

Northwest Atlantic



Fisheries Organization

Serial No. N117

NAFO SCR Doc. 80/VI/69

SCIENTIFIC COUNCIL MEETING - JUNE 1980

The Selectivity of Bottom Trawls in Fishing Greenland Halibut
in the Central Labrador and Baffin Island Area

by

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Abstract

The results of determining the selectivity parameters of trawl nets with a 120-mm mesh size for Greenland halibut are given in the paper.

Introduction

The problems connected with optimum fishing of live resources in the sea areas of coastal countries have become very important over recent years.

Fishery control by means of changing the mesh size in fishing gears is of primary significance among the measures of fishery regulation, which changes the intensity of escape and retention of fish belonging to different length groups and, thus, influences the selective properties of fishing gears.

The paper presents information on determining the trawl net selectivity for Greenland halibut. It should be mentioned that no published materials on the subject were found, that is why only the results of our investigations are given in the paper.

Methods

Estimation of the selectivity of bottom trawls in fishing Greenland halibut was performed during Cruise 3/20 of the FRV "Suloy" from 1 August to 22 December 1979.

The investigations on selectivity were carried out by a

grid of trawl stations with one trawl. A cover of small-meshed netting was attached to the topside of the cod-end to retain fish from escaping through it. The front edge of the cover was lashed to the tapered part of the net, side edges were fixed to rope bellylines.

The type of netting used for making the cover was attached to the underside of the cod-end. This part of the net was lashed to rope bellylines and prevented fish from escaping through the lower half of the cod-end.

The correlations of the main dimensions of the cod-end and the cover were as follows:

$$\frac{a_1}{a} = 0.65; \quad \frac{h_1}{h} = 1.5; \quad \frac{l_1}{l} = 1.2$$

where a_1 , h_1 , l_1 - the mesh size, width and length of the cover, respectively;

a , h , l - the mesh size, width and length of the cod-end, respectively.

The cod-end is made of double polyamide with $R=5700$ tex., and the cover - of polyamide with $R=2740$ tex.

Two series of trawlings were performed (five trawlings in each series). The first series of trawlings was carried out in the Central Labrador area in late October. The second series of trawlings was made in the Baffin Island area in mid November. In the Central Labrador area trawlings were made at the depth of about 370 m with the speed of 3.6 knots (6.66 km/h). The duration of trawling was assumed to be 1.5 hours, the catches on the average were 0.8 tons per trawling. In the Baffin Island area trawlings were made at the depth of about 700 m with the speed of 3.5 knots (6.48 km/h). Catches were about 0.7 ton per 1.5 hours of trawling.

While determining selectivity in accordance with the accepted rules the mesh size of the cod-end was measured by a wedge - shaped plate 2 mm thick at a pressure of 5 kg.

To compare various size-ranges of fish analytically, besides generally accepted characteristics, coefficients β and C_{EM} determined by the formulae given below are introduced:

$$\beta = \bar{L} \cdot \bar{M} \quad (1)$$

and
$$C_{LM} = \frac{\sigma_L}{\bar{L}} \cdot \frac{\sigma_M}{\bar{M}} \quad (2)$$

where \bar{L}, \bar{M} - mathematical expectation of length and mass of fish size-range, respectively;
 σ_L, σ_M - standard deviation of length and mass of fish size-range, respectively.

The coefficient β is a generalized index characterizing the mean size and mass of fish taken together in the size-range. The increase of this index as the characteristic of size distribution, is exercised by multiplying the values of \bar{L} and \bar{M} .

The coefficient C_{LM} determines the relative dispersion of size and mass of fish in the size-range in portions of \bar{L} and \bar{M} .

Discussion

The mean mesh size was 124 mm according to measurements.

The results of determining the dependence of the mass on the size of fish (Table 1) turned out to be close to the data of K.G. Konstantinov and A.K. Chumakov (personal statement).

The characteristics of size composition of caught and escaped fish as well as obtained parameters of trawl bags selectivity are listed in Tables 2 - 7.

On the basis of analysis of the data given in these Tables it can be seen that concentrations of Greenland halibut fished in the Baffin Island area have the coefficient $\beta = 61.9 \text{ cm} \cdot \text{kg}$, and in the Central Labrador area - $124.1 \text{ cm} \cdot \text{kg}$, in the first case the caught fish were smaller than in the second one. The consequence is that the relative number of fish in the range of length of escaping fish in the Baffin Island area was 1.84 times as high as that in the Central Labrador area.

The values of relative dispersion of length and mass of fish (coefficient C_{LM}) in both areas were close.

The mentioned circumstances were the main cause of the increase in fish escape from the trawl net in the Baffin Island area.

As is seen from Tables 5 - 7, the maximal length of fish able to escape from the net with a 124 mm mesh size was 48-50 cm.

The total losses in the catch were from 3 to 8% by abundance and from 0.7 to 3% by mass. The total fish escape in relation to the summarized quantity of fish in the range of length of escaping fish was from 9 to 14% by abundance and from 5 to 11% by mass.

Table 1. Dependence of Greenland halibut mass (m) on their length (l).

l_i cm	m_i kg ⁱ	l_i cm	m_i kg	l_i cm ⁱ	m_i kg ⁱ	l_i cm	m_i kg ⁱ	l_i cm	m_i kg ⁱ
20	0,05	40	0,60	60	2,00	80	5,20	100	11,0
1	0,07	1	0,66	1	2,10	1	5,46	1	11,83
2	0,09	2	0,72	2	2,20	2	5,72	2	12,66
3	0,11	3	0,78	3	2,30	3	5,98	3	13,49
4	0,13	4	0,84	4	2,40	4	6,24	4	14,32
25	0,15	45	0,90	65	2,50	85	6,50	105	15,15
6	0,17	6	0,95	6	2,64	6	6,80	6	16,0
7	0,19	7	1,00	7	1,78	7	7,10	7	16,44
8	0,21	8	1,05	8	2,92	8	7,40	8	16,98
9	0,23	9	1,10	9	3,06	9	7,70	9	17,32
30	0,25	50	1,15	70	3,20	90	8,0	110	17,76
1	0,28	1	1,22	1	3,38	1	8,34	1	18,2
2	0,31	2	1,29	2	3,56	2	8,68	2	18,64
3	0,34	3	1,36	3	3,74	3	9,02	3	19,08
4	0,37	4	1,43	4	3,92	4	9,36	4	19,52
35	0,40	55	1,50	75	4,10	95	9,7	115	20,00
6	0,44	6	1,60	6	4,32	6	9,06	6	20,50
7	0,48	7	1,70	7	4,54	7	10,22	7	21,0
8	0,52	8	1,80	8	4,76	8	10,48	8	21,50
9	0,56	9	1,90	9	4,98	9	10,74	9	22,00

Table 2. Relative composition of Greenland halibut size groups in 5 trawlings made in the Central Labrador area.

Fish length l _i cm	Caught fish						Escaped fish					
	Amount			Relative composition ‰			Amount			Relative composition ‰		
	♂	♀	total	♂	♀	total	♂	♀	total	♂	♀	total
20-29	5	4	9	3,2	2,5	5,7	4	2	6	2,5	1,3	3,8
30-39	24	13	37	15,3	8,3	23,5	12	3	15	7,6	1,9	9,5
40-41	14	17	31	8,9	10,8	19,7	3	4	7	1,9	2,5	4,1
42-43	28	21	49	17,8	13,4	31,2	5	5	10	3,2	3,2	6,4
44-45	26	17	43	16,5	10,8	27,4	2	1	3	1,3	0,6	1,9
46-47	50	36	86	31,8	22,9	54,7	-	1	1	-	0,6	0,6
48-49	58	44	102	36,9	28,0	64,9	1	1	2	0,6	0,6	1,3
50-51	77	53	130	49,0	33,7	82,7	-	1	1	-	0,6	0,6
52-53	75	37	112	47,7	23,5	71,2	-	-	-	-	-	-
54-55	55	43	98	35,0	27,4	62,3	-	-	-	-	-	-
56-57	66	44	110	42,0	28,0	70,0	-	-	-	-	-	-
58-59	61	36	97	38,8	22,9	61,7	-	-	-	-	-	-
60-61	83	44	127	52,8	28,0	80,8	-	-	-	-	-	-
62-63	95	41	136	60,4	26,1	86,5	-	-	-	-	-	-
64-65	55	27	82	35,0	17,2	52,2	-	-	-	-	-	-
66-67	49	28	77	31,2	17,8	49,0	-	-	-	-	-	-
68-69	25	27	52	15,9	17,2	33,1	-	-	-	-	-	-
70-71	10	20	30	64,0	127,0	19,1	-	-	-	-	-	-
72-73	3	18	21	1,9	11,4	13,4	-	-	-	-	-	-
74-75	2	13	15	1,3	8,3	9,5	-	-	-	-	-	-
76-77	-	18	18	-	11,4	11,4	-	-	-	-	-	-
78-79	-	21	21	-	13,4	13,4	-	-	-	-	-	-
80-89	-	55	55	-	35,0	35,0	-	-	-	-	-	-
90-99	-	28	28	-	17,8	17,8	-	-	-	-	-	-
100-109	-	5	5	-	3,2	3,2	-	-	-	-	-	-
110-119	-	1	1	-	0,6	0,6	-	-	-	-	-	-
Σ	861	711	1572				29	18	47			

Table 3. Relative composition of Greenland halibut size groups in 5 trawlings made in the Baffin Island area.

Fish length l _i cm	Caught fish					Escaped fish						
	Amount		Relative composition ‰			Amount		Relative composition ‰				
	♂	♀	total	♂	♀	total	♂	♀	total	♂	♀	total
24-25	I	I	0,4	0,4								
26-27	5	5	I,9	I,9	2	2			0,8	0,8		
28-29	4	II	I5	I,6 4,3	5,8	I	6	7	0,4	2,3	2,7	
30-3I	I7	20	37	6,6 7,8	I4,4	8	5	I3	3,I	I,9	5,0	
32-33	46	45	9I	I7,9 I7,4	35,3	I2	7	I9	4,7	2,7	7,4	
34-35	68	60	I28	26,4 23,3	49,7	2I	I6	37	8,2	6,2	I4,4	
36-37	8I	89	I70	3I,5 34,6	66,0	2I	25	46	8,I	9,7	I7,8	
38-39	II2	I03	2I5	43,5 40,0	83,5	22	I6	38	8,5	6,2	I4,8	
40-4I	I29	I23	252	50,I 47,8	97,8	2I	I3	34	8,2	5,0	I3,2	
42-43	I05	83	I88	40,I 32,2	73,0	5	4	9	I,9	I,6	3,5	
45-45	73	53	I26	28,3 20,6	48,9	I	-	I	0,4	-	0,4	
46-47	76	52	I28	29,5 20,2	49,7	I	-	I	0,4	-	0,4	
48-49	66	42	I08	25,6 I6,3	4I,9	2	-	2	0,8	-	0,8	
50-5I	II0	39	I49	42,7 I5,I	57,9							
52-53	I0I	27	I28	39,2 I0,5	49,7							
54-55	92	27	II9	35,7 I0,5	46,2							
56-57	I04	28	I32	40,4 I0,9	5I,3							
58-59	94	40	I34	36,5 I5,5	52,0							
60-6I	99	32	I3I	38,4 I2,4	50,9							
6I-63	40	27	67	I5,5 I0,5	26,0							
64-65	34	I5	49	I3,2 5,8	I9,0							
66-67	29	22	5I	II,3 8,5	I9,8							
68-69	I3	I4	27	5,0 5,4	I0,5							
70-7I	8	2I	29	3,I 8,I	II,3							
72-73	2	I8	20	0,8 7,0	7,8							
74-75	3	I0	I3	I,2 3,9	5,0							
76-77	9	9	9	3,5 3,5								
78-79	6	6	6	2,3 2,3								
80-8I	8	8	8	3,I 3,I								
82-83	8	8	8	3,I 3,I								
84-85	2	2	2	0,8 0,8								
86-87	8	8	8	3,I 3,I								
88-89	3	3	3	I,2 I,2								
90-9I	4	4	4	I,6 I,6								
92-93	4	4	4	I,6 I,6								
94-95	2	2	2	0,8 0,8								
96-97	3	3	3	I,2 I,2								
98-99	3	3	3	I,2 I,2								
I00-I0I	I	I	I	0,4 0,4								
I02-I03												
I04-I05												
I06-I07	I	I	I	0,4 0,4								
Σ	I506	I069	2575			II5	94	209				

Table 4. Main characteristics of size-ranges of fished off Greenland halibut*.

Characteristics of a size-range	the Central Labrador area	the Baffin Island area
Minimal length of caught fish l_{\min} (cm)	24	24
Maximal length of caught fish l_{\max} (cm)	114	106
Mathematical expectation of fish length \bar{l} (cm)	58	48
Mathematical expectation of fish mass \bar{M} (kg)	2,14	1,29
Index of mean size and mass of fish $\beta = \bar{l} \cdot \bar{M}$ (cm·kg)	124,1	61,9
Index of fish size and mass dispersion in a size-range $C_{lM} = \frac{\sigma_l}{\bar{l}} \cdot \frac{\sigma_M}{\bar{M}} \cdot 100$	18,1	22,1
Location of the peak of fish size-range $l_{\text{calcul. peak}}$ (cm)	50,5; 62,5	40
Relation of total amount of caught fish within the length range of escaping fish to to- tal amount of all caught fish %	31	57

* σ_l, σ_M - standard deviation of fish length and mass distribution relative to their mathematical expectation, respectively.

Table 5. Characteristics of trawl bag selectivity for size groups within the limits of length of escaping fish (the Central Labrador).

Fish length cm	Caught fish			Escaped fish			Relation of escaped to caught fish		
	♂	♀	total	♂	♀	total	♂	♀	total
by fish abundance									
20-29	5	4	9	4	2	6	0,8	0,5	0,67
30-39	24	13	37	12	3	15	0,5	0,23	0,41
40-41	14	17	31	3	4	7	0,21	0,24	0,23
42-43	28	21	49	5	5	10	0,18	0,24	0,20
44-45	26	17	43	2	1	3	0,08	0,06	0,07
46-47	50	36	86	-	1	1	-	0,03	0,01
48-49	58	44	102	1	1	2	0,02	0,02	0,02
50-51	77	53	130	-	1	1	-	0,02	0,01
Σ	282	205	487	27	18	45	0,096	0,088	0,092
by fish mass									
20-29	0,70	0,56	1,26	0,56	0,28	0,84			
30-39	4,32	2,34	6,65	2,16	0,54	2,70			
40-41	8,82	10,71	19,53	1,89	2,52	4,41			
42-43	21,0	15,75	36,75	3,75	3,75	7,50			
44-45	22,62	14,79	37,41	1,74	0,87	2,61			
46-47	48,50	34,92	83,42	-	0,97	0,97			
48-49	62,06	47,08	109,14	1,07	1,07	2,14			
50-51	90,86	62,54	153,4	-	1,18	1,18			
Σ	258	189	448	11,17	11,18	22,35	0,043	0,062	0,050

Table 6. Characteristics of trawl net selectivity for size groups of Greenland halibut within the range of length of escaping fish (the Baffin Island area).

Fish length l _i cm	Caught fish			Escaped fish			Relation of escaped to caught fish		
	♂	♀	total	♂	♀	total	♂	♀	total
by fish abundance									
24-25	-	I	I	-	-	-	-	-	-
26-27	-	5	5	-	2	2	-	0,40	0,40
28-29	4	II	I5	I	6	7	0,25	0,54	0,47
30-3I	I7	20	37	8	5	I3	0,47	0,25	0,35
32-33	46	45	9I	I2	7	I9	0,26	0,I6	0,2I
34-35	68	60	I28	2I	I6	37	0,3I	0,27	0,29
36-37	8I	89	I70	2I	25	46	0,26	0,28	0,27
38-39	II2	I03	2I5	22	I6	28	0,20	0,I6	0,I8
40-4I	I29	I23	252	2I	I3	34	0,I6	0,II	0,I3
42-43	I05	83	I88	5	4	9	0,05	0,05	0,05
44-45	73	53	I26	I	-	I	0,0I	-	0,0I
46-47	76	52	I28	I	-	I	0,0I	-	0,0I
48-49	66	42	I08	2	-	2	0,03	-	0,02
Σ	777	687	I464	II5	94	209	0,I5	0,I4	0,I4
by fish mass									
24-25	-	0,I4	0,I4	-	-	-	-	-	-
26-27	-	0,90	0,90	-	0,36	0,36	-	-	-
28-29	0,88	2,42	3,3	0,22	I,32	I,54	-	-	-
30-3I	4,42	5,2	9,62	7,08	I,3	3,38	-	-	-
32-33	I5,I8	I4,85	30,03	3,96	2,3I	6,27	-	-	-
34-35	25,84	22,8	48,64	7,98	6,08	I4,06	-	-	-
36-37	37,26	40,94	78,20	9,66	II,50	2I,I6	-	-	-
38-39	60,48	55,62	II6,I	II,88	8,64	20,52	-	-	-
40-4I	8I,27	77,49	I58,76	I3,23	8,I9	2I,42	-	-	-
42-43	78,75	62,25	I4I,0	3,75	3,00	6,75	-	-	-
44-45	63,5I	46,II	I09,62	0,87	-	0,87	-	-	-
46-47	74,48	50,96	I25,4I	0,98	-	0,98	-	-	-
48-49	7I,28	45,36	II6,64	2,I6	-	2,I6	-	-	-
Σ	5I3	425	938	56,77	42,7	99,47	0,II	0,I0	0,II

Table 7. Main characteristics of trawl net selectivity in fishing Greenland halibut.

No.	Type of characteristics	Central Labrador	Baffin Island
1	Minimal length of fish retained by a bag	24	24
2	(l _{ret.}) min (cm) Minimal length of escaped fish (l _{esc.}) min (cm)	24	26
3	Maximal length of escaped fish (l _{esc.}) max (cm)	50	48
4	Minimal length of fish fully retained by the bag (l _{ret. fully}) min (cm)	52	50
5	Relation of total abundance (mass) of escaped fish in the length range of escaping fish to the total abundance of caught fish in this range (%)	9,2 (5,0)	14 (11)
6	Relation of total abundance (mass) of caught fish in the length range of escaping fish to the total abundance of caught fish in the whole range of length	97,14 (99,34)	91,89 (97,01)