - 13.4)[a]
		958	224	4.3)		
Greenland	1B,C,F					
		2,215	155	14.3)		
		2,215	197	11.2)	173	12.3
		2,087	209	9.8)		
		1,839	133	13.8)		

[a]Assumed migration to Greenland and return

Recovery locations and rate of movement

Maine-tagged post-kelts are widely distributed along the western North Atlantic Ocean. The Convention Area distributions of the tag recoveries is presented in Table 2. The pattern of tag returns has been essentially similar for the study period.

Information reported with the tag returns permits a preliminary assessment of where and when the post-kelts are migrating. The returns can logically be grouped into 7 geographic areas. The straight-line distances from the tagging site to recovery site were calculated. The estimation of rate of movement requires a determination of the actual period of time spent in the marine environment. Most kelts have left the Narraguagus River in the spring by 1 May, so that date was chosen as being representative of the migrants. The number of days at large after 1 May and the rate of movement in statute miles per day were calculated for each fish. Group means were then established (Table 3).

The average rate of movement of Maine's kelts seems to be about 10 to 12 statute miles per day. This rate includes the acclimation period in the estuary when actual marine migration will be little. The information falls well within the rates of travel for feeding salmon from salmon tagging projects on both sides of the Atlantic Ocean (Table 4).

Table 4.

Tagging site	Percent recaptures	Rate of movement (miles per day)	Reference
Tadoussac, Quebec, Canada	1.8	—	Lagueux, 1953
Seven Islands, Quebec, Canada	14.2	0.4-17.3	Belding & Prefontaine, 1961
Francis Harbour Light, Labrador, Canada	15 (salmon) 7 (grilse)	5.8-17.0	Blair, 1957
Cape Charles, Labrador, Canada	17.1(salmon) 8.3(grilse)	—	Blair, 1957
St. Anthony, Newfoundland	18.5	1.0-32.4	Belding & Prefontaine, 1961
Bonavista, Newfoundland	42.7(salmon) 39.2(grilse)	1.1-26.2 0.8-32.5	Blair, 1956
Ireland	—	4.3-11.1	Went, 1965
Co. Waterford, Ireland	33.9	Most less than 10	Twomey & O'Riordan, 1963
Ireland	12.2-43.2	Most less than 15	Went, 1964

Discussion

Atlantic salmon movements in the western North Atlantic have been studied using tagged salmon. Adult fish are usually captured in commercial fishing gear in the salt water. Subsequent distribution of tag returns has been the major means of assessing migration routes and rates.

Study of the salmon populations in the Gulf of St. Lawrence indicates movement into the Gulf both via the Cabot Strait and the Strait of Belle Isle (Belding, 1939; Belding and Prefontaine, 1961). Results from kelt tagging in Quebec support movement from the Gulf by way of the Cabot Strait (Lagueux, 1953). Huntsman (1939) reports the movement of kelts from New Brunswick and Nova Scotia rivers to the east coast of Newfoundland, but the recaptures mostly occurred later than the year after tagging. Murray (1958) reports information which might indicate a clockwise movement of feeding salmon around Newfoundland. However, tagging experiments in Labrador (Blair, 1957) and in northeastern Newfoundland (Belding and Prefontaine, 1961) point to the movement of salmon southwesterly through the Strait of Belle Isle. Kelts released into the Annapolis River, Nova Scotia (Bay of Fundy) have been recaptured on the east coast of Newfoundland (Huntsman, 1938), and the movement pattern is suggestive of a similarity with the returns from Narraguagus kelts.

Figure 1 is a map indicating the 7 geographic areas for the Maine tag returns. The group mean number of days at large since 1 May and the number of tag returns are presented. Apparently, the feeding kelts take about 50 days to reach the Halifax area on the south-central Nova Scotian coast. Another 10 to 20 days' feeding finds them along the southern Newfoundland coast. Cape Race, Newfoundland, is circumnavigated during the following 10-20 days. Thereafter, from late summer until well into autumn, the fish drop from sight. Late autumn finds them along the Greenland coast where there are some recaptures. By early winter, some fish have turned back toward the natal river, have reached a weight of 15 to 20 lb (7-9 kg), and appear in the fishery along the northeastern Newfoundland coast. Table 2 has an adjusted rate of travel listed for this latter group of fish. The adjusted figure assumes a migration to the vicinity of Greenland and return to Newfoundland. The recalculated rate of movement is much more realistic when compared to the other listed rates of movement.

The recaptures of tags in ICNAF Div. 4X seem to be a separate group of fish. Three of the 5 fish for which we have recapture data have mended well, grown in weight, and have been captured in commercial gear not too distant from the natal river. It seems very likely that this group includes salmon which will spawn in consecutive years. Consecutive-year spawners are not uncommon in Maine waters. Assuming for the moment that this group includes spawners which returned to the sea in the fall and estimating a distance of travel at the indicated rate of movement of 11 miles per day for the interim period before capture, we would point toward a feeding migration to the vicinity of Newfoundland, then a return journey toward the natal river.

Our data would indicate that Maine-tagged salmon move counterclockwise, or easterly, along the southern and easterly coasts of Newfoundland during July and early August. Tagging by Blair (1956) revealed a clockwise or westerly movement of salmon, destined for the streams of the Gulf of St. Lawrence, as they migrate along the east and south coasts of Newfoundland during the month of June. Murray (1958), following the movements of salmon tagged in the Little Codroy River, found these fish returning from their feeding migration in a clockwise direction along the east and south coasts.

Belding and Prefontaine (1961) report a progressive northerly movement of the peak of the salmon run along the easterly coast of Newfoundland. In 1938, the peak passed St. Anthony about 24 June. In the same year, the peak passed Port-aux-Basques on the southwestern tip of Newfoundland about 1 June. It appears that the movement of Maine post-kelts does not coincide with the peak movements either on the southern or easterly Newfoundland coasts.

These findings provide a base for more detailed studies on salmon migrations in the Atlantic Ocean. The Maine salmon program in 1966 was expanded to provide 200% more tagged kelts per year. The excellent cooperation received from Canadian and Danish fisheries personnel has given very useful information to date. We know that continued cooperation will permit even greater strides in the international understanding of Atlantic salmon migrations in the North Atlantic.

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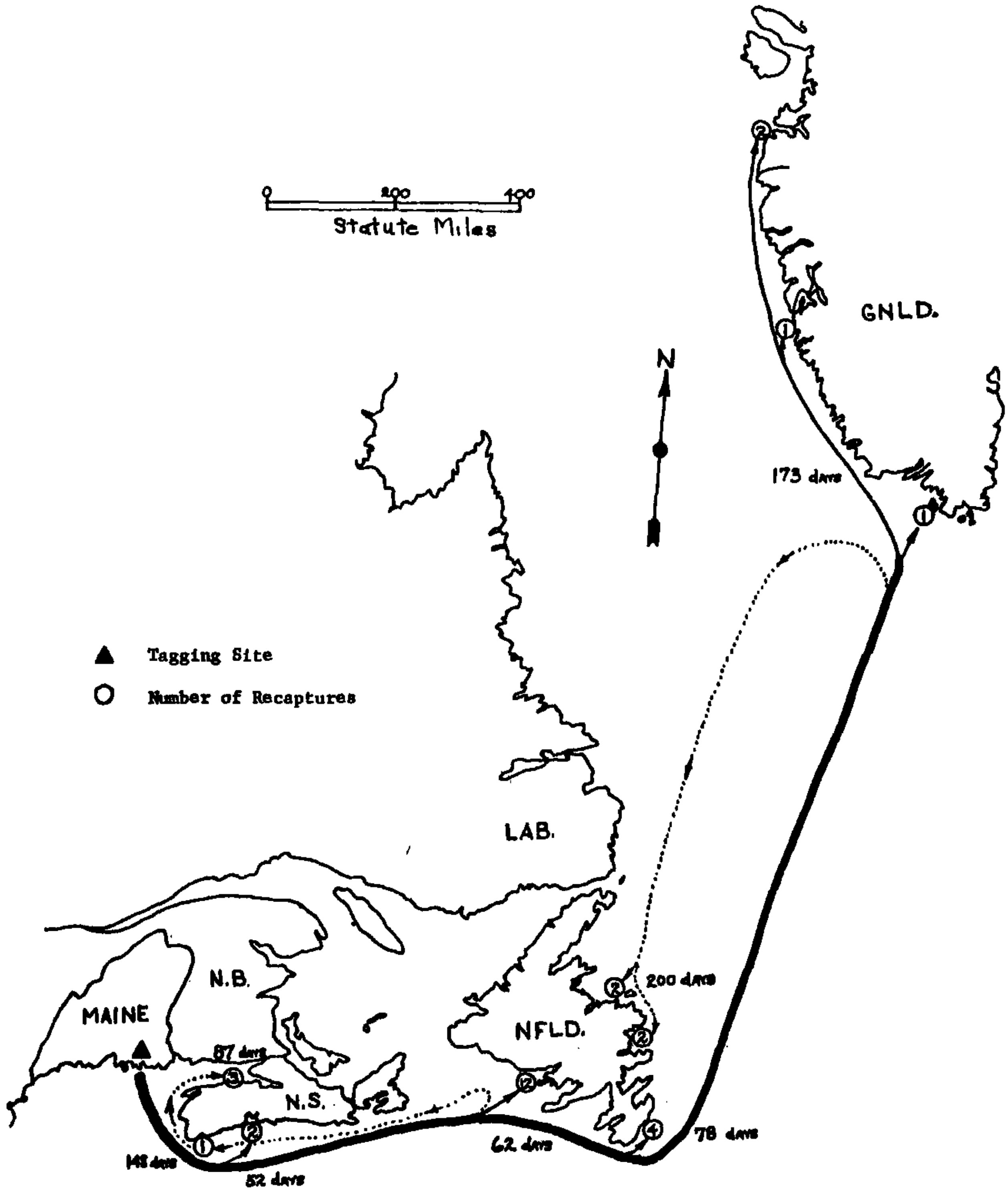

Fig. 1. Recaptures of tagged Narraguagus Atlantic salmon for 1962-1966 grouped by geographic area. Group mean time interval and probable migration routes are indicated.

3. A revised estimate of the rate of growth between Greenland and home waters of salmon from the Miramichi River, New Brunswick, Canada[1]

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In a paper submitted to the first meeting of the ICES/ICNAF Joint Working Party on North Atlantic Salmon (ICES/ICNAF Salmon Doc. 66/9) a preliminary estimate was made of the rate of growth of Atlantic salmon from the Miramichi River over the period between their presence on the Greenland coast during their second autumn in the sea, and their return to their home rivers in the following summer. The estimated instantaneous rate of growth in weight on a monthly basis was 0.04.

Since preparation of that paper, additional data have become available enabling a more soundly based estimate to be obtained. As before, the most satisfactory estimate is obtained by determining the mean length of fish at both stages of their lives, and using data on the weight-length relationship to estimate the corresponding weights. For this report, larger samples have been available for determining mean lengths, and better data on the weight-length relationship at each stage have been collected.

In 1966, the number of salmon tagged as smolts in the Miramichi River and caught at Greenland was much greater than in any previous year. The largest homogeneous group was composed of naturally produced smolts which had been tagged as they passed through the counting fence on the lower Northwest Miramichi River. The mean total length to maximum extension of the caudal fin for the group of 48 fish recaptured in Greenland was 64.5 cm. Other studies (Saunders and Allen, in press) have shown that tagging reduces the size of Miramichi fish at the time of return by about 2.3% in length. Applying this correction also to fish taken at Greenland raises the estimated true mean length to 66.0 cm. The mean date of capture of these fish was 10 October.

Examination of data accumulated in scale studies between 1952 and 1964 has greatly increased the records of 2-sea-year maiden fish taken in the Miramichi River and its vicinity. Most of the data refer to fish caught in the Miramichi estuary and further upstream in the river itself or its tributaries, and nearly all these fish would be Miramichi natives. The data also include, for the period prior to 16 August, some fish caught in the commercial drift-net fishery outside the estuary. Belding and Prefontaine (1939) studied

[1]Submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/93

this fishery and concluded that, at that time, the catch consisted about equally of Miramichi fish and fish bound for the Bay of Chaleur further north. They also showed that there was no significant difference in length between 2-sea-year fish caught in the drift-net fishery and 2-sea-year Miramichi fish. Use of the entire sample will therefore have little effect on the present result. This included 1,268 fish with a mean total length of 76.6 cm and mean capture date of 29 August. Most of the drift-net-caught fish may be eliminated by using only fish caught after 31 July; this leaves a sample of 810 fish with a mean length of 78.0 cm and mean capture date of 30 September.

In 1966, total weights and total lengths were carefully recorded for 19 fish taken at Greenland and examined during parasitological studies. A logarithmic regression leads to the relation

$$W = 10^{-5} \times 4.15\ L^{2.67} ,$$

where W is in kg and L in cm. At about the mean length of the fish taken at Greenland, this corresponds to a condition factor of about 106. Applying this relationship gives a weight of 3.04 kg for Miramichi fish of average length caught at Greenland.

Total lengths and weights were also recorded for samples of salmon taken in the Miramichi area in 1966. For a sample of 52 2-sea-year maiden fish caught at the counting fence on the lower Northwest Miramichi River the weight-length relationship was

$$W = 10^{-6} \times 2.50\ L^{3.28}$$

This corresponds at the mean length to a condition factor of about 84. These fish had ceased feeding and commenced their upstream journey, and a sample was therefore also examined from the catch of the drift-net fishery. The mean condition factor of a sample of 186 fish judged by their size to be 2-sea-year fish was found to be 104. This value, although very different from that for the upstream sample, corresponds closely with figures obtained by Hoar (1940) for salmon from the commercial catch at several different points on the New Brunswick and Nova Scotia coasts. Since the purpose of the present studies is to examine the effect of the Greenland fishery on the weight of the catch of salmon in home waters, it is appropriate to use the condition factor of fish caught in the home-water fishery and not that for fish which have begun their upriver journey. Using a condition factor of 104, the estimated weights of fish of mean length were

Total sample - mean length 76.6 cm weight 4.67 kg

Late-run sample - mean length 78.0 cm weight 4.94 kg

The time intervals (t) between the mean date of capture at Greenland and in the total and late-run Miramichi samples are 10.6 and 11.3 months respectively.

The instantaneous growth rate may be calculated as

$$\frac{\log_e W_2 - \log_e W_1}{t}$$

where W_1 and W_2 are weights at Greenland and home waters respectively.

The estimates of instantaneous growth rate on a monthly basis are then

Total sample - .040

Late-run sample - .043

These values are almost identical with, and thus confirm, the tentative estimates made in the previous report.

The Joint Working Party, in its first report, pointed out that on the data then available the ratio between the weights of fish at Greenland and at the time of return to the Miramichi was 1:1.46 and this led to the conclusion that "if more than about 70% of the fish present in West Greenland waters were, in the absence of the Greenland fishery, caught in home waters, then a West Greenland fishery would reduce the total world catch."

The mean date of the Greenland sample was 10 October, while the mid-date of the commercial fishing season in the Maritimes area is approximately 1 July. Thus, the time interval is about 8.6 months. At an instantaneous growth rate of .04, the weight at the time of the Canadian fishery is $e^{8.6 \times .04}$ times that at the time of the Greenland fishery. This ratio equals 1.41, which corresponds exactly to the value of 70% suggested by the Working Party as being the critical percentage in determining whether or not the Greenland fishery leads to an increase in the total world catch of Atlantic salmon.

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4. Results of Atlantic salmon tagging in the Maritime Provinces of Canada, 1964-66[1]

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Although the earliest Canadian tags recovered from Greenland were attached in 1959, it is only the 1963, 1964 and 1965 smolt taggings which have given sufficient numbers of recoveries there to provide a useful basis for analysis. In the earlier years, the numbers of tags used were comparatively small, and the Greenland fishery had not reached sufficient intensity to give a high recovery rate. The still larger number of smolts tagged in Canada in 1966 will, of course, not begin to appear in Greenland catches until the autumn of 1967.

The principal results for 1963, 1964 and 1965 are summarized in the appended table. They have been divided into three areas: (a) on the west coast of the Gulf of St. Lawrence; the Miramichi River in New Brunswick; (b) on the south and southeast coasts of the Gulf in Nova Scotia, the Margaree River and the River Philip; and (c) in the Bay of Fundy; the Big Salmon River on the south coast of New Brunswick. Counting fences or traps which permitted the examination of returning adults were operated on all these rivers except the Margaree River, where the only fence was on a minor tributary.

The additional data which have become available from the 1966 fishery have brought out three points:

(a) The effect of the size and condition of smolts at the time of migration on their subsequent movements may extend to influencing the proportion which travel to the Greenland area.

(b) There may be major variations from year to year in the proportion of Canadian salmon visiting Greenland.

(c) There may be differences in the proportion of salmon going to Greenland from different parts of the Canadian coast.

Effects of smolt size and condition

Some indications of the effect of size and condition at migration on subsequent movements can be obtained by examination of the data for the

[1] submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/108

hatchery-produced fish, since these may vary much more in growth rate and parentage than the natural smolts in any one river. For example, of the hatchery-produced smolts liberated in the Miramichi River in 1964, 3 returns were received from Greenland and 24 as grilse or 2-sea-year salmon in home waters (Greenland giving 11% of total recaptures), while in the same year the natural smolts were 7 against 236 (2%). In 1963, the corresponding figures were: hatchery smolts 3 against 105 (3%), natural smolts 9 against 78 (10%). Thus, the hatchery smolts gave a return from Greenland which was much higher than that for natural smolts in 1964 and much lower in 1963. There appear to be no significant differences in the proportions returning as grilse as 2-sea-year salmon between the various lots. Detailed examination of the full data for hatchery-produced fish suggests that there may be a tendency for the larger smolts to produce relatively fewer grilse and, perhaps as a result, a larger proportion of fish visiting Greenland.

Variations from year to year

The number of Canadian tags recovered from Greenland in 1966 was much greater than in any previous year, and the increase was due more to a higher proportion of tags being recaptured and reported than to the increase in the number of tags used. Pooling all data for the Gulf of St. Lawrence, the results are:

Year of	Total smolts			Natural smolts		
tagging	Tagged	Greenland	%	Tagged	Greenland	%
1963	12,710	13	.10	4,678	9	.19
1964	40,135	14	.03	14,220	7	.05
1965	41,980	110	.26	16,483	58	.35

The trend is similar if the hatchery smolts are examined separately, the 1964 return being lowest, and the 1965 return highest.

These figures would be affected by any differences in the tagging procedure which could influence overall recovery. It is, therefore, interesting to compare the returns as grilse and from Greenland for the same material.

	Total smolts			Natural smolts		
	Grilse	Greenland	Greenland grilse	Grilse	Greenland	Greenland grilse
1963	196	13	.07	66	9	.14
1964	260	14	.05	187	7	.04
1965	445	110	.25	163	58	.36

Comparisons between Greenland and 2-sea-year returns can only be made yet for the first two years. These give the following results.

	Total smolts			Natural smolts		
	2-sea-year	Greenland	Greenland/2-sea-year	2-sea-year	Greenland	Greenland/2-sea-year
1963	37	13	.35	12	9	.75
1964	100	14	.14	59	7	.12

Thus, all analyses show similar trends: a moderate drop in the relative return from Greenland from 1963 to 1964, and a strong rise in 1965 to well above the 1963 level.

To obtain overall figures which would indicate approximately the relation between the proportions of returns coming from Greenland in the three years, the values for 1963 have been taken as 1.0, and geometric means determined for all the series of data for the other years. This leads to the following table.

	Ratio	Greenland catches for following year
1963	1.0	1,400 metric tons
1964	0.3	716 " "
1965	2.5	1,235 " "

The comparison in the table with the Greenland catches shows that while the decline in the 1964 returns is of the same order as the change in the Greenland catch, the rise in returns for 1965 is not associated with a rise of similar magnitude in the Greenland catch. A better comparison would be with the size of the fishing effort in each year at Greenland but these data are not available. The information which has been received does not suggest that there was any substantial increase in effort at Greenland in 1966.

If the increased return from Greenland for the 1965 tags is not due to more intensive fishing, it could be the result either of more efficient tag recovery there, or of a real increase in the proportion of Canadian smolts entering Greenland inshore waters. An increase of 2½ times in the proportion of tags handed in seems unlikely to have been achieved between one season and the next, but the tag data from other countries should also bear on this point.

An increase in the proportion of Canadian smolts going to Greenland could be contributed to both by an increase in the proportion remaining in the sea for a second year, and by a larger part of those which spend 2 years in the sea reaching the Greenland coast. There is no indication at present of any decrease in the proportion of fish returning as grilse from the 1965 taggings such as might be expected if more of these fish than usual had remained at sea for 2 years. The tag recoveries from 2-sea-year fish caught in Canadian waters in 1967 will, however, provide more satisfactory evidence on this point. If these confirm the indications from the data now available, an increase in the proportion of 2-sea-year fish reaching Greenland may remain the most probable hypothesis.

If it is possible for a significantly greater proportion of Canadian fish to visit Greenland in one year than in another, then obviously the effects of the Greenland fishery on Canadian fisheries and stocks may vary from one year to another, and it will be correspondingly more difficult to reach soundly-based generalizations until long series of good data are available.

Migration to Greenland from different areas

In the previous section the results for the Miramichi and Nova Scotia have been pooled, and on the present data the hypothesis that equal proportions of smolts go to Greenland from these two areas in the Gulf of St. Lawrence cannot be rejected.

The returns from the Bay of Fundy, however, give very different results as the following table, summarizing the data for hatchery smolts, shows.

	Miramichi and Nova Scotia					Bay of Fundy				
	Tagged	Grilse	Greenland	% Greenland	Greenland grilse	Tagged	Grilse	Greenland	% Greenland	Greenland grilse
1963	25,915	73	7	.027	.10	21,000	29	0	.000	.000
1964	25,497	282	52	.204	.18	20,000	72	1	.005	.014
Total	51,412	355	59	.115	.17	41,000	101	1	.002	.010

The results for both years show a very small return from Greenland for the Bay of Fundy smolts. Since the Bay of Fundy tagged smolts produced satisfactory numbers of grilse, the difference cannot be due to poor survival from these fish. More rigorous comparisons are not, however, possible at this stage on account not only of the limited amount of data, but also of the possibility, discussed early, of different batches of hatchery smolts tending to show different migration behaviour.

Year of Liberation		GULF OF ST. LAWRENCE											
		MIRAMICHI RIVER				NOVA SCOTIA				BAY OF FUNDY			
		No. liber-ated	Grilse	Green-land	2-sea-year	No. liber-ated	Grilse	Green-land	2-sea-year	No. liber-ated	Grilse	Green-land	2-sea-year
1963	Nat.	4,678	66 (33)	9	12(1)	0	-	-	-	0	-	-	-
	Hat.	4,280	89 (47)	3	16(0)	3,752[a]	41 (3)	1	9 (1)	0	-	-	-
	Total	8,958	155 (80)	12	28(1)	3,752	41 (3)	1	9 (1)	0	-	-	-
1964	Nat.	14,000	187 (82)	7	59(1)	220[a]	0	0	0	0	-	-	-
	Hat.	11,533	20 (1)	3	4(1)	14,382[b]	53(46)	4	57(34)	21,000	29 (9)	0	6(4)
	Total	25,533	207 (83)	10	63(2)	14,602	53(46)	4	57(34)	21,000	29 (9)	0	6(4)
1965	Nat.	15,452	162 (85)	58	-	1,031[a]	1	0	0	0	-	-	-
	Hat.	14,823	250 (69)	40	-	10,674[a]	32 (0)	12	-	20,000	72(56)	1	-
	Total	30,275	412(154)	98	-	11,705	33 (0)	12	-	20,000	72(56)	1	-
	GRAND TOTAL	64,766	774(317)	120	91(3)	30,059	127(49)	17	66(35)	41,000	101(65)	1	6(4)

[a]All Margaree River.
[b]Margaree River 2,999; River Philip 11,383.

Figures in parentheses are numbers of fish caught in counting fences; they are included in the totals.

SECTION F
SELECTIVITY OF CODENDS AND CHAFERS

1. Selection of cod by bottom trawl codends in southwest Greenland waters[1]

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On the 100th cruise of FRV *Anton Dohrn*(27 September - 30 October, 1966) some trawl mesh selection experiments were carried out in the vicinity of Cape Thorvaldsen (ICNAF Div. 1F).

Four codends of about the same wet knot breaking strength (115-124 kg) and mesh size (113-124 mm) were used. They were made from polyamide continuous, polyethylene monofilament, polypropylene continuous and polypropylene monofilament. The same codends have already been used on the 12th cruise of FRV *Walther Herwig* in November/December 1965 (Bohl, 1966).

During the trials, a total of 23 successful hauls was made; 13,665 cod were caught in the codend and 5,056 cod in the cover. The total length of each fish was measured to the nearest centimeter. Figure 1 shows the relative length composition of the total cod catches made between 6 and 10 October on the one hand and on 18 and 19 October on the other. It can be seen that the cod caught during the second part of the experiments were conspicuously smaller (mean length 46.6 cm) than those caught during the first part (mean length 49.1 cm).

The catches, ranging from 0.3 to 4.6 metric tons per 75-100 minutes' fishing time, were of uniform composition. Cod were clearly predominant; other fish (wolffishes, American plaice, skates, lumpsucker) and invertebrates (mainly holothurians) were caught in small quantities.

The selection curves shown in Fig. 2 for each codend are based on smoothed percentages of retained fish (three-point moving averages). They are fitted by eye.

The selection factors calculated for combined hauls are as follows (the figures in brackets represent the selection factors obtained from the *Walther Herwig* trials in 1965):

Polyamide continuous	:	3.53 (3.51)
Polyethylene monofilament	:	3.40 (3.38)
Polypropylene monofilament	:	3.26 (3.22)
Polypropylene continuous	:	3.30 (3.28)

From this compilation it becomes obvious that the experiments conducted by *Anton Dohrn* off Cape Thorvaldsen in October 1966, and those conducted by *Walther Herwig* on Store Hellefiske Bank in November/December 1965 (Bohl,

[1]Submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/31

1966), yielded practically the same selection factors. This striking conformity of the experimental findings claims attention, particularly as there are great differences in the design, size and fishing power of the two research vessels concerned. *Anton Dohrn* is an 850 h.p. side trawler with an average towing speed of 4 knots; *Walther Herwig*, however, is a large 2,000 h.p. stern trawler with a towing speed of about 4.5 knots. The conclusions to be drawn from the above-mentioned data would be more reliable if the trials had taken place simultaneously on the same fishing ground. From the evidence available, however, it is likely that the selectivity of bottom trawls is not appreciably influenced by the characteristics of the towing vessel.

In another ICNAF research document (Bohl, 1966) the results of the *Walther Herwig* trials have been compared with those of trials carried out previously in Subarea 1. Since the *Walther Herwig* data are in line with the recent *Anton Dohrn* data, it is not necessary to repeat such a comparison here. But, in view of the R&S Committee's task to keep the current mesh differentials under control, it may be useful to review once more the upshot of the German experiments conducted in 1965 and 1966.

Compared to the selection factors determined for the polyamide codend, the corresponding factors for the polypropylene continuous and polypropylene monofilament codends were found in both years to be lower by 7% and 8% respectively. These differences are in accordance with previous results showing the selectivity of polypropylene similar to that of manila. In 1965, as well as in 1966, the selection factors for the polyethylene codend were only 3.7% lower than those for the polyamide codend. This small difference shows polyethylene to have selective properties similar to polyamide rather than to manila/polypropylene. It is remarkable that, in both years, no significant difference was found between the selectivity of the two types of polypropylene codends used. Theoretically, the monofilament codend made from relatively stiff twine should have yielded a markedly lower selection factor than the continuous codend made from relatively flexible twine.

Finally, it must be mentioned that 1,398 girth measurements were made off Cape Thorvaldsen in 1966. The relationship between maximum body girth (G) and total length (L) is described by the regression equation $G = 0.49L - 0.49$ cm (Fig. 3). In 1965, the regression $G = 0.56L - 2.46$ cm was obtained from 1,490 measurements on Store Hellefiske Bank (Bohl, 1966). These equations imply that cod of the 50% retention lengths (39-44 cm) were thinner in 1966 than in 1965 by 3.6-4.5%.

References

Bohl, H., 1966. Selection of cod by bottom trawl codends on Store Hellefiske Bank. *Annu. Meet. int. Comm. Northw. Atlant. Fish.*, Res. Doc. 66/67, Ser. No. 1685.

Compilation of selection data for grouped hauls

Ship	FRV ANTON DOHRN, 62.3 m length o.a., 850 h.p.e.			
Gear	German standard roundfish bottom trawl, 140' groundrope			
Locality	Off Cape Thorvaldsen (ICNAF Div. 1 F)			
Depth range (m)	100 - 135			
Species studied	Cod			
Experimental method	Topside cover			
Cover	ICES specification			
Material	Nylon continuous			
Runnage (m/kg)	1200			
Tex	23 tex x 11 x 3			
Braiding	Single twine			
Twine construction	Twisted			
Mesh size	60			
Codend material	Polyamide continuous	Polyethylene monofilament	Polypropylene monofilament	Polypropylene continuous
Runnage (m/kg)	252	153	208	204
R..tex	3962	6516	4800	4905
Braiding	Double twine			
Twine construction	Plaited			
Wet knot breaking strength (kg)	119.5	115	122	124
Twine diameter, wet (mm)	2.1	4.5	3.5	3.6
Date	6.-9.10.1966	9.-10.10.1966	18.-19.10.1966	19.10.1966
Greenwich mean time	09.00-18.25	08.45-23.20	11.15-21.40	08.40-17.35
No. of hauls	7	8	4	4
Av. duration of haul (min)	75	80	90	100
Av. towing speed through water (kn)	4.0	4.0	4.0	4.0
Type of mesh gauge	ICES gauge; 4 kg pressure			
Codend mesh size; mean ± s.e. (mm)	123.7 ± 0.2	113.2 ± 0.2	119.8 ± 0.2	119.9 ± 0.2
Range (mm)	106 - 130	104 - 126	113 - 133	113 - 127
No. of measurements	413 (= 7x59)	464 (= 8x58)	188 (= 4x47)	192 (= 4x48)

Compilation of selection data for grouped hauls (continued)

			Polyamide continuous	Polyethylene monofilament	Polypropylene monofilament	Polypropylene continuous
25 - 75% selection range (mm)			110	68	69	82
No. of cod in sel. range	codend		544	702	351	1386
	cover		641	710	329	1287
Total no. of cod	codend		2067	4160	1682	5756
	cover		952	1273	730	2101
Av. quantity of cod	codend	(baskets[1])	7 1/2 (= 514 kg)	11 (= 754 kg)	7 3/4 (= 531 kg)	27 1/4 (= 1867 kg)
	cover	(baskets[1])	1 1/3 (= 91 kg)	1 1/8 (= 77 kg)	1 1/3 (= 91 kg)	4 2/3 (= 320 kg)
of other fish[2])	codend	(baskets)	1 1/2	3 1/2	2	2 2/3
	cover	(baskets)	+	+	+	+
of invertebrates[3])	codend	(baskets)	1/8	1 1/4	1	1 1/4
	cover	(baskets)	3/4	1 1/3	1 1/2	2 1/2
Range of tot. catch/tow	codend	(baskets)	3 3/4 - 18 1/4	6 3/4 - 30 1/4	6 - 15	10 1/2 - 54 1/4
	cover	(baskets)	3/4 - 4 3/4	3/4 - 5 1/2	1 3/4 - 3 1/3	4 1/2 - 12 1/3
50% retention length (mm)			437	385	391	396
Selection factor			3.53	3.40	3.26	3.30

[1]) The average net weight of one basket filled with cod is 68.5 kg

[2]) Anarhichas minor, A.lupus, A.denticulatus, Hippoglossoides platessoides, Raja spp., Cyclopterus lumpus and some few Hippoglossus hippoglossus and Sebastes

[3]) Mainly holothurians

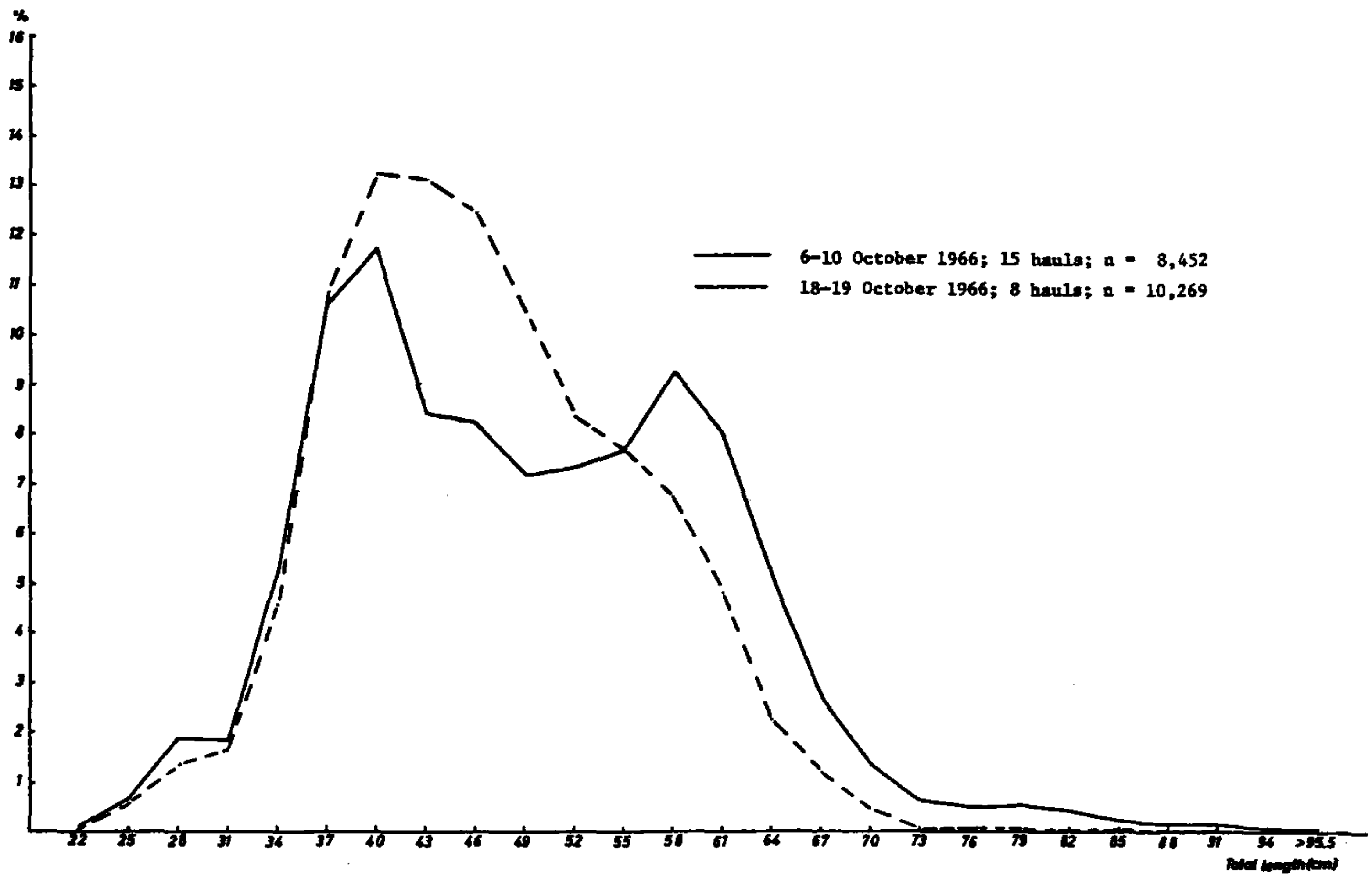
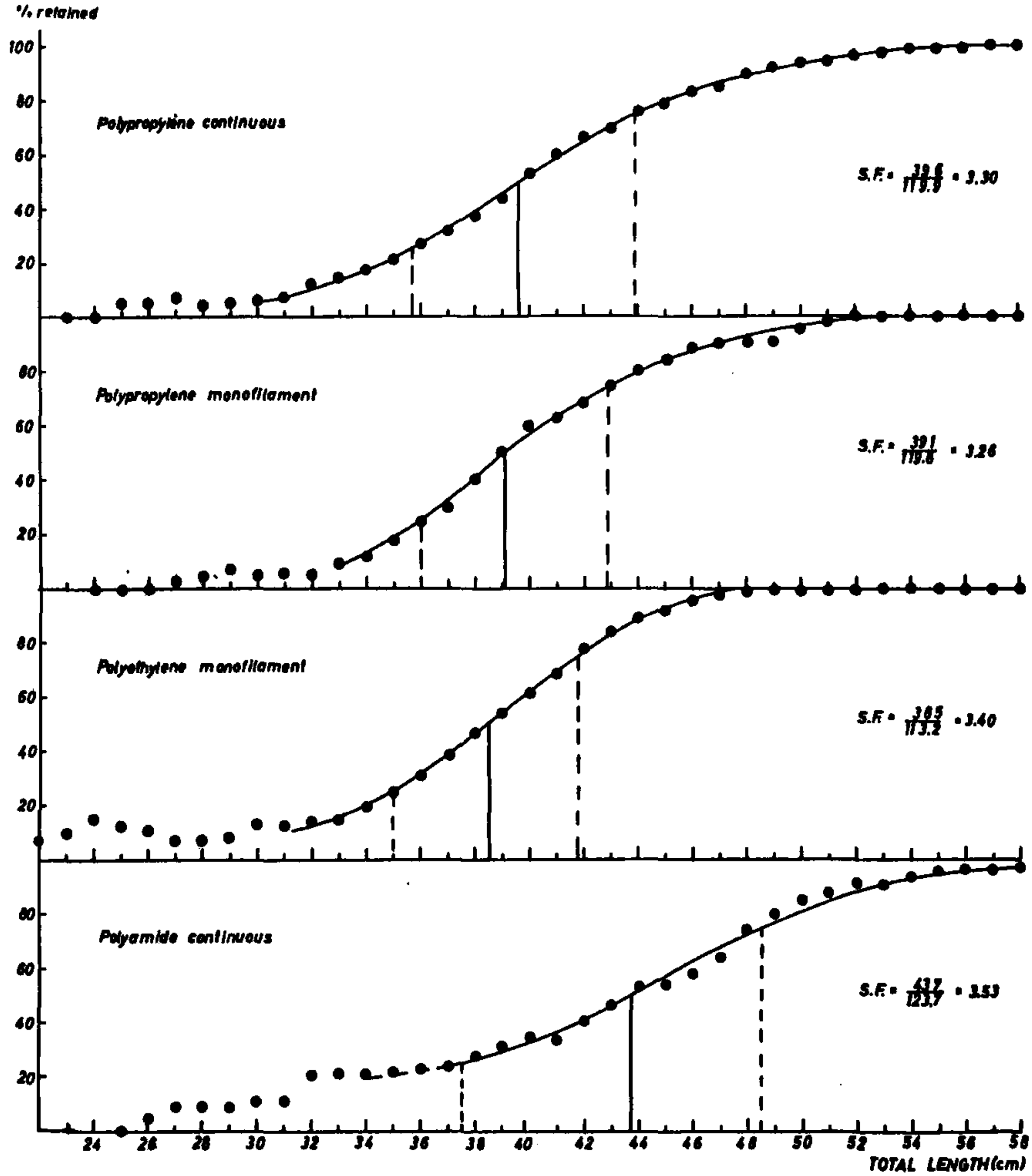


Fig.1: Relative length composition of cod (codend + cover) off Cape Thorvaldsen.
(3-cm -groups)



<u>*Fig. 2: Cod selection curves for combined hauls.*</u>

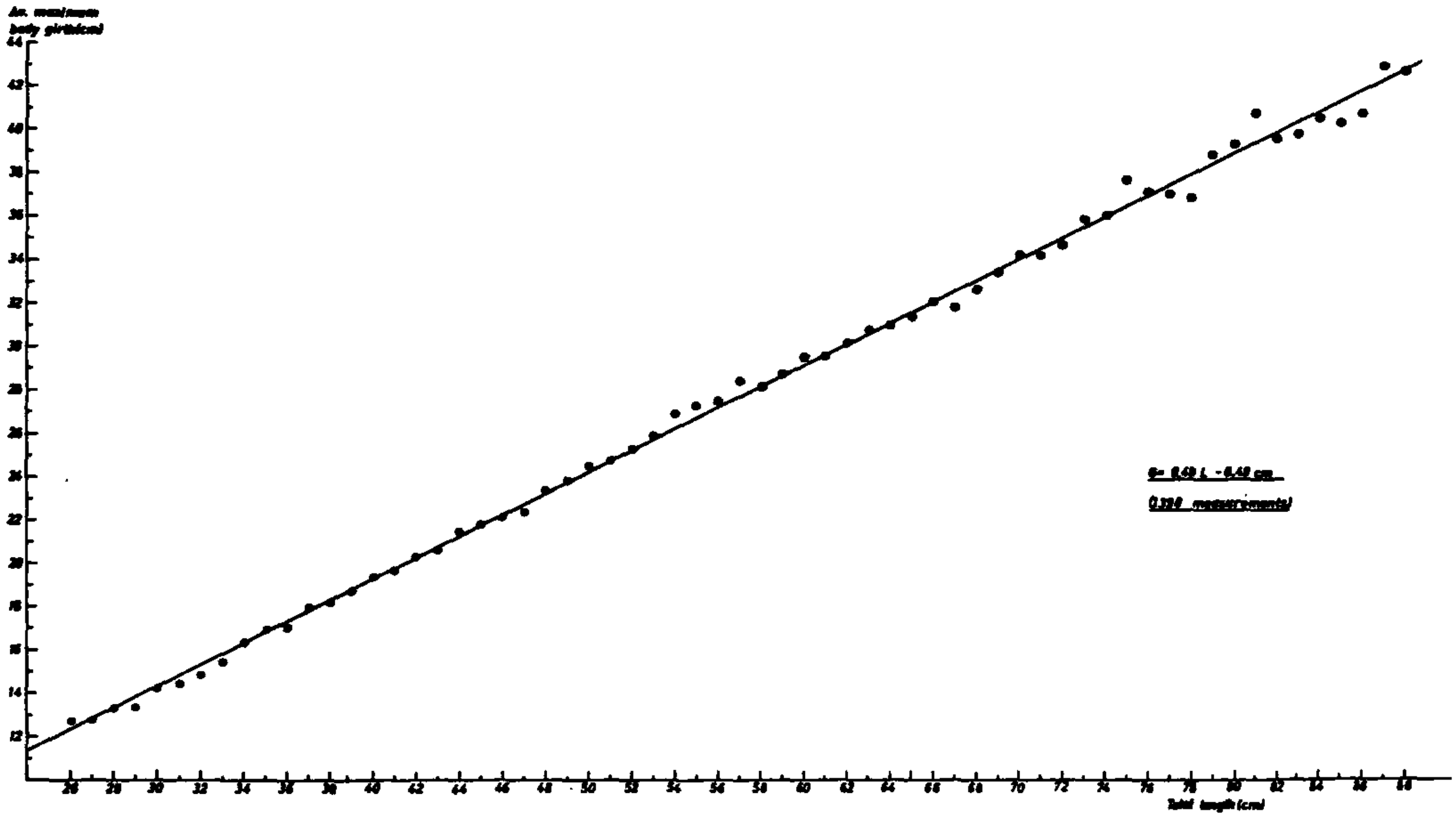


Fig.3: Cod girth/length relationship at Cape Thorvaldsen in October 1966.

2. Selection experiments with a large-meshed topside chafer[1]

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At the 1966 Annual Meeting, the results of experiments on the effect of large-meshed topside chafers, as designed in Poland, were presented and discussed (Strzyzewski, 1966). The Standing Committee on Research and Statistics informed the Commission that, from the scientific evidence available, it seems that the Polish type of chafer, having a mesh size at least twice as large as the codend mesh size and a width at least as great as that of the codend, has a negligible effect on codend selectivity. The Committee, furthermore, recommended "that selectivity experiments with topside chafers of the Polish type should be continued" (Rec. 17, Redbook 1966, Part I, p. 21).

Following this recommendation, some appropriate experiments were conducted during the 100th cruise of FRV *Anton Dohrn* in southwest Greenland waters. Fishing was carried out in October 1966 between Cape Farvel and Banana Bank, but suitable sizes of cod, although in rather low abundance, were only found in the vicinity of Cape Thorvaldsen (ICNAF Div. 1F).

During the trials a double-braided polyamide codend of 118 mm mesh size, 54 meshes long and 48 meshes wide, was used. To the upper panel of this codend was attached a double-braided polyamide chafer with meshes about twice as large as those of the codend (224 mm). The chafer, having approximately the same length and width as the codend, was carefully laced knot by knot along the selvedges and along the second and last but one row of codend knots. The rigging of the chafer is shown schematically in Fig. 1.

The first three successful hauls of the experiments were carried out with a chafer having a length of 26½ meshes and a width of 24 meshes. This chafer proved to be a bit too short since, whenever the catch was hauled on deck, the weight of the catch was observed to strain the chafer whereas the upper panel of the codend was hanging loosely. As a result, the chafer was lengthened in the rear by one mesh and the rear edge again fixed to the last but one row of codend knots. This lengthening was obviously sufficient; during the next hauling operations the strain of the catch seemed to be distributed equally on the chafer and the upper codend panel. Four successful hauls were made with the lengthened chafer. Then three hauls were carried out without chafer in order to find out whether the large-meshed codend protection had had any effect on the selectivity.

In the course of the experiments, a total of 5,048 cod were caught

[1] submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/32

in the codend and 3,923 cod in the cover. The total length of each fish was measured to the nearest centimeter. Figure 2 shows the relative length composition of the total cod catch in 3 cm groups. Most abundant were cod between 34 and 61 cm in length. Fish of more than 70 cm were very sparsely represented.

The material collected with the chafered codend was rather scanty. The total catches made with the chafer, as rigged initially, ranged between 9 1/2 and 11 1/2 baskets (av. 10 3/4 baskets) and those with the lengthened chafer between 9 3/4 and 24 1/2 baskets (av. 15 2/3 baskets) per 1 1/2 hours' fishing time. The catches obtained from the unchafered codend were larger; these varied between 21 1/2 and 46 1/2 baskets (av. 36 baskets) per 1 3/4 hours' fishing time.

All the catches were of uniform composition. Cod were always clearly predominant; other fish (mainly wolffishes) and invertebrates (holothurians) were caught in small quantities.

The details of the experiments mentioned so far and further interesting particulars are summarized in the attached compilation of selection data. The selection curves, which are based on smoothed percentages of retained fish (three-point moving averages), are shown in Fig. 3. Owing to the scanty material, some of the selection factors and selection ranges could not be determined precisely. In the tables and figures these unreliable data are designated by question marks.

The results obtained from the experiments were, at first glance, rather unexpected. The presence of the large-meshed topside chafer did not handicap the process of codend mesh selection; quite the contrary, the tows with chafer gave markedly higher selection factors (4.08 and 3.91) than those without chafer (3.70).

It is thought reasonable to connect these findings with the dimensions of the chafer used. The chafer, as rigged initially (26½ meshes long and 24 meshes wide), was certainly somewhat shorter than the chafered part of the codend. Thus, during fishing, the pulling forces were only acting on the chafer. This implies that the upper panel of the codend was not under strain, and that again leads to the assumption that cod escaping from the codend were enabled to adapt the mesh shape to their body shape.

This assumption is supported by the fact that the ratio

$$\frac{\text{maximum body girth at 50\% ret. length}}{\text{av. internal perimeter of codend mesh}} = \frac{231 \text{ mm}}{240 \text{ mm}}$$

is equal to 0.96. That is a very high value which could never be obtained if the meshes had been in a rigid condition.

The numerator of the above fraction is derived from the regression equation G = 0.49L - 0.49 cm, which describes the relationship between maximum body girth (G) and total length (L) as found for cod off Cape Thorvaldsen in October 1966 (Bohl, 1967). The denominator corresponds to twice the average codend mesh size (2 x 118 mm) plus twice the thickness of the jaws of the ICES gauge (2 x 2 mm).

The selection factor for the codend with the lengthened chafer (3.91) was markedly lower, but still unusually high. It must, therefore, be assumed that even this chafer, contrary to visual impression, was somewhat shorter than the chafered part of the codend.

The results of the Polish experiments on the effect of large-meshed topside chafers (Strzyzewski, 1966) have been confirmed meanwhile by appropriate English and Norwegian trials (Blacker, 1966; Hylen, 1966; Olsen, 1966). All these tests have shown that chafers with a mesh size about twice as large as the codend mesh size do not impair the codend selectivity appreciably. The recent German investigations, however, reveal another fact, namely, that large-meshed chafers of the above specifications improve the selectivity.

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Hylen, A., 1966. Selectivity experiments with a large-meshed topside chafer. ICES, Comparative Fishing Committee, C.M. 1966/F: 13.

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Strzyzewski, W., 1966. The effect of the use of chafing gear on selection factor. *Annu. Meet. int. Comm. Northw. Atlant. Fish.*, Res. Doc. 66/21, Ser. No. 1620.

<u>Compilation of selection data for grouped hauls</u>

	With chafer 26 1/2 x 24 meshes	With chafer 27 1/2 x 24 meshes	Without chafer
Ship	FRV ANTON DOHRN, 62.3 m length o.a., 850 h.p.e.		
Gear	German standard roundfish bottom trawl, 140' groundrope		
Date	15.10.1966	16./17.10.1966	17./18.10.1966
Greenwich mean time	13.25 - 19.40	08.45 - 16.45	16.45 - 23.50
Locality	Off Cape Thorvaldsen (60°20'N, 47°23'W)		
Depth range (m)	110 - 120	110 - 120	110 - 135
Species studied	Cod		
Experimental method	Topside cover		
Cover	ICES specification		
Material	Nylon continuous		
Runnage (m/kg)	1200		
Tex	23 tex x 11 x 3		
Braiding	Single twine		
Twine construction	Twisted		
Mesh size (mm)	60		
Codend and chafer material	PERLON continuous		
Runnage (m/kg)	200		
R..tex	R 5000 tex		
Braiding	Double twine		
Twine construction	Twisted		
Number of hauls	3	4	3
Av. duration of haul (min)	90	90	105
Av. towing speed through water (kn)	4.0	4.0	4.0
Type of mesh gauge	ICES gauge - 4 kg pressure		
Codend mesh size; mean ± s.e. (mm)	118.0 ± 0.2	118.2 ± 0.2	118.0 ± 0.3
Range (mm)	110 - 125	109 - 126	108 - 126
No. of measurements	159 (= 3 x 53)	212 (= 4 x 53)	159 (= 3 x 53)
Av. chafer mesh size (mm)	224	224	224

<u>Compilation of selection data for grouped hauls</u> (continued)

		With chafer		Without chafer
		26 1/2 x 24 meshes	27 1/2 x 24 meshes	
25 - 75% selection range (cm)		12.2 ?	9.5 ?	7.3
No.of cod in selection range	codend	160 ?	313 ?	612
	cover	293 ?	418 ?	693
Total no. of cod	codend	612	1386	3050
	cover	816	1054	2053
Av.quantity of cod	codend (baskets[1])	4 1/2 (= 308 kg)	8 1/2 (= 582 kg)	21 3/4 (= 1490 kg)
	cover (baskets[1])	2 1/2 (= 171 kg)	2 1/2 (= 171 kg)	6 (= 411 kg)
other fish[2])	codend (baskets)	2 3/4	3	4 1/3
	cover (baskets)	+	+	+
invertebrates[3])	codend (baskets)	3/4	1	1 1/2
	cover (baskets)	1/4	2/3	2 1/3
Range of tot.catch/tow	codend (baskets)	7 1/2 - 9 3/4	7 1/4 - 20 1/2	18 - 35
	cover (baskets)	2 - 4	2 1/2 - 4	3 2/3 - 11 1/2
50% retention length (mm)		481 ?	462	436
Selection factor		4.08 ?	3.91	3.70

1) Average net weight of one basket filled with cod : 68.5 kg.

2) <u>Anarhichas lupus</u>, <u>A.minor</u>, <u>A.denticulatus</u> and small quantities of <u>Hippoglossoides platessoides</u>, <u>Reinhardtius hippoglossoides</u>, <u>Hippoglossus hippoglossus</u>, <u>Cyclopterus lumpus</u>, <u>Raja spp</u>. and <u>Sebastes</u>.

3) Holothurians.

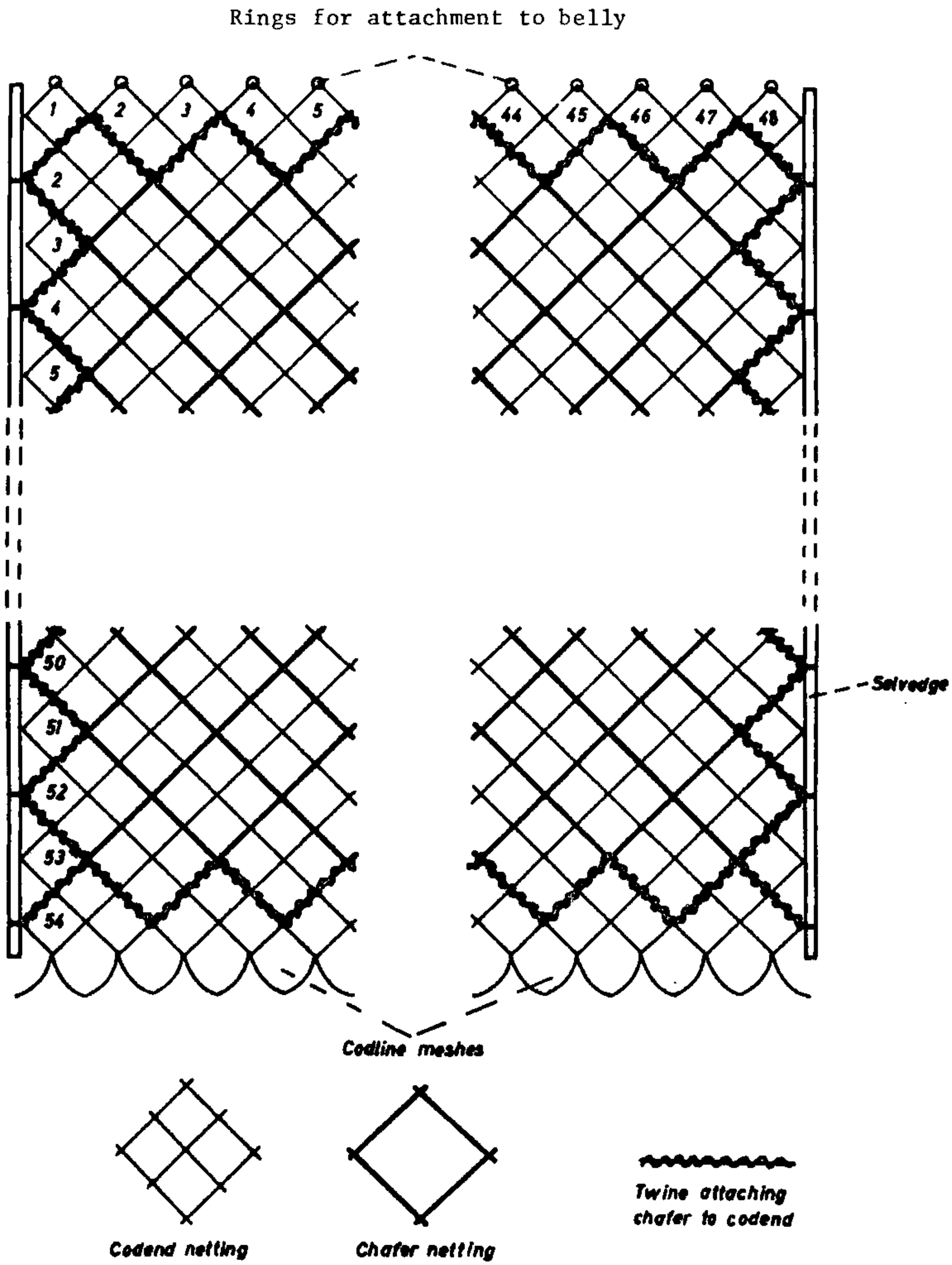

Fig.1 : Rigging of the chafer.

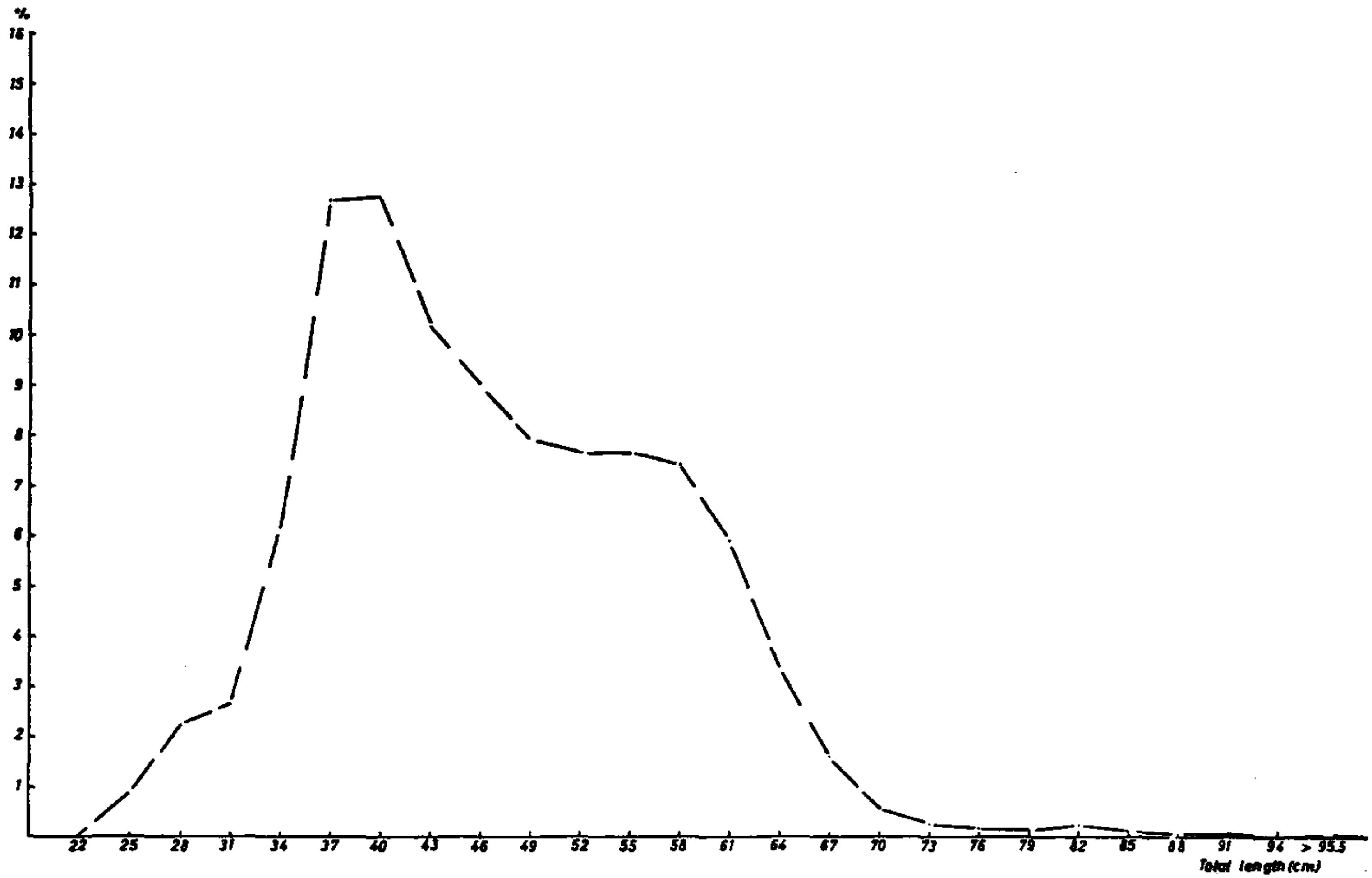

Fig. 2: Relative length composition of cod (codend + cover) in 3-cm-groups

10 hauls, n = 8 971

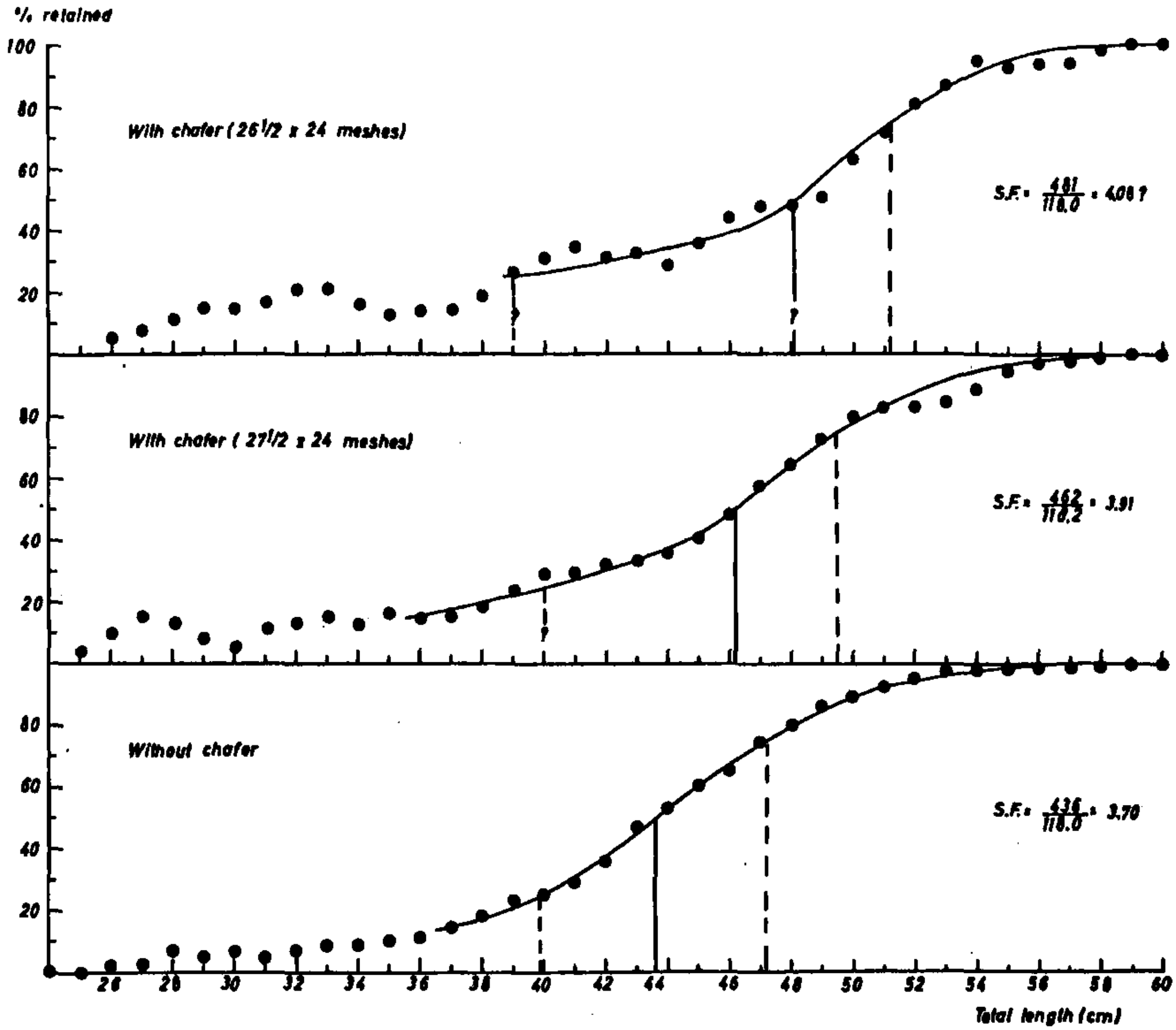

Fig.3: Cod selection curves for combined hauls.

3. The study of the effect of large-meshed chafer on the selectivity of the trawl net[1]

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At the 1966 Annual Meeting of ICNAF, the Subcommittee on Gear and Selectivity passed a recommendation urging all member countries to continue experiments on the selectivity of trawls furnished with chafers of the Soviet and Polish types.

The results of the investigations of the effect of topside chafer of the Soviet type on the selectivity, strength and durability of trawls were set out in Res. Doc. 66 (Serial No. 1534) and Res. Doc. 66/58 (Serial No. 1663), submitted to the 1965 and 1966 Annual Meetings respectively.

Newly obtained data do not change the essence of the earlier conclusions as to these chafers and therefore they are not referred to in this contribution.

The following is a short description and an account of the results of the experiments with a large-meshed chafer of the so-called Polish type. These experiments were completed on board the trawler *Vitebsk* in ICNAF Div. 2J (Labrador) in the period from 2 February through 8 March, 1967.

A conventional trawl net with a codend made of double Kapron of 3.1 mm diameter and an inner mesh size of 110 mm was used in the experiments. The codend was fitted with a chafer made of double-twisted Kapron of 3.5 mm in diameter and with the inner mesh size about twice the size of mesh in the codend itself. The chafer was of the same length and width as the codend and was attached to it along all four selvedges and upper lacings (one central and four transverse). During the trials normal fishing conditions were observed *i.e.*, speed of trawl haul 3.5 - 4 knots; average duration of trawling 1 1/2 hours. In order to evaluate the selectivity of the codends, a standard cover made of Kapron webbing with the inner mesh size of 40 mm was fastened over the chafer and was 1.5 times wider and 2 m longer than the codend. Protective flaps made of used Kapron netting and bull hide were attached to the underside of the codend. In the beginning the sizes of the meshes in the codend and chafer were measured after each trawl haul and later, after the stretching of the twine had stabilized, measurements were made after every 2 or 3 trawl hauls. The measurements were made with the ICES gauge at a pressure of 4 kg. In all, 28 measurements of meshes in both the codend and chafer were completed, and as a result, the mean inner mesh size of the codend was determined as 107 mm

[1]submitted to the 1967 Annual Meeting of ICNAF as ICNAF Res.Doc.67/63

and the chafer a· 225 mm. The measurements are given in Table 1.

Table 1. Results of mesh measurement.

Part of trawl net	Average size (mm) of meshes in series				Mean value
	I	II	III	IV	
Codend	103.8	106.7	103.8 (110.0)	113.2	106.9 (108.4)
Chafer	223.7	225.2	225.5 (226.9)	228.6	225.8 (226.1)

The length of fishes was measured by a conventional method with rounding off to the nearest cm. The whole catch was measured. There were 40 experimental trawl hauls completed using the Polish type chafer. The results of trials grouped by 10 successive trawl hauls are set out in Tables 2-5. Table 6 gives the summary results of the tests and Table 7, the selection factors. The selectivity curves are shown in Fig. 1.

Along with the study of the effect of the chafer on the selectivity of the trawl net, observations of the strength and durability of the codend fitted with this chafer were made.

When the mesh measurements were made, the whole codend was also examined for distortions of the meshes and damage to threads and knots. But, in the course of the 40 experimental trawl hauls, no noticeable changes were observed in the codend. Later, during commercial fishing operations, this same codend with its Polish-type chafer was torn off during the eighteenth haul and was lost with its catch. Thus, a total of 58 trawl hauls was made with that codend.

At present, some trawl nets fitted with Polish type chafers are being tested on two fishing vessels with special reference to their resistance to wear and tear.

Discussion and conclusions

As seen from Table 1, the mesh size of the codend and chafer increased regularly with the number of trawl hauls with the exception, however, of the third series of tests where the mean mesh size of the codend became considerably less than that in the second series of trials, whereas the average size of the mesh of the chafer remained almost the same. This can be attributed to the fact that at the time of the third series of experiments the air temperature dropped to -10 and -15°C, which caused the Kapron to shrink. For this reason, it seemed advisable to take as actual mesh size, for the third series of tests, a mean value based on the results of preceding and following series of trials. The figures so calculated are shown in Table 1 in brackets.

From Tables 2-6 it may be seen that the variations in magnitude and size composition of catches are of such an extent it appears possible to compare the results of the experiments. Moreover, due to the lack of particularly large catches (the maximum catch per haul did not exceed 4 tons), the conditions for fish escapement from the codend in this experiment can be considered to be favourable, and therefore, the results obtained are evidently quite close to the actual selectivity of the codend.

The mean selection factor of the commercial trawl net using a Polish type chafer is 3.9 in relation to the measured mesh size and 3.8 in relation to the precisely defined mesh size. It follows from this that the effect of a Polish type chafer on the selectivity of the trawl net is negligible and within the range of experimental error.

The observations on the resistance to wear and tear also showed that the loss of the codend with chafer in the fifty-eighth haul can hardly be considered as the limit of its durability since no noticeable change was observed in its structure, and it could be destroyed when it got afoul an underwater obstacle.

Further use of such chafers will prove the limits of their application. However, data obtained to date show grounds for recommending the use of these chafers at least in the areas where moderate (3-4 tons) catches are made.

Table 2. Series I - Soviet experiment, 1967. Commercial trawl net furnished with Polish-type chafer, trawler *Vitebsk*.

Area - Labrador, 2J
Date - 2-7 February, 1967
Number of trawl hauls - 10

Fish species - cod
Codend material - double Kapron 103.8 mm
Depth of fishing - 265-400 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
up to 25	1	2	3	33.3
25	-	8	8	0.0
26	-	3	3	0.0
27	-	5	5	0.0
28	-	15	15	0.0
29	-	13	13	0.0
30	19	86	105	18.1
31	9	39	48	18.8
32	14	82	96	14.6
33	13	76	89	14.6
34	10	80	90	11.1
35	42	203	245	17.1
36	29	159	188	15.4
37	47	148	195	24.1
38	41	174	215	19.1
39	59	143	202	29.2
40	254	392	646	39.3
41	107	191	298	35.9
42	236	273	509	46.4
43	205	162	367	55.8
44	247	144	391	63.2
45	552	303	855	64.6
46	473	186	659	71.8
47	359	109	468	76.7
48	506	111	617	82.0
49	382	85	467	81.8
50	970	113	1083	89.6
51	543	35	578	93.9
52	585	26	611	95.7
53	390	7	397	98.2
54	407	6	413	98.5
55	668	10	678	98.5
56	435	2	437	99.5
57	262	1	263	99.6
58	220	1	221	99.5
59	229	1	230	99.6

(continued)

Table 2 (cont'd).

Area - Labrador, 2J
Date - 2-7 February, 1967
Number of trawl hauls - 10

Fish species - cod
Codend material - double Kapron 103.8 mm
Depth of fishing - 265-400 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
60	468	1	469	99.8
61	169	1	170	99.4
62	218	1	219	99.5
63	127	-	127	100.0
64	72	-	72	100.0
65	142	-	142	100.0
66	70	-	70	100.0
67	56	-	56	100.0
68	53	-	53	100.0
69	29	-	29	100.0
70	77	-	77	100.0
over 70	150	-	150	100.0
Total	9,945	3,397	13,342	

Table 3. Series II - Soviet experiment, 1967. Commercial trawl net furnished with Polish-type chafer, trawler *Vitebsk*.

Area - Labrador, 2J
Date - 7-13 February, 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 106.7 mm
Depth of fishing - 220-450 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
up to 25	1	37	38	2.6
25	2	39	41	4.9
26	-	33	33	0.0
27	3	45	48	6.2
28	4	70	74	5.4
29	4	71	75	5.3
30	72	223	295	24.4
31	27	163	190	14.2
32	54	280	334	16.2
33	23	338	361	6.4
34	52	315	367	14.2
35	146	490	636	23

(continued)

Table 3 (cont'd).

Area - Labrador, 2J
Date - 7-13 February, 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 106.7 mm
Depth of fishing - 220-450 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
36	87	368	455	19.1
37	97	360	457	21.2
38	121	420	541	22.4
39	202	380	582	34.7
40	594	585	1179	50.4
41	363	387	750	48.4
42	441	438	879	50.2
43	405	345	750	54.0
44	493	272	765	64.4
45	886	366	1252	70.8
46	731	215	946	77.3
47	661	220	881	75.0
48	581	140	721	80.6
49	690	116	806	85.6
50	1103	118	1221	90.3
51	796	40	836	95.2
52	826	40	866	95.4
53	539	15	554	97.3
54	586	17	603	97.2
55	792	22	814	97.3
56	511	6	517	98.8
57	435	6	441	98.6
58	378	1	379	99.7
59	294	-	294	100.0
60	494	3	497	99.4
61	211	1	212	99.5
62	251	-	251	100.0
63	165	2	167	98.8
64	142	-	142	100.0
65	172	-	172	100.0
66	95	1	96	99.0
67	79	-	79	100.0
68	83	-	83	100.0
69	48	-	48	100.0
70	88	-	88	100.0
over 70	172	-	172	100.0
Total	15,000	6,988	21,988	

Table 4. Series III - Soviet experiment, 1967. Commercial trawl net furnished with Polish-type chafer, trawler *Vitebsk*.

Area - Labrador, 2J
Date - 14-18 February, 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 103.8 (110.0) mm
Depth of fishing - 295-375 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
up to 25	-	13	13	0.0
25	2	23	25	8.0
26	-	41	41	0.0
27	1	30	31	3.2
28	2	46	48	4.2
29	1	64	65	1.5
30	10	101	111	9.0
31	7	106	113	6.2
32	11	135	146	7.5
33	6	164	170	3.5
34	19	165	184	10.3
35	48	214	262	18.3
36	45	234	279	16.1
37	39	310	349	11.2
38	43	257	300	14.3
39	35	263	298	11.7
40	131	348	479	27.3
41	115	248	363	31.7
42	205	312	517	39.6
43	186	258	444	41.9
44	193	238	431	44.8
45	391	322	713	54.8
46	373	208	581	64.2
47	332	216	548	60.6
48	388	174	562	69.0
49	444	117	561	79.1
50	512	126	638	80.2
51	454	35	489	92.8
52	487	28	515	94.6
53	471	17	488	96.5
54	395	10	405	97.5
55	502	14	516	97.3
56	358	4	362	98.9
57	268	-	268	100.0
58	260	2	262	99.2
59	235	3	238	98.7

(continued)

Table 4 (cont'd).

Area - Labrador, 2J
Date - 14-18 February, 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 103.8 (110.0) mm
Depth of fishing - 295-375 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
60	280	-	280	100.0
61	173	-	173	100.0
62	170	-	170	100.0
63	111	-	111	100.0
64	95	-	95	100.0
65	108	-	108	100.0
66	61	-	61	100.0
67	43	-	43	100.0
68	48	-	48	100.0
69	35	-	35	100.0
70	41	-	41	100.0
over 70	120	-	120	100.0
Total	8,254	4,846	13,100	

Table 5. Series IV - Soviet experiment, 1967. Commercial trawl net furnished with Polish-type chafer, trawler *Vitebsk*.

Area - Labrador, 2J
Date - 21-25 February, 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 113.2 mm
Depth of fishing - 280-360 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
up to 25	-	5	5	0.0
25	2	7	9	22.2
26	2	7	9	22.2
27	2	7	9	22.2
28	3	20	23	13.0
29	1	29	30	3.3

(continued)

Table 5 (cont'd).

Area - Labrador, 2J
Date - 21-25 February, 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 113.2 mm
Depth of fishing - 280-360 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
30	25	61	86	29.1
31	23	77	100	23.0
32	58	154	212	27.4
33	59	150	209	28.2
34	60	166	226	26.5
35	138	267	405	34.1
36	123	258	381	32.3
37	142	297	439	32.3
38	167	263	430	38.8
39	187	247	434	43.1
40	389	332	721	54.0
41	319	269	588	54.2
42	513	352	865	59.3
43	515	269	784	65.7
44	537	190	727	73.9
45	883	286	1169	75.5
46	819	191	1010	81.1
47	796	189	985	80.8
48	786	128	914	86.0
49	803	77	880	91.2
50	1021	84	1105	92.4
51	835	35	870	96.0
52	874	35	909	96.1
53	727	25	752	96.1
54	662	8	670	98.8
55	843	12	855	98.6
56	693	5	698	99.3
57	504	2	506	99.6
58	403	1	404	99.8
59	366	2	368	99.4
60	505	-	505	100.0
61	298	-	298	100.0
62	288	-	288	100.0
63	154	-	154	100.0
64	132	-	132	100.0
65	212	-	212	100.0
66	78	-	78	100.0
67	70	-	70	100.0
68	44	-	44	100.0
69	30	-	30	100.0
70	71	-	71	100.0
over 70	83	-	83	100.0
Total	16,245	4,507	20,752	

Table 6 (Summary). Series V - Soviet experiment, 1967. Commercial trawl net furnished with Polish-type chafer, trawler *Vitebsk*.

Area - Labrador, 2J
Date - 2-25 February 1967
Number of trawlings - 10

Fish species - cod
Codend material - double Kapron 106.9 (108.4) mm
Depth of fishing - 220-450 m

Fish length (cm)	Number of fishes in codend	Number of fishes in cover	Total number	Retention %
up to 25	2	57	59	3.4
25	6	77	83	7.2
26	2	84	86	2.3
27	6	87	93	0.4
28	9	151	160	5.6
29	6	177	183	3.3
30	126	471	597	21.1
31	66	385	451	14.6
32	137	651	788	17.4
33	101	728	829	12.2
34	141	726	867	16.3
35	374	1174	1548	24.2
36	284	1019	1303	19.0
37	325	1115	1440	22.6
38	372	1114	1486	25.0
39	483	1033	1516	31.9
40	1368	1657	3025	45.2
41	904	1095	1999	45.2
42	1395	1375	2770	50.4
43	1311	1034	2345	55.9
44	1470	844	2314	63.5
45	2712	1277	3989	68.0
46	2396	800	3196	75.0
47	2148	734	2882	74.5
48	2261	553	2814	80.3
49	2319	395	2714	85.4
50	3606	441	4047	89.1
51	2628	145	2773	94.8
52	2772	129	2901	95.6
53	2127	64	2191	97.1
54	2050	41	2091	98.0
55	2805	58	2863	98.0
56	1997	17	2014	99.1
57	1469	9	1478	99.4
58	1261	5	1266	99.6
59	1124	6	1130	99.5
60	1747	4	1751	99.8
61	851	2	853	99.8
62	927	1	928	99.9
63	557	2	559	99.6
64	441	-	441	100.0
65	634	-	634	100.0
66	304	1	305	99.7
67	248	-	248	100.0
68	228	-	228	100.0
69	142	-	142	100.0
70	277	-	277	100.0
Over 70	525	-	525	100.0
Total	49,444	19,737	69,182	

Table 7. Selection factors of Kapron codend (108.4 mm) with Polish type chafer (226.1 mm).

	Series				
	I	II	III	IV	Mean value
Selection factor	4.08	3.89	4.29 (4.04)	3.50	3.92 (3.86)

4. Compilation of selectivity data presented to the Commission from 1962 to 1966

by the ICNAF Secretariat

At the Annual Meeting of the Commission in Halifax, 1963, the Gear and Selectivity Subcommittee

recommended

that in accordance with the recommendation passed at the 1962 Annual Meeting:

(a) the results of all future selectivity experiments in the ICNAF area should, after first being presented as Meeting Documents by authors, be incorporated each year in a tabular summary, compiled by the Secretariat;

(b) composite summaries of all selectivity data of past years should be compiled by the Secretariat and issued at Annual Meetings at 5-yearly intervals.

(*Redbook* 1963, Pt. I, p. 49)

In fulfilling this recommendation, selectivity data for cod, haddock, redfish, silver hake, red hake, American plaice and yellowtail, which have been submitted to the Commission from 1962 to 1966 by Canada, Federal Republic of Germany, Norway, Poland, USSR and USA are compiled and presented hereunder.

This is the second such compilation.

An earlier compilation of selectivity data for cod, haddock, silver hake, redfish, American plaice and witch submitted to the Commission during the period 1953-1961, was presented to the 1962 Annual Meeting as Meeting Document No. 6 (Serial No. 941).

ICNAF MESH SELECTION SUMMARY   SPECIES: Cod   SUBAREA: 1

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS NUMBER	HAULS DURATION	METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE CODEND	FISH IN SELECTION RANGE COVER	WEIGHT OR NUMBER PER TOW SPECIES STUDIED	WEIGHT OR NUMBER PER TOW ALL SPECIES
		GEAR: Otter trawl						CODEND MATERIAL: Manila, double								
Bratberg ICNAF, Res.Doc. 10 1965, p. 2-3	Division 1D	April 1964	Hamburg 140' trawl			2		covered	133.5	ICES	3.4	10.5	734	806		
		GEAR: Otter trawl						CODEND MATERIAL: Polypropylene - Ulstron								
Bratberg ICNAF, Res.Doc. 10 1965, p.2-3	Division 1D	April 1964	Hamburg 140' trawl			7		covered	141.5	ICES	3.3	12.2	1420	1394		
		GEAR: Otter trawl						CODEND MATERIAL: Polyethylene - Courlene								
Bratberg ICNAF Res.Doc. 10 1965, p.2-3	Division 1D	April 1964	Hamburg 140' trawl			4		covered		ICES	3.2	11.5	461	386		
		GEAR: Bottom trawl						CODEND MATERIAL: Polyamide, continuous								
Bohl ICNAF Res.Doc.66-67 1966	Division 1B 180-220 m	Nov-Dec/65	German standard roundfish bottom trawl, 140' ground-rope	252 3962	4.4	8	65	Topside cover	125.4	ICES	3.51	11.4	1395	1651		
		GEAR: Bottom trawl						CODEND MATERIAL: Polyethylene monofilament								
Bohl ICNAF Res.Doc.66-67 1966	Division 1B 180-220 m	Nov-Dec/65	German standard roundfish bottom trawl, 140' ground-rope	153 6516	4.5	10	65	Topside cover	114.4	ICES	3.38	9.3	2044	1867		
		GEAR: Bottom trawl						CODEND MATERIAL: Polypropylene continuous								
Bohl ICNAF Res.Doc.66-67 1966	Division 1B 180-220 m	Nov-Dec/65	German standard roundfish bottom trawl, 140' ground-rope	204 4905	4.6	8	70	Topside cover	121.6	ICES	3.28	10.3	1274	1218		
		GEAR: Bottom trawl						CODEND MATERIAL: Polypropylene monofilament								
Bohl ICNAF Res.Doc.66-67 1966	Division 1B 180-220 m	Nov-Dec/65	German standard roundfish bottom trawl, 140' ground-rope	208 4800	4.4	8	75	Topside cover	121.6	ICES	3.22	8.2	850	850		
		GEAR: Bottom trawl						CODEND MATERIAL: Polyamide - Perlon, continuous								
Bohl ICNAF Res.Doc. 66-15 1965, p. 1-3	Division 1D 80-110 m	Dec. 1965	German standard roundfish bottom trawl, 140' ground-rope	200 R5000 tex single twine	4.6	4	75	covered codend without chafer	60	ICES	3.38	9.4	1279	1152		
as above	"	"	"	"	4.3	2	75	covered codend with chafer	60	ICES	3.38	8.5	727	705		

ICNAF MESH SELECTION SUMMARY   SPECIES: Cod   SUBAREA: 2

GEAR: Otter trawl   CODEND MATERIAL: Manila

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS NUMBER	HAULS DURATION	METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE CODEND	FISH IN SELECTION RANGE COVER	WEIGHT OR NUMBER PER TOW SPECIES STUDIED	WEIGHT OR NUMBER PER TOW ALL SPECIES
	Division 2J															
Hodder and May ICNAF Res.Bull.No.2,1965, p. 8-18	160-275	August 1962	41-5 Yankee trawl	101 9925[1] / 101 9925	3.5	8	60	covered-codends	98	Westhoff	3.57	9.7	159	141	742[2] / 465	3/
as above	214-223	"	"	"	"	4	60	"	113	"	3.39	10.9	226	183	1067 / 620	
"	221-280	"	"	"	"	8	60	"	120	"	3.98	10.5	114	159	857 / 560	
"	220-255	"	"	"	"	16	60	Alternate hauls	4	"	-	-	-	-	761 / 520	
"	"	"	"	"	"	8	60	"	6	"	3.54	12.4	264	-	614 / 465	
"	"	"	"	"	"	16	60	"	106	"	3.58	8.7	122	-	367 / 345	
"	"	"	"	"	"	8	60	"	113	"	3.45	9.4	166	-	363 / 330	
"	160-170	October 1963	"	"	"	9	60	"	109	ICES	3.41	10.0	88	77	815 / 1140	
"	140-165	"	"	"	"	12	60	"	120	"	3.52	10.4	65	69	667 / 930	
"	145-185	"	"	"	"	8	60	"	130	"	3.48	10.6	86	78	507 / 615	

1 Codend / lengthening piece
2 Number / Weight (kg)
3 Catches consisted almost entirely of cod alone

ICNAF MESH SELECTION SUMMARY SPECIES: Cod SUBAREA: 2 and 3

GEAR: Otter trawl CODEND MATERIAL: Polyamide - Capron

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Treschev ICNAF Res.Doc. 66-58 1966, p. 1-13	Division 3M	March/ April 1963	Standard commercial	R 8500 tex 80 S R 9500 tex 71 S	3.5-4.0	5		without chafer	104.8	ICNAF & ICES	4.0	9.2				
"	"	Dec. 1964-Jan. 1965	"	"	3.5-4.0	5	30-180	"	102.1	ICNAF & ICES	4.0	11.8				
"	"	Jan. 1965	"	"	3.5-4.0	5	30-180	"	107	ICNAF & ICES	3.9	11.5				
"	"	March/ April 1963	"	"				with chafer (Sevryba type)	104		3.8					

ICNAF MESH SELECTION SUMMARY SPECIES: Cod SUBAREA: 3 and 4

GEAR: Otter trawl CODEND MATERIAL: Polyamide - Steelon, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Strzyzewski ICNAF Redbook 1966 P.111, p.112-121	Divisions 3M-4W 60-360 m	April-June/65				6		without chafing gear	114.3	ICES	3.92	10.1				
"	"	"				9		with chafing gear	114.4	ICES	3.67	9.1				
"	"	"				6		"	117.6	"	3.77	11.2				
"	"	"				9		without chafing gear	124.4	"	3.39	10.7				

ICNAF MESH SELECTION SUMMARY   SPECIES: Haddock   SUBAREA: 3

GEAR: Otter trawl   CODEND MATERIAL: Manila

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE (m)	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW knot	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION (min)						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Bodder and May ICNAF Res.Bull.No.1, 1964, p.28-35	Division 3N 55-73	May/June 1959	41-5 Yankee trawl	151 6617 / 151 6617 [1]	3.5	19	60	Alternate hauls	71 / 79 [1]	ICNAF	-			-	4680 / 1685 [3]	2112[4]
	"	"	"	101 9925 / 101 9925	"	5	60	" I[2]	94 / 94	"	3.26			-	1176 / 461	603
	"	"	"	"	"	5	60	" II	"	"	3.04			-	2298 / 862	1246
	"	"	"	"	"	5	60	" III	"	"	3.17			-	3943 / 1500	1694
	"	"	"	"	"	4	60	" IV	"	"	2.72			-	7828 / 2965	3254
	"	"	"	"	"	6	60	" I	104 / 107	"	3.34			-	1171 / 504	694
	"	"	"	"	"	5	60	" II		"	3.25			-	1561 / 677	1185
	"	"	"	"	"	5	60	" III		"	3.02			-	2787 / 1112	1444
	"	"	"	"	"	4	60	" IV		"	3.02			-	5330 / 2241	2685
	3N 40-46	July/Aug. 1959	"	151 6617 / 151 6617	"	6	60	" -	70 / 76	"	-			-	25870 / 8943	9176
	"	"	"	101 9925 / 101 9925	"	3	60	" I	96 / 91	"	3.56			-	5070 / 2142	2215
	"	"	"	"	"	3	60	" II	"	"	3.37			-	19690 / 7659	8413
	"	"	"	101 995 / 101 995	"	3	60	" I	104 / 106	"	3.54			-	4895 / 2125	2250
	"	"	"	"	"	2	60	" II	"	"	3.24			-	15500 / 6034	6163
	3O 81-86	May 1960	"	121 8271 / 121 8271	"	15	60	" -	87 / 84	"	-			-	8330 / 4099	4892
	"	"	"	101 9925 / 101 9925	"	5	60	" I	94 / 100	"	3.42			-	4095 / 2090	2521
	"	"	"	121 8271 / 121 8271	"	5	60	" II	"	"	3.37			-	7020 / 3530	4176
	"	"	"	"	"	5	60	" III	"	"	3.28			-	9390 / 4888	5883
	"	"	"	"	"	6	60	" I	109 / 107	"	3.17			-	2215 / 1185	1789
	"	"	"	"	"	5	60	" II	"	"	3.10			-	4175 / 2177	2836
	"	"	"	"	"	5	60	" III	"	"	3.09			-	8880 / 4969	6012

1 Codend / Lengthening piece

2 Roman numerals refer to various categories of catch size

3 Number / Weight (kg)

4 Cod and haddock weight (kg)

ICNAF MESH SELECTION SUMMARY SPECIES: Haddock SUBAREA: 3

GEAR: Otter trawl CODEND MATERIAL: Manila

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE (m)	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW knot	HAULS NUMBER	HAULS DURATION (min)	METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE CODEND	FISH IN SELECTION RANGE COVER	WEIGHT OR NUMBER PER TOW SPECIES STUDIED	WEIGHT OR NUMBER PER TOW ALL SPECIES
Hodder and May ICNAF Res.Bull. No. 1, 1965, p. 28-35	Division 3N 46-49	July 1960	41-5 Yankee trawl	121 8271 / 121 8271 [1]	3.5	20	40	Alternate hauls	74 / 83 [1]	ICNAF	-			-	11780 / 5991 [3]	6250 [4]
	"	"	"	"	"	5	40	" I[2]	108 / 105	"	3.33			-	2220 / 1293	1474
	"	"	"	"	"	5	40	" II	"	"	3.28			-	5175 / 2896	3103
	"	"	"	"	"	5	40	" III	"	"	3.15			-	7490 / 4051	4215
	"	"	"	"	"	5	40	" IV	"	"	3.22			-	10610 / 6086	6767
	"	"	"	101 9925 / 121 8271	"	5	40	" I	110 / 113	"	3.44			-	2490 / 1444	1509
	"	"	"	"	"	5	40	" II	"	"	3.36			-	5020 / 3551	3819
	"	"	"	121 8271 / 121 8271	"	5	40	" I	125 / 118	"	3.26			-	1505 / 1121	1758
	"	"	"	"	"	5	40	" II	"	"	3.20			-	6835 / 4448	4836

[1] Codend / Lengthening piece

[2] Roman numerals refer to various categories of catch size

[3] Number / Weight (kg)

[4] Cod and haddock weight (kg)

ICNAF MESH SELECTION SUMMARY SPECIES: Haddock SUBAREA: 5

GEAR: Otter trawl CODEND MATERIAL: Polyamide - Steelon, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Draganik & Zukowski ICNAF, Res.Doc.66-28, 1966	Division 5Z 70-110 m	Aug./Sept. 1965			4.5	8	120-180	without chafing gear	113.7	ICES	3.64	9.3				

ICNAF MESH SELECTION SUMMARY SPECIES: Haddock SUBAREA: 3 and 4

GEAR: Otter trawl CODEND MATERIAL: Polyamids - Steelon, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Strzyzewski ICNAF Redbook 1966 P.111, p.112-121	Divisions 3M-4W 60-360 m	April-June 1965				5		without chafing gear	113.4	ICES	3.78	9.1				
	"	"				3		"	127.3	ICES	3.21	11.2				

ICNAF MESH SELECTION SUMMARY   SPECIES: Redfish   SUBAREA: 2 and 3

GEAR: Otter trawl   CODEND MATERIAL: Polyamide - Capron, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R.. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUM-BER	DUR-ATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Treschev ICNAF Res.Doc. 66-58 1966, p. 1-13	Division 3M	March/ April 1963	Standard commercial	R 8500 tex 80 S R 9500 tex 71 S	3.5-4.0			without chafer	107.2	ICNAF & ICES	2.7					
	"	"	"	"	3.5-4.0			with chafer (Sevryba type)	102.8	ICNAF & ICES	2.7					

ICNAF MESH SELECTION SUMMARY SPECIES: Redfish SUBAREA: 3 and 4

GEAR: Otter trawl CODEND MATERIAL: Polyamide- Steelon, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Strzyzewski ICNAF Redbook 1966 P.111, p.112-121	Divisions 3M-4W 60-360 m	April- June 1965				5		without chafing gear	114.6	ICES	2.85	6.8				
	"	"				3		with chafing gear	103.9	ICES	2.92	5.0				
	"	"				1		without chafing gear	128.5	ICES	2.31	13.4				

ICNAF MESH SELECTION SUMMARY SPECIES: Silver Hake SUBAREA: 5

GEAR: Otter trawl CODEND MATERIAL: Polyamide - Nylon

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R., TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Jensen & Hennemuth ICNAF Res.Doc. No. 61 1965, p. 1-14	Division 5Y 14-70 F	June/Aug. 1964	Trawl net similar to commercial type	-	-	20	45	covered with 31mm	52	ICES	3.2	12-37 cm	24,524	2,845	1,411	
	"	"	"	-	-	20	45	without cover	52	ICES	5.08	12-39 cm	20,413	-	1,042	-
	"	"	"	-	-	20	45	"	73	ICES	4.16	12-51 cm	9,773	-	459	
	Div. 5Y no depth	Sept/Oct. 1964	"	-	2	4	120	without cover	50	ICES	-	-		-	12,656	
	"	"	"	-	"	4	105	"	71	ICES	4.27	12-40 cm	18,876	-	4,773	-
	Div. 5Y	October 1964	"	-	"	11	85	"	33	ICES	-	-		-	7,746	-
	"	"	"	-	"	10	75	"	71	ICES	4.13	12-36 cm	39,681	-	4,443	-

ICNAF MESH SELECTION SUMMARY SPECIES: Red Hake SUBAREA: 5

GEAR: Otter trawl CODEND MATERIAL: Polyamide - Nylon

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R., TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Jensen & Bennemuth ICNAF Res.Doc. No. 61 1965, p. 1-14	Division 5Y 12-70 F.	June/Aug. 1964	Trawl net similar to commercial type	-	-	10	40	covered with 31mm	52	ICES	5.6	12-33 cm	26	77	44	-
	"	"	"	-	-	13	40	without cover	52	ICES	4.9	18-31 cm	47	-	31	-
	"	"	"	-	-	18	50	"	73	ICES	4.2	21-33 cm	30	-	14	-
	Division 5Y 20-24 F.	October 1964	"	-	2	4	60	"	33	ICES	-	-		-	162	-
	"	"	"	-	"	4	85	"	71	ICES	5.1	30-41 cm	131	-	97	-

ICNAF MESH SELECTION SUMMARY SPECIES: American Plaice SUBAREA: 3 and 4

GEAR: Otter trawl CODEND MATERIAL: Polyamide - Steelon, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Strzyzewski ICNAF Redbook 1966 P.111,p.112-121	Divisions 3M-4W 60-360 m	April-June 1965				3		without chafing gear	113.6	ICES	2.42	4.7				
	"	"				3		with chafing gear	108.9	ICES	2.33	4.0				
	"	"				2		without chafing gear	123.0	ICES	2.20	5.2				

ICNAF MESH SELECTION SUMMARY

SPECIES: Yellowtail Flounder

SUBAREA. 3 and 4

GEAR: Otter trawl

CODEND MATERIAL: Polyamide - Steelon, double

AUTHOR AND SOURCE	LOCALITY AND DEPTH RANGE	DATE	TRAWL	RUNNAGE AND R. TEX	SPEED OF TOW	HAULS		METHOD	MESH SIZE	MESH GAUGE	SELECTION FACTOR	SELECTION RANGE	FISH IN SELECTION RANGE		WEIGHT OR NUMBER PER TOW	
						NUMBER	DURATION						CODEND	COVER	SPECIES STUDIED	ALL SPECIES
Strzyzewski ICNAF Redbook 1966 P.111, p.112-121	Divisions 3M-4W 60-360 m	April-June 1965				1		without chafing gear	114.2	ICES	2.29	3.1				
	"	"				1		"	127.0	ICES	2.15	7.7				