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Survey for Greenland Halibut in NAFO Divisions 1C-1D

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Introduction

During the period 1987-1995 Japan Marine Fishery Resources Research Center (JAMARC) and Greenland Institute of Natural Resources jointly conducted 12 bottom trawl surveys (Jørgensen 1998) and 4 pelagic surveys (Jørgensen 1997a) at West Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters. The bottom trawl surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) off West Greenland (NAFO Div. 1B-1D). In 1997 Greenland Institute of Natural Resources continued the bottom trawl surveys series with the Institute's own vessel PAAMIUT which had been rigged for deep sea trawling. There has unfortunately not been any comparative trawlings between the Japanese research vessel SHINKAI MARU and PAAMIUT making comparisons between the surveys difficult.

Materials and methods

The survey in 1997 took place in the period 20/9-8/10. The first three days were used to test trawl gear and rigging.

Stratification
The survey covered NAFO Div. 1C and 1D between the 3-nm line and the 200-nm line or the midline to Canada at depths between 400 and 1500 m. (Most of the joint Greenland/Japan surveys also covered Div.1B. This area is, however, covered down to 600 m by the Greenland Shrimp Survey and the area of depths > 600 m in Div. 1B is small). The survey area was stratified in NAFO Divisions and subdivided in 6 depth strata: 401-600, 601-800, 801-1000, 1001-1200, 1201-1400 and 1401-1500 m. The depth stratification was mainly based on Greenland Geological Survey's 10 m depth contour maps. These maps do not cover the western part of the survey area, but here a Canadian map and depth soundings made under previous surveys were used. The area of each stratum was measured using "Mapinfo Version 4.0"(Table 1).

The survey was planned as a Stratified Random Bottom Trawl Survey with in total 70 hauls (5 hauls a day in 14 days). Basically hauls were allocated proportional to stratum area. Analysis of the joint Greenland/Japan survey data showed that Div. 1C depth stratum 601-800 m traditionally had been oversampled, while depth stratum 1001-1200 m and 1201-1400 m in Div. 1D had been undersampled. More hauls were, hence, allocated to the two latter strata, than their area justified, in order to reduce the variance of the estimated biomass and abundance of Greenland halibut. The positions of the hauls were selected at random within each stratum.

Vessel and gear
The survey was conducted by the 722 GRT trawler PAAMIUT, using an ALFREDO III trawl with a mesh size on 140 mm and a 30-mm mesh-liner in the cod-end. The ground gear was of the rock hopper type. The ground gear (Fig. 1) was mounted with an extra 50 kg 5/8" chain through the rubber discs in the central part of the gear (not shown). Rigging and bobbins chain is shown in fig.2. The trawl doors were Greenland Perfect (370*250 cm) weighing 2400 kg mounted with extra 20 kg. A Furuno net sonde mounted on the head rope measured net height. Scanmar sensors measured the distance between the trawl doors. Wingspread, taken as the distance between the outer bobbins, was calculated as:

distance between outer bobbins=10.122 + distance between trawl doors * 0.142

This relationship was estimated based on flume tank measurements of the trawl and rigging used in the survey (Fig. 2, 3).

Trawling procedure
Towing time was usually 30 min, but towing times down to 15 min were accepted. Average towing speed was 3.0 kn. Towing speed was estimated from the start and end positions of the haul. Trawling took place in daytime only (7 a.m. to 7 p.m. local time, 9 to 21 UTC).

Otoliths for age determination of Greenland halibut (n=437) were soaked in water and read in transparent light. Age distributions were estimated using age/length keys and survey length frequencies pooled in 3-cm groups.

Near-bottom temperatures were measured, by 0.1 °C, by a Seamon sensor mounted on a trawl door.

Handling of the catch
After each haul the catch was sorted by species and weighed to nearest 0.1 kg, and the number of specimens recorded. Most fish species were sexed and measured as total length (TL) to 1.0 cm below. Grenadiers were measured as pre anal fin length (AFL) to 0.5 cm below. In case of large catches subsamples of the catch were measured, subsamples comprised always of at least 200 specimens.

Biomass and abundance estimates were obtained by applying the swept area method (estimated trawling speed * estimated bobbin spread) taking the catchability coefficient as 1.0. All catches were standardised to 1 km^2 swept.

Results and discussion

In total 63 successful hauls were made, giving a mean coverage of 830 km^2 per haul (Table 1). After 30 hauls the rigging was changed slightly (a 48 m upper bridle was removed, because it was difficult to handle on deck). The influence on the comparability of the present survey with coming surveys is negligible, because the change of the shape of the trawl was limited (the net height was reduced about 1 m, the influence on the wing spread is unknown, but must be minor). Further, the density of Greenland halibut and roundnose grenadier in the area covered during the first 30 hauls use to be low in previous years joint Greenland/Japan surveys.

Greenland halibut (*Reinhardtius hippoglossoides*).
Greenland halibut was caught in all hauls and the catches ranged between 2.1 kg at 706 m in Div. 1C and 472.2 kg at 1141 m in Div. 1D (Fig. 4, Table 2).

The biomass of Greenland halibut in Div. 1C-1D, 401-1500 m, was estimated at 56260.2 tons (S.E. 4399.6) compared to 38079.3 (S.E. 7921.2) in 1995 (Jørgensen 1998) .The survey in 1995 was, however, conducted a month earlier and with another vessel and gear. The highest densities were found at depths > 1000 m (Table 3), where it was found in depth stratum 1001-1200 m in 1995. The change in distribution was probably caused by seasonal migrations (Jørgensen 1997b)

The abundance in Div. 1C-1D was estimated at $53.613*10^6$ (S.E. $4.118*10^6$) compared to $33.025*10^6$ (S.E. $6.7*10^6$) in 1995. The highest concentrations were found in depth stratum 1001-1200 m in Div. 1C and 1D. (Table 4)

The length ranged from 15 cm to 102 cm. Generally the length distributions in the different depth strata were dominated by a single mode, except in the most shallow stratum. Fish size increased with depth and from north to south at the same depth (Fig. 5) as seen in previous surveys (Jørgensen 1997b). The overall length distribution (weighted by stratum area) was dominated by a mode around 51 cm with a "shoulder" around 48 cm (Fig. 6).

The age ranged from 2 to 17 years with the youngest fish in shallow water in Div. 1C and the oldest fish in deep water in Div. 1D (Fig. 7). Generally the age increased by depth and there was a tendency towards an increase in age from north to south at the same depth. At 401-600 m the ages 4-6 dominated. At depths between 601 and 1000 m the ages 6-7 were dominating, while the ages 8 and 9 dominated at deeper waters. The overall age distribution (weighted by stratum area) was monomodal with a mode around age 8 (Fig. 8). The length distributions in the surveys have always been very similar (Jørgensen 1998). In the surveys in 1994 and 1995 the mode was located around age 7. Two different readers have read the otoliths. The age distribution in 1997 resembled the age

distribution in 1988 and 1989 (Jørgensen 1998), when the same person who read the 1997 otoliths read the otoliths. Mean length at age data from 1995-1997 showed a clear change in mean length at age from 1996 to 1997 for fish younger than 11 years (Table 5). This suggests a systematic difference in the interpretation of the otoliths by the two age readers. The age composition should therefore be interpreted with caution.

Males started maturing at age 6 and 50 % of the males were mature between age 7 and 8 (Table 6) corresponding to a length of about 46-47 cm (Table 7). A single female was maturing at age 6 and 50% of the females were mature between age 9 and 10 (Table 6) corresponding to 55-56 cm (Table 7).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in 52 of the 63 hauls, but the catches were low, ranging from 0.1 kg in several hauls to 74.3 kg at 1460-m depths in Div. 1D. (Fig. 9, Table 2).

The biomass of roundnose grenadier in Div. 1C-1D, 401-1500 m, was estimated at 5686.5 tons (S.E. 926.4) compared to 7187.2 tons (S.E. 2445.7) in 1995 (Jørgensen 1998). Almost all the biomass was found in Div. 1D at depths > 1000 m (Table 8), generally more southerly compared to 1995. The 1997 survey was conducted one month later than the 1995 survey and the decrease in biomass could be caused by a migration out of the survey area as seen previously (Jørgensen 1998). Comparisons between the two surveys should, however, be done cautiously.

The abundance in Div. 1C-1D was estimated at $32.441*10^6$ (S.E. $7.056*10^6$) compared to $31.745*10^6$ (S.E. $13.016*10^6$) in 1995. The highest concentration was found in depth stratum 1001-1200 m in Div. 1D and relatively high concentrations were found at depths > 1000 m (Table 9).

Pre anal fin length ranged from 2.0 to cm 20 cm. Generally the length distributions in the different depth strata (length frequencies in Div. 1C and 1D are combined due to few observations in Div.1C) were dominated by a single mode. Fish size increased with increasing depth, the mode being located around 5 cm in depth stratum 601-800 m, while it was located around 12 cm in depth stratum 1401-1500 m (Fig. 10). The overall length distribution (weighted by stratum area) was dominated by a mode around 8 cm with a "shoulder" around 6 cm (Fig. 11).

Roughhead grenadier (*Macrourus berglax*)

Roughhead grenadier was caught in 55 of the 63 hauls, but the catches were low, ranging from 0.1 kg to 21.8 kg, with the largest catches in Div. 1D at depths between 1000 and 1400 m (Fig.12, Table 2).

The biomass of roughhead grenadier in Div. 1C-1D, 401-1500 m, was estimated at 2258.6 tons (S.E. 250.1) compared to 1130 tons (S.E. 134.5) in 1995 (Yokawa *et. al* 1996). Almost all the biomass was found in Div. 1D at depths > 1000 m (Table 10). The abundance in Div. 1C-1D was estimated at $4.60*10^6$ (S.E. $0.45*10^6$) (Table 11).

Pre anal fin length ranged from 2.0 to cm 20 cm. The overall length distribution (weighted by stratum area) was dominated by a mode around 8 cm with a "shoulder" around 6 cm (Fig. 13).

Deep sea redfish (*Sebastes mentella*)

Deep-sea redfish was caught in 29 the 63 hauls, but the catches were low, ranging from 0.1 kg to 30.6 kg. (Fig. 14, Table 2).

The biomass of deep-sea redfish in Div. 1C-1D, 401-1500 m, was estimated at 2464.3 tons (S.E. 787.1) compared to 600 tons (S.E. 244.8) in 1995 (Yokawa *et. al* 1996). Almost all the biomass was found in at depths < 800 m, mainly in Div. 1C (Table 12).

The abundance in Div. 1C-1D was estimated at $14.69*10^6$ (S.E. $5.50*10^6$) (Table 13).

The overall length distribution ranged from 8 to 42 cm and was dominated by modes at 21, 23, and 25 cm (Fig. 15).

American place (*Hippoglossoides platessoides*).

American place was caught in 8 of the 63 hauls, and the catches were low, ranging from 0.2 kg to 4.7 kg (Table 2).

The biomass of American place in Div. 1C-1D, 401-1500 m, was estimated at 137.1 tons (S.E. 26.7) compared to 50 tons (S.E. 17.5) in 1995 (Yokawa *et. al* 1996). Almost all the biomass was found at depths < 600 m, mainly in Div. 1D (Table 14).

The abundance in Div. 1C-1D was estimated at $0.83*10^6$ (S.E. $8.11*10^4$) (Table 15).

Temperature

The bottom temperature was measured in 54 of the 63 hauls and it ranged from 3.0 °C in depth stratum 1401-1500 m in Div. 1D to 5.0 °C in depth stratum 401-600 m in Div. 1D. Mean temperatures by NAFO Div. and depth strata are given in Table 16.

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Table 1. Area (sq. km) of depth strata by NAFO Division and number of hauls ( ).

Div.	Depth stratum (m)						Tot.
	401-600	601-800	801-1000	1001-1200	1201-1400	1401-1500	
1C	3366 (3)	16120 (11)	6066 (8)	611 (2)	-	-	26163 (24)
1D	903 (2)	1940 (2)	3874 (4)	10140 (18)	6195 (8)	3091 (5)	26143 (39)
Tot	4269 (5)	18060 (13)	9940 (12)	10751 (20)	6195 (8)	3091 (5)	52306 (63)

Table 2. Catch weight and number (not standardised to kg/km^2) of Greenland halibut, roundnose and roughhead grenadier, Sebastes mentella and American place by haul. Depth in m, swept area in km^2 and bottom temperature in °C.

								Greenland halibut		Roundnose grenadier		Roughhead grenadier		Sebastes mentella		American plaice	
Stat. No	Month	Day	Depth	SWEPT AREA	Div.	Stra..	Temp.	Number	Kg	Number	Kg	Number	Kg	Number	Kg	Number	Kg
1	9	24	580.5	0.069509	1C	6	4.2	32	9.0	0	0.0	1	0.2	325	30.6	3	0.8
2	9	24	669.0	0.074273	1C	8	3.5	37	18.4	0	0.0	0	0.0	149	25.8	0	0.0
3	9	24	569.5	0.059264	1C	6	4.2	21	9.4	0	0.0	0	0.0	55	5.8	2	0.3
4	9	24	679.5	0.070272	1C	8	3.3	59	32.0	7	0.2	2	2.0	34	7.5	0	0.0
5	9	26	688.0	0.068217	1C	8		47	28.8	0	0.0	0	0.0	2	0.5	0	0.0
6	9	26	630.0	0.072695	1C	8		36	7.8	0	0.0	1	0.3	4	0.5	0	0.0
7	9	26	737.0	0.071797	1C	8		45	32.0	2	0.1	0	0.0	0	0.0	0	0.0
8	9	26	770.0	0.082134	1C	8		50	35.2	0	0.0	0	0.0	0	0.0	0	0.0
9	9	26	791.5	0.08259	1C	8		68	56.0	0	0.0	1	0.5	4	1.2	0	0.0
10	9	27	771.0	0.0723	1C	8	3.5	22	17.9	6	0.2	0	0.0	0	0.0	1	0.4
11	9	27	873.5	0.075851	1C	10	3.5	36	28.2	0	0.0	4	1.3	0	0.0	0	0.0
12	9	27	930.0	0.083537	1C	10	3.5	40	36.4	0	0.0	4	1.4	0	0.0	0	0.0
13	9	27	974.5	0.073484	1C	10	3.6	115	105.8	18	1.5	2	0.5	3	0.5	0	0.0
14	9	27	786.0	0.070653	1C	8	4.1	53	37.0	45	2.5	1	0.3	2	1.0	0	0.0
15	9	27	899.0	0.070057	1C	10	3.5	43	37.5	6	0.4	2	0.5	0	0.0	0	0.0
16	9	28	705.5	0.078803	1C	8	4.1	6	2.1	5	0.2	1	0.1	29	8.8	0	0.0
17	9	28	569.5	0.076699	1C	6	4.7	4	2.2	0	0.0	0	0.0	37	6.1	8	1.6
18	9	28	709.5	0.052705	1C	8	4.2	12	7.8	17	0.7	2	0.2	40	9.7	1	0.2
19	9	28	865.0	0.075851	1C	10	3.5	122	109.6	3	0.3	6	1.2	0	0.0	0	0.0
20	9	28	909.0	0.075456	1C	10	3.5	80	74.4	2	0.2	4	2.4	1	0.2	0	0.0
21	9	29	826.0	0.074667	1C	10	3.4	53	39.9	3	0.2	10	2.9	1	0.1	0	0.0
22	9	29	870.0	0.074273	1C	10	3.5	34	27.6	0	0.0	12	3.9	0	0.0	0	0.0
23	9	29	875.0	0.064028	1D	10	3.4	44	43.1	4	0.2	5	1.0	1	0.1	0	0.0
24	9	29	964.5	0.066079	1D	10	3.5	72	62.3	2	0.1	0	0.0	0	0.0	0	0.0
25	9	29	1107.5	0.078379	1D	12	3.4	124	120.4	2	0.1	2	1.6	1	0.4	0	0.0
26	9	30	714.5	0.065053	1D	8	3.5	35	22.5	1	0.0	5	2.7	7	1.2	0	0.0
27	9	30	873.5	0.075062	1D	10	3.6	73	69.0	8	0.8	2	0.5	0	0.0	0	0.0
28	9	30	1052.0	0.081749	1C	12	3.3	260	267.9	45	4.3	15	6.6	0	0.0	0	0.0
29	9	30	1095.0	0.076245	1C	12	3.3	98	95.9	35	4.3	4	1.7	1	0.2	0	0.0
30	9	30	1113.0	0.071797	1D	12	3.4	166	215.0	59	6.8	3	2.0	0	0.0	0	0.0
31	10	1	848.0	0.074107	1D	10	4.0	64	56.0	154	8.4	19	4.4	2	1.4	0	0.0
32	10	1	742.0	0.067105	1D	8	4.5	34	27.1	396.6	16.8	6	1.6	77	29.7	4	0.8
33	10	1	1116.0	0.067798	1D	12	3.2	77	95.2	161	25.7	9	6.2	0	0.0	0	0.0
34	10	2	1314.5	0.062277	1D	14	3.3	71	115.5	76	14.7	14	6.4	0	0.0	0	0.0
35	10	2	1280.0	0.086124	1D	14	3.3	56	78.6	232.8	54.7	13	6.9	0	0.0	0	0.0
36	10	2	1424.5	0.080584	1D	15	3.0	16	43.1	129	61.3	15	8.7	0	0.0	0	0.0
37	10	2	1120.5	0.06551	1D	12	3.2	40	44.8	138	33.6	5	13.0	1	0.9	0	0.0
38	10	3	1211.0	0.060529	1D	14	3.3	40	54.4	138	23.0	7	3.7	0	0.0	0	0.0
39	10	3	1142.5	0.072635	1D	12	3.2	67	110.4	8	2.2	7	2.4	0	0.0	0	0.0
40	10	3	1194.0	0.08164	1D	12	3.1	57	70.7	39	9.4	6	3.4	0	0.0	0	0.0
41	10	3	1166.0	0.074844	1D	12	3.2	105	139.4	29	6.6	8	2.0	1	0.2	0	0.0
42	10	4	1065.5	0.077428	1D	12	3.2	147	146.6	17	1.3	34	21.8	0	0.0	0	0.0
43	10	4	1095.5	0.082162	1D	12	3.3	111	113.8	120	10.4	18	6.3	0	0.0	0	0.0
44	10	4	1164.0	0.085536	1D	12	3.2	143	176.0	83	14.7	10	4.5	0	0.0	0	0.0
45	10	4	1219.0	0.069686	1D	14	3.3	97	123.6	16	2.6	7	3.1	0	0.0	0	0.0
46	10	4	1293.0	0.074476	1D	14	3.2	145	176.2	36	7.2	13	6.3	0	0.0	0	0.0
47	10	4	1131.0	0.080417	1D	12	3.2	318	368.5	87	12.0	27	13.7	0	0.0	0	0.0
48	10	5	1140.5	0.083853	1D	12	3.2	451	472.2	69	8.1	30	15.1	1	0.1	0	0.0
49	10	5	1353.5	0.074107	1D	14	3.2	100	156.5	58	12.4	7	5.3	1	0.2	0	0.0
50	10	5	1460.0	0.077517	1D	15	3.1	73	141.6	145	74.3	12	6.6	0	0.0	0	0.0
51	10	5	1469.0	0.071106	1D	15	3.1	50	89.4	129	60.9	12	15.4	0	0.0	0	0.0
52	10	5	1419.5	0.08327	1D	15	3.2	115	188.5	43	12.3	3	2.3	0	0.0	0	0.0
53	10	6	1431.5	0.075212	1D	15		251	322.2	61	27.0	3	1.7	0	0.0	0	0.0
54	10	6	1225.5	0.039521	1D	14		53	74.3	10	2.8	8	2.0	2	0.3	0	0.0
55	10	6	1143.0	0.082863	1D	12		147	157.2	5	0.7	22	11.6	1	0.1	0	0.0
56	10	6	1304.0	0.076754	1D	14		212	254.6	15	2.1	23	13.5	1	0.1	0	0.0
57	10	6	1166.5	0.077517	1D	12		167	162.3	21	2.1	22	10.4	0	0.0	0	0.0
58	10	7	1147.0	0.040664	1D	12	3.5	47	51.6	182	41.5	6	2.3	0	0.0	0	0.0
59	10	7	1182.0	0.079401	1D	12	3.2	72	108.6	142	18.0	15	5.0	0	0.0	0	0.0
60	10	7	1162.0	0.038911	1D	12	3.3	135	165.7	63	8.0	4	2.1	0	0.0	0	0.0
61	10	7	1119.5	0.032234	1D	12	3.2	48	60.1	52	8.3	15	7.6	0	0.0	0	0.0
62	10	8	427.0	0.078803	1D	6	5.0	59	23.4	0	0.0	0	0.0	143	16.6	47	4.7
63	10	8	494.0	0.042088	1D	6	5.0	45	19.6	1	0.2	0	0.0	9	1.5	26	4.0

Table 3. Biomass pr sq km, biomass (tons), STD and SE of Greenland halibut by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	STD	SE
1C	401-600	3366	3	0.1056	355.4	229.5	132.5
	601-800	16120	11	0.3389	5463.0	3195.1	963.4
	801-1000	6066	8	0.7821	4744.1	2728.6	964.7
	1001-1200	611	2	2.2675	1385.4	872.4	616.9
1D	401-600	903	2	0.3813	344.3	107.8	76.2
	601-800	1940	2	0.3749	727.2	79.5	56.2
	801-1000	3874	4	0.8227	3187.2	503.2	251.6
	1001-1200	10140	18	2.1760	22064.3	13601.9	3206.0
	1201-1400	6195	8	1.8893	11704.3	4835.6	1709.6
	1401-1500	3091	5	2.0333	6284.9	4373.7	1956.0

Table 4. Abundance pr sq km, abundance, STD and SE of Greenland halibut by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	STD	SE
1C	401-600	3366	3	289.0	972629.3	712988.3	411644.0
	601-800	16120	11	539.9	8703471.9	4016058.8	1210887.3
	801-1000	6066	8	889.9	5398103.5	2842119.8	1004841.1
	1001-1200	611	2	2232.9	1364303.9	818783.1	578967.1
1D	401-600	903	2	908.9	820778.4	204641.0	144703.0
	601-800	1940	2	522.3	1013350.7	43003.4	30408.0
	801-1000	3874	4	903.2	3499145.8	662655.6	331327.8
	1001-1200	10140	18	1881.5	19078824.3	12560585.0	2960558.3
	1201-1400	6195	8	1405.3	8705960.5	4276879.3	1512105.2
	1401-1500	3091	5	1312.3	4056467.7	3739305.2	1672268.1

Table 5. Mean weight and mean length at age of Greenland halibut in 1997-1995.

	1997		1996		1995	
AGE	weight	length	weight	length	weight	length
2	23.33	15.33			50.00	20.00
3	58.18	19.82	175.00	30.50	140.00	27.00
4	136.96	26.13	378.26	36.35	339.43	35.09
5	271.82	32.82	555.56	41.22	495.53	40.13
6	443.93	38.04	794.10	45.72	691.59	45.00
7	736.89	43.87	1055.95	49.90	986.56	49.82
8	1070.18	49.85	1447.01	55.34	1360.00	54.51
9	1453.73	55.61	2092.16	61.45	1816.98	59.63
10	2042.90	61.23	2740.63	65.84	2163.50	62.70
11	2814.55	66.68	3241.67	68.43	2679.63	66.30
12	3827.69	72.58	4100.21	72.98	3248.64	69.91
13	4840.00	77.29	4994.00	76.43	4133.57	73.36
14	6679.44	84.00	5946.67	80.56	5685.56	79.78
15	7711.11	87.78	7523.68	86.76	6631.05	83.63
16	9166.00	94.60	8663.04	89.93	7533.00	89.00
17	10796.67	97.83	9208.33	91.94	10413.64	94.64
18			10127.27	95.27	11180.00	97.00
19			11168.18	98.45	11566.67	98.33
20			11100.00	95.00	11326.67	100.33
21			11250.00	98.33	13100.00	103.50
22					13700.00	104.00
24					15300.00	115.00

Table 6. Maturity at age, Greenland halibt 1CD 1997.

Males=1, Females=2, Maturity:1=immature 2=maturing

		MAT		
		1	2	
		PCTN	PCTN	N
AGE	SEX			
2	2	100.00	.	3.00
3	1	100.00	.	7.00
	2	100.00	.	15.00
4	1	100.00	.	15.00
	2	100.00	.	8.00
5	1	100.00	.	8.00
	2	100.00	.	3.00
6	1	77.78	22.22	18.00
	2	90.00	10.00	10.00
7	1	67.74	32.26	31.00
	2	100.00	.	14.00
8	1	58.14	41.86	43.00
	2	100.00	.	12.00
9	1	34.00	66.00	50.00
	2	55.56	44.44	9.00
10	1	12.90	87.10	31.00
	2	22.58	77.42	31.00
11	1	15.79	84.21	19.00
	2	16.00	84.00	25.00
12	1	.	100.00	3.00
	2	.	100.00	23.00
13	1	.	100.00	2.00
	2	.	100.00	19.00
14	1	.	100.00	1.00
	2	.	100.00	17.00
15	2	.	100.00	9.00
16	2	.	100.00	5.00
17	2	.	100.00	6.00

Table 7. Maturity at length Greenland halibut 1997. No mature fish < 37 cm no maturing fish > 70 cm.

Males=1, Females=2, Maturity:1=immature 2=maturing

		MAT		
		1	2	
		PCTN	PCTN	N
LEN	SEX			
37	1	100.00	.	4.00
	2	100.00	.	2.00
38	1	75.00	25.00	4.00
	2	100.00	.	1.00
39	1	75.00	25.00	4.00
	2	.	100.00	1.00
40	1	33.33	66.67	3.00
	2	100.00	.	2.00
41	1	100.00	.	5.00
	2	100.00	.	2.00
42	1	50.00	50.00	4.00
	2	100.00	.	3.00
43	1	71.43	28.57	7.00
44	1	75.00	25.00	4.00
	2	100.00	.	2.00
45	1	75.00	25.00	8.00
	2	100.00	.	2.00
46	1	66.67	33.33	6.00
	2	100.00	.	4.00
47	1	16.67	83.33	6.00
	2	100.00	.	4.00
48	1	100.00	.	5.00
	2	100.00	.	3.00
49	1	71.43	28.57	7.00
	2	100.00	.	2.00
50	1	55.56	44.44	9.00
	2	100.00	.	1.00
51	1	75.00	25.00	8.00
	2	100.00	.	3.00
52	1	44.44	55.56	9.00
	2	100.00	.	1.00
53	1	62.50	37.50	8.00
	2	100.00	.	2.00

54	1	62.50	37.50	8.00
	2	100.00	.	2.00
55	1	44.44	55.56	9.00
	2	66.67	33.33	3.00
56	1	10.00	90.00	10.00
	2	.	100.00	2.00
57	1	.	100.00	9.00
	2	100.00	.	1.00
58	1	12.50	87.50	8.00
	2	33.33	66.67	3.00
59	1	16.67	83.33	6.00
	2	25.00	75.00	4.00
60	1	.	100.00	5.00
	2	.	100.00	5.00
61	1	20.00	80.00	5.00
	2	44.44	55.56	9.00
62	1	30.00	70.00	10.00
	2	.	100.00	3.00
63	1	.	100.00	2.00
	2	37.50	62.50	8.00
64	1	50.00	50.00	6.00
	2	.	100.00	4.00
65	1	.	100.00	4.00
	2	20.00	80.00	5.00
66	1	.	100.00	5.00
	2	16.67	83.33	6.00
67	1	.	100.00	4.00
	2	16.67	83.33	6.00
68	1	.	100.00	2.00
	2	20.00	80.00	5.00
69	1	.	100.00	1.00
	2	28.57	71.43	7.00
70	1	.	100.00	3.00
	2	.	100.00	7.00

Table 7. Cont.

Table 8. Biomass pr sq km, biomass (tons), STD and SE of roundnose grenadier by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	STD	SE
1C	401-600	3366	3	0.0000	0.0	0.0	0.0
	601-800	16120	11	0.0053	85.3	172.5	52.0
	801-1000	6066	8	0.0044	26.8	41.2	14.6
	1001-1200	611	2	0.0545	33.3	1.6	1.2
1D	401-600	903	2	0.0024	2.1	3.0	2.1
	601-800	1940	2	0.1252	242.8	343.4	242.8
	801-1000	3874	4	0.0322	124.6	210.2	105.1
	1001-1200	10140	18	0.1960	1987.7	2490.8	587.1
	1201-1400	6195	8	0.2063	1278.2	1298.2	459.0
	1401-1500	3091	5	0.6165	1905.5	1072.3	479.6

Table 9. Abundance pr sq km, abundance, STD and SE of roundnose grenadier by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	STD	SE
1C	401-600	3366	3	0.0	0.0	0.0	0.0
	601-800	16120	11	112.1	1807448.2	3195747.2	963554.0
	801-1000	6066	8	54.6	331227.7	498978.9	176415.7
	1001-1200	611	2	504.8	308406.4	39497.5	27929.0
1D	401-600	903	2	11.9	10727.6	15171.1	10727.6
	601-800	1940	2	2962.7	5747637.1	8086212.1	5717815.4
	801-1000	3874	4	569.3	2205646.2	3898401.8	1949200.9
	1001-1200	10140	18	1149.3	11653483.4	11235174.2	2648156.0
	1201-1400	6195	8	1015.1	6288393.1	6065930.7	2144630.4
	1401-1500	3091	5	1322.6	4088159.9	1912303.9	855208.3

Table 10. Biomass pr sq km, biomass (tons), STD and SE of roughhead grenadier by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	STD	SE
1C	401-600	3366	3	0.0010	3.2	5.6	3.2
	601-800	16120	11	0.0044	70.3	133.8	40.3
	801-1000	6066	8	0.0240	145.7	97.1	34.3
	1001-1200	611	2	0.0515	31.5	25.2	17.9
1D	401-600	903	2	0.0000	0.0	0.0	0.0
	601-800	1940	2	0.0327	63.4	24.2	17.1
	801-1000	3874	4	0.0204	79.1	103.6	51.8
	1001-1200	10140	18	0.1047	1061.5	807.7	190.4
	1201-1400	6195	8	0.0839	519.7	258.3	91.3
	1401-1500	3091	5	0.0920	284.3	243.3	108.8

Table 11. Abundance pr sq km, abundance, STD and SE of roughhead grenadier by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	STD	SE
1C	401-600	3366	3	4.8	16141.8	27958.5	16141.8
	601-800	16120	11	10.8	174558.2	207523.7	62570.8
	801-1000	6066	8	74.9	454240.2	294938.3	104276.4
	1001-1200	611	2	118.0	72083.2	56609.0	40028.6
1D	401-600	903	2	0.0	0.0	0.0	0.0
	601-800	1940	2	83.1	161284.4	17219.5	12176.0
	801-1000	3874	4	90.3	349745.3	446991.1	223495.5
	1001-1200	10140	18	193.1	1957965.0	1372947.6	323606.8
	1201-1400	6195	8	170.4	1055425.7	436462.9	154312.9
	1401-1500	3091	5	117.1	362032.3	226044.6	101090.2

Table 12. Biomass pr sq km, biomass (tons), STD and SE of Sebastes mentella by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	STD	SE
1C	401-600	3366	3	0.2059	693.0	683.9	394.8
	601-800	16120	11	0.0721	1161.7	1778.9	536.4
	801-1000	6066	8	0.0013	8.2	14.6	5.2
	1001-1200	611	2	0.0013	0.8	1.1	0.8
1D	401-600	903	2	0.1231	111.2	111.7	79.0
	601-800	1940	2	0.2305	447.2	581.8	411.4
	801-1000	3874	4	0.0051	19.8	35.7	17.8
	1001-1200	10140	18	0.0013	13.5	34.2	8.1
	1201-1400	6195	8	0.0014	9.0	16.5	5.8
	1401-1500	3091	5	0.0000	0.0	0.0	0.0

Table 13. Abundance pr sq km, abundance, STD and SE of Sebastes mentella by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	STD	SE
1C	401-600	3366	3	2028.7	6828619.6	7752354.0	4475823.7
	601-800	16120	11	343.5	5536461.3	9778229.6	2948247.1
	801-1000	6066	8	8.4	51159.8	87385.1	30895.3
	1001-1200	611	2	6.6	4006.8	5666.5	4006.8
1D	401-600	903	2	1014.2	915859.9	1022142.0	722763.6
	601-800	1940	2	627.5	1217413.9	1426463.7	1008662.1
	801-1000	3874	4	10.7	41264.0	50927.7	25463.8
	1001-1200	10140	18	3.6	36829.8	61468.8	14488.3
	1201-1400	6195	8	9.6	59726.4	109054.0	38556.4
	1401-1500	3091	5	0.0	0.0	0.0	0.0

Table 14. Biomass pr sq km, biomass (tons), STD and SE of American plaice by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	STD	SE
1C	401-600	3366	3	0.0125	42.0	26.7	15.4
	601-800	16120	11	0.0008	13.7	31.0	9.4
	801-1000	6066	8	0.0000	0.0	0.0	0.0
	1001-1200	611	2	0.0000	0.0	0.0	0.0
1D	401-600	903	2	0.0773	69.8	22.6	16.0
	601-800	1940	2	0.0060	11.6	16.4	11.6
	801-1000	3874	4	0.0000	0.0	0.0	0.0
	1001-1200	10140	18	0.0000	0.0	0.0	0.0
	1201-1400	6195	8	0.0000	0.0	0.0	0.0
	1401-1500	3091	5	0.0000	0.0	0.0	0.0

Table 15. Abundance pr sq km, abundance, STD and SE of American plaice by division and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	STD	SE
1C	401-600	3366	3	51.7	174061.1	78901.5	45553.8
	601-800	16120	11	3.0	48073.6	108551.2	32729.4
	801-1000	6066	8	0.0	0.0	0.0	0.0
	1001-1200	611	2	0.0	0.0	0.0	0.0
1D	401-600	903	2	607.1	548201.1	13622.5	9632.6
	601-800	1940	2	29.8	57820.2	81770.0	57820.2
	801-1000	3874	4	0.0	0.0	0.0	0.0
	1001-1200	10140	18	0.0	0.0	0.0	0.0
	1201-1400	6195	8	0.0	0.0	0.0	0.0
	1401-1500	3091	5	0.0	0.0	0.0	0.0

Table 16. Mean temperature, S.E and number of observations by NAFO Division and depth stratum.

Div.	Depth stratum (m)																	
	401-600			601-800			801-1000			1001-1200			1201-1400			1401-1500		
	°C	SE	n	°C	SE	n	°C	SE	n	°C	SE	n	°C	SE	n	°C	SE	n
1C	4.4	.17	3	3.8	.16	6	3.5	.02	8	3.3	0	2						
1D	5.0	0	2	4.0	.50	2	3.6	.13	4	3.3	.03	16	3.3	.02	6	3.1	.04	4

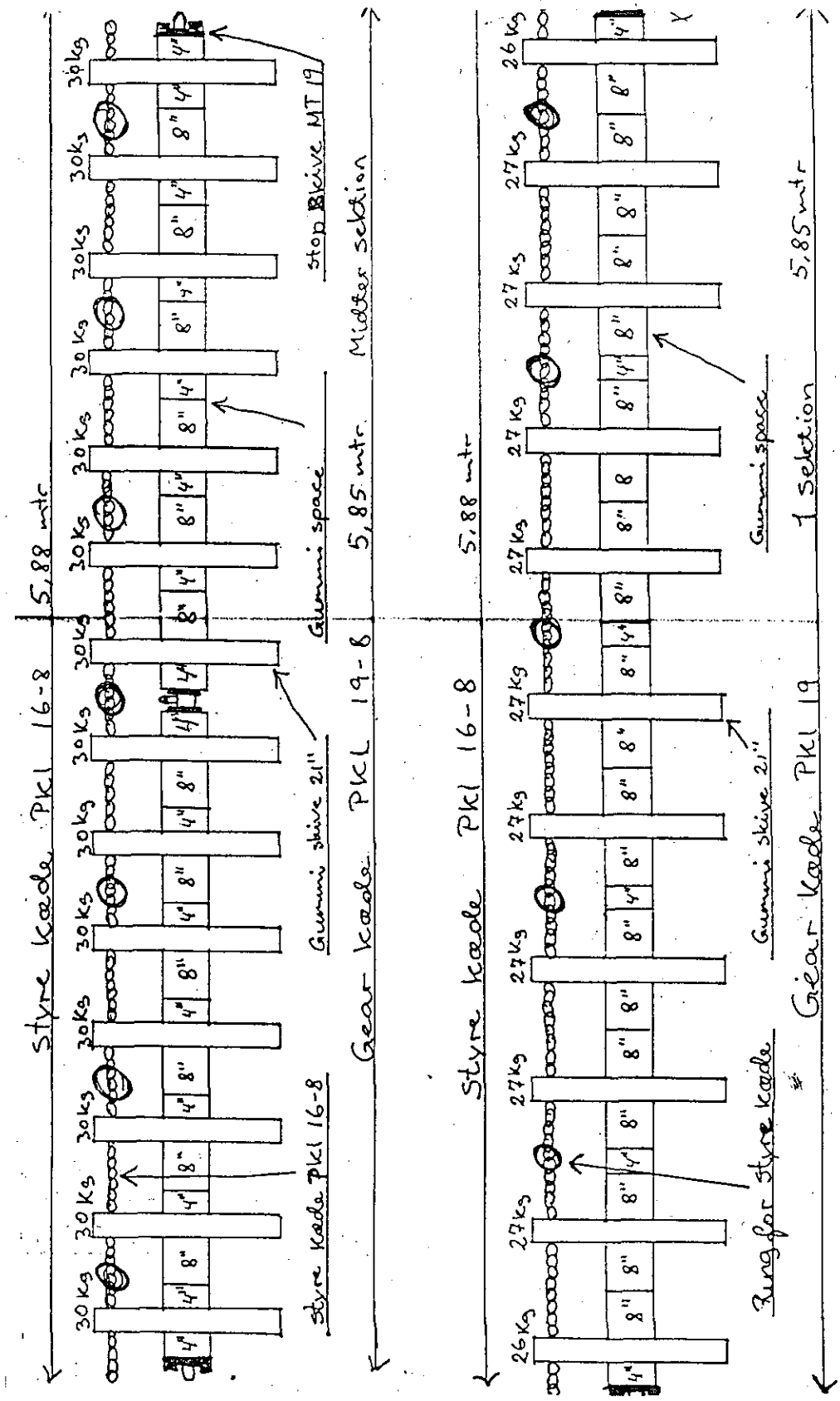
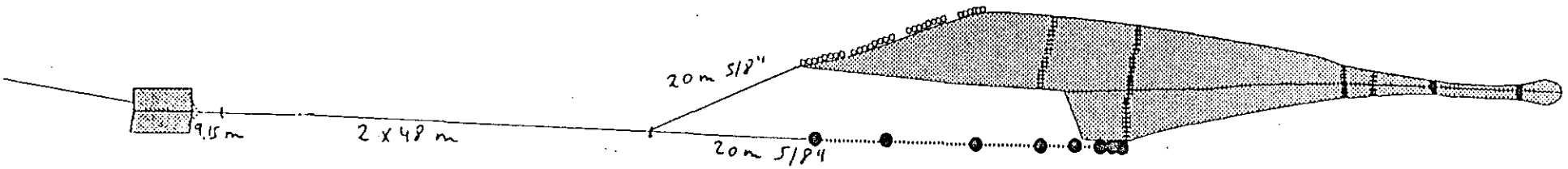


Fig. 1. Rock hopper ground gear.

Alfredo no. 3,

444 masker i 74 mm (= 719 masker i 40mm)



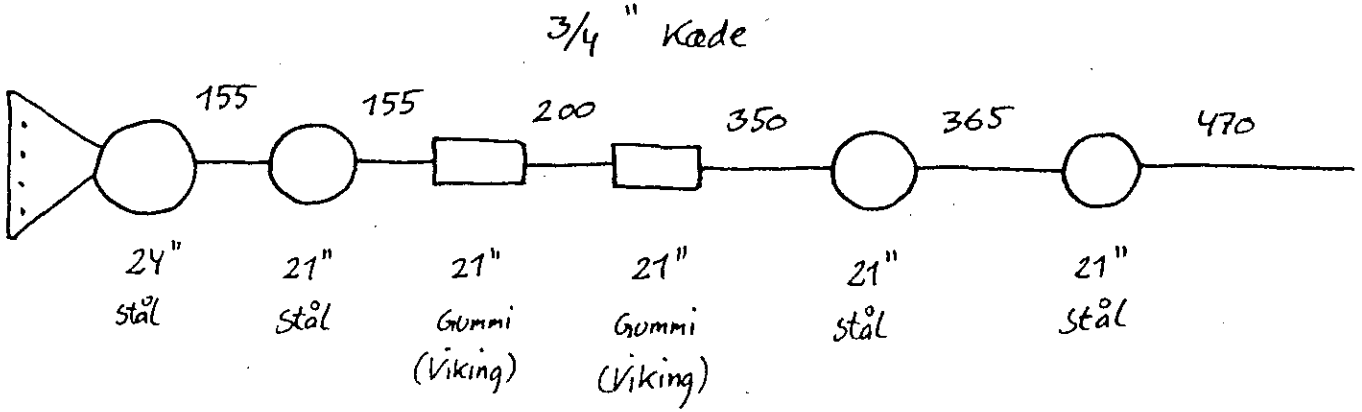


Fig. 2. Bobbins chain and rigging of trawl.

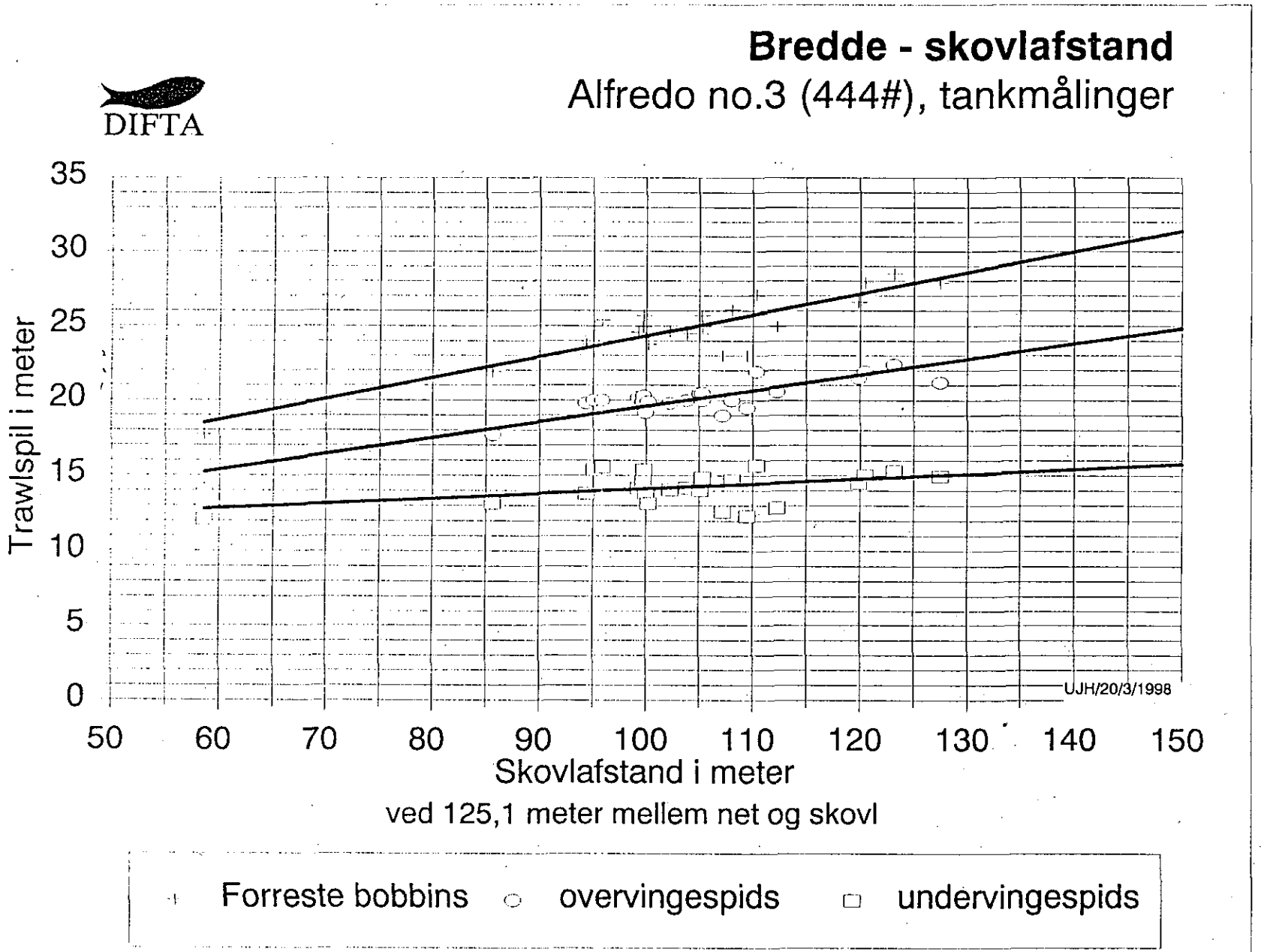


Fig. 3. Relation between distance of trawl doors and wingspread: outer bobbins +, top wing ○ and lower wing □, at 125.1 m between trawl and doors at 3 kn from flume tank measurements.

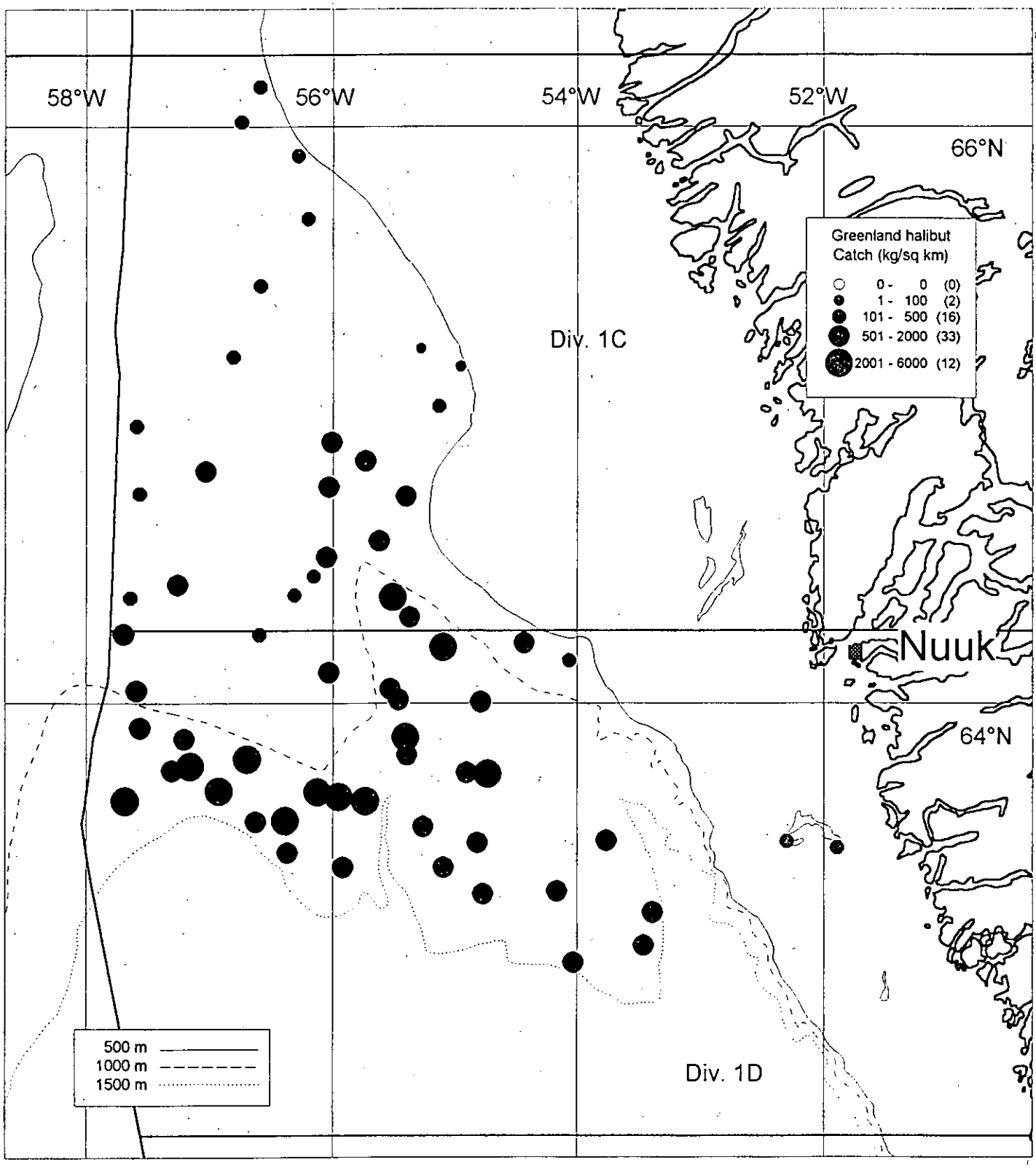


Fig. 4. Distribution of catches of Greenland halibut.

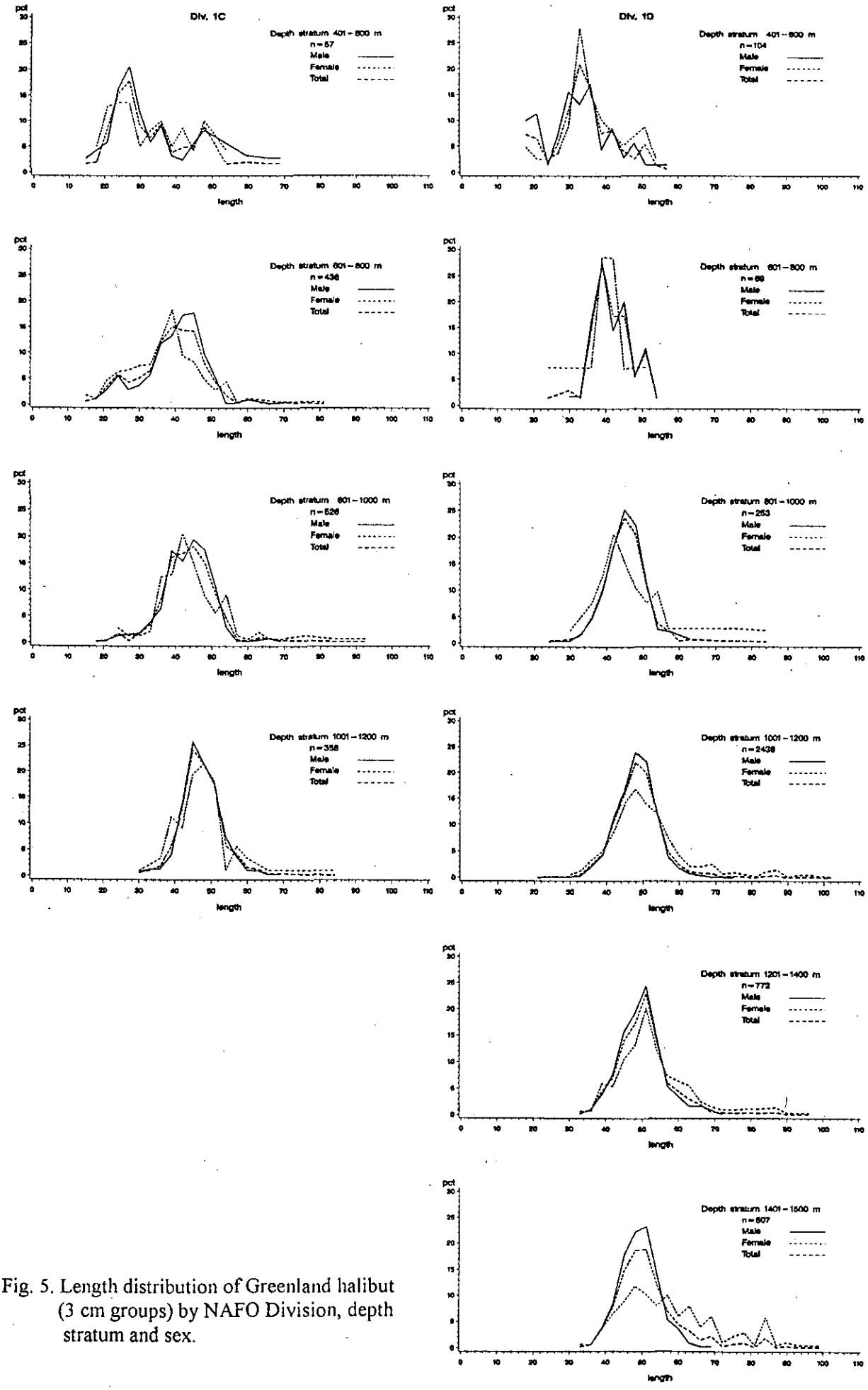


Fig. 5. Length distribution of Greenland halibut (3 cm groups) by NAFO Division, depth stratum and sex.

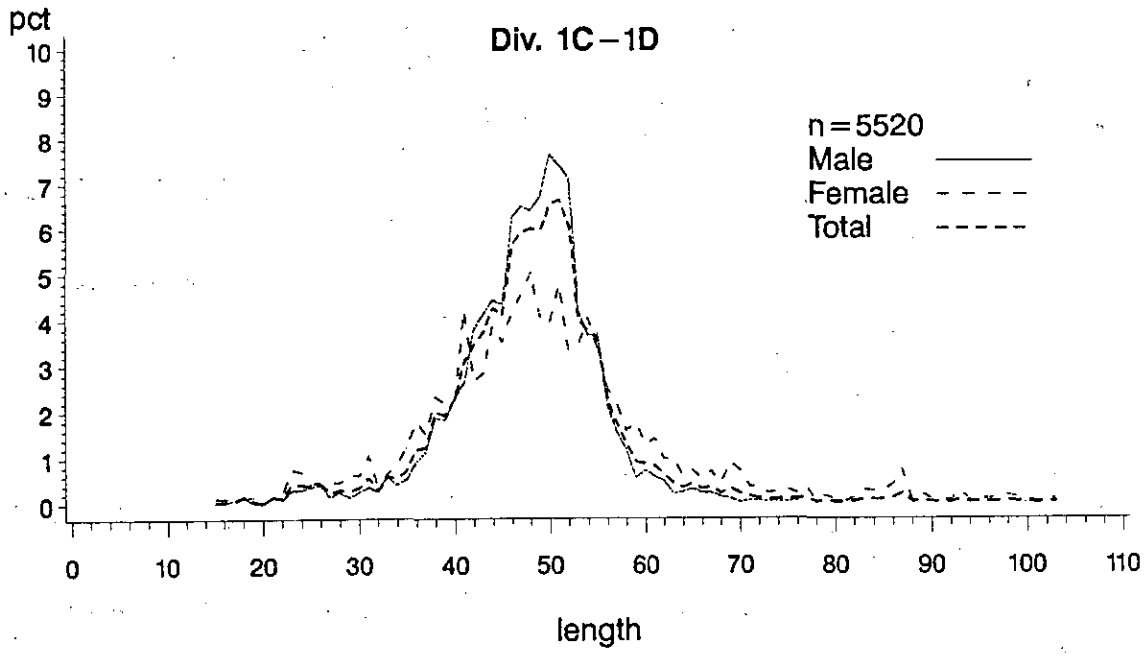


Fig. 6. Overall length distribution (weighted by stratum area) of Greenland halibut.

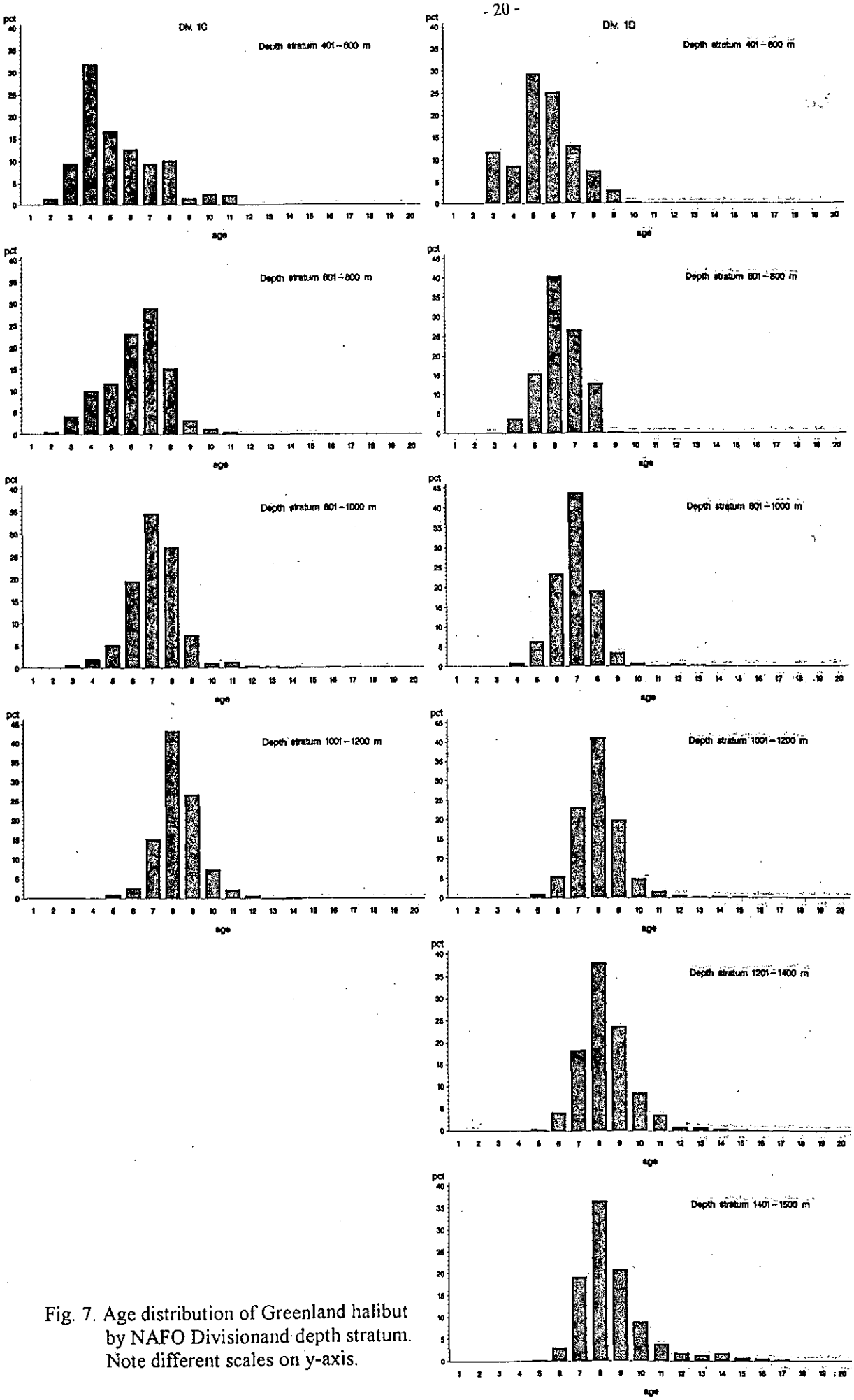


Fig. 7. Age distribution of Greenland halibut by NAFO Divisionand depth stratum. Note different scales on y-axis.

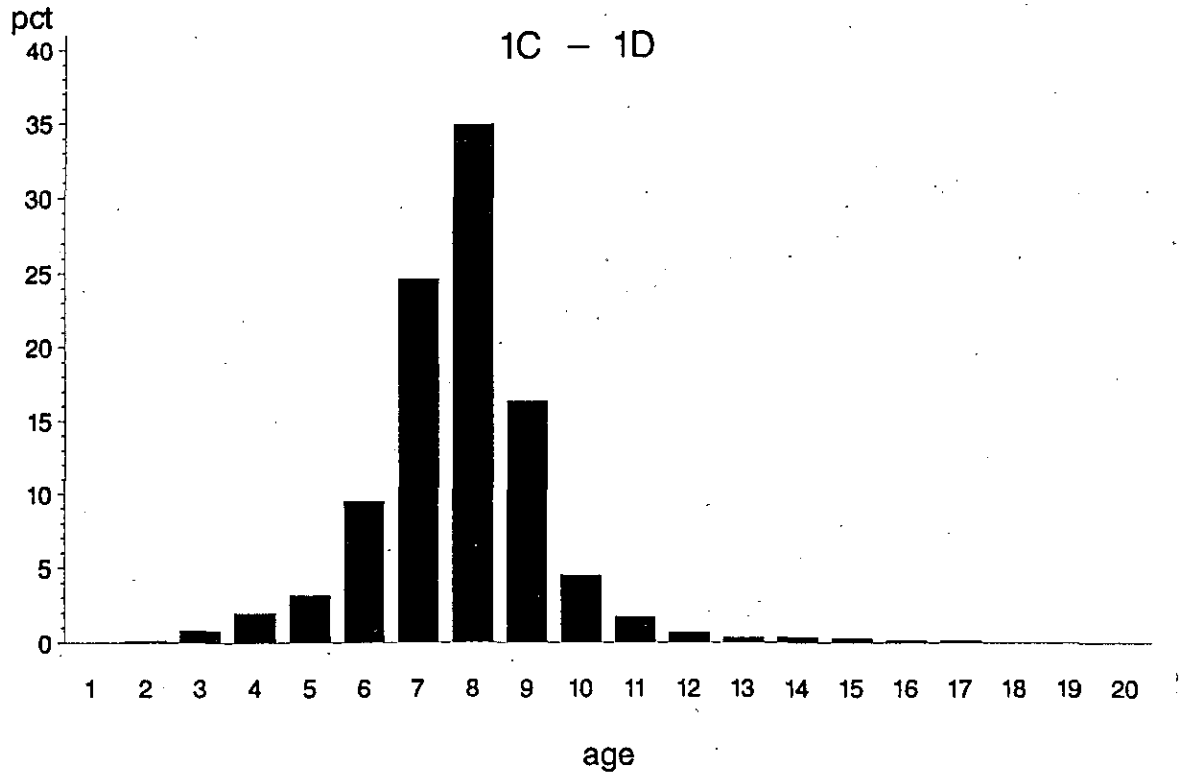


Fig. 8. Overall age distribution (weighted by stratum area) of Greenland halibut.

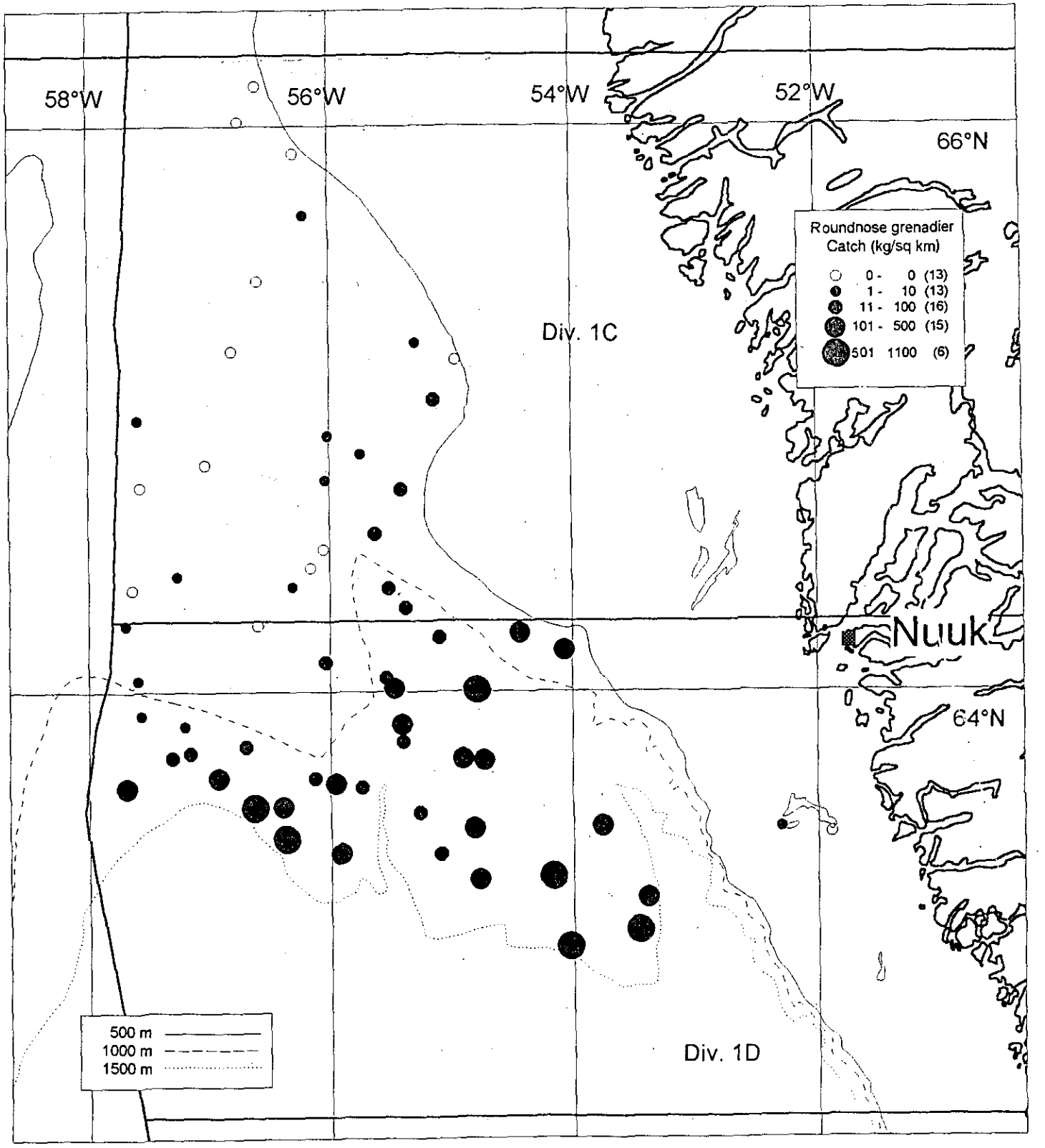


Fig. 9. Distribution of catches of roundnose grenadier.

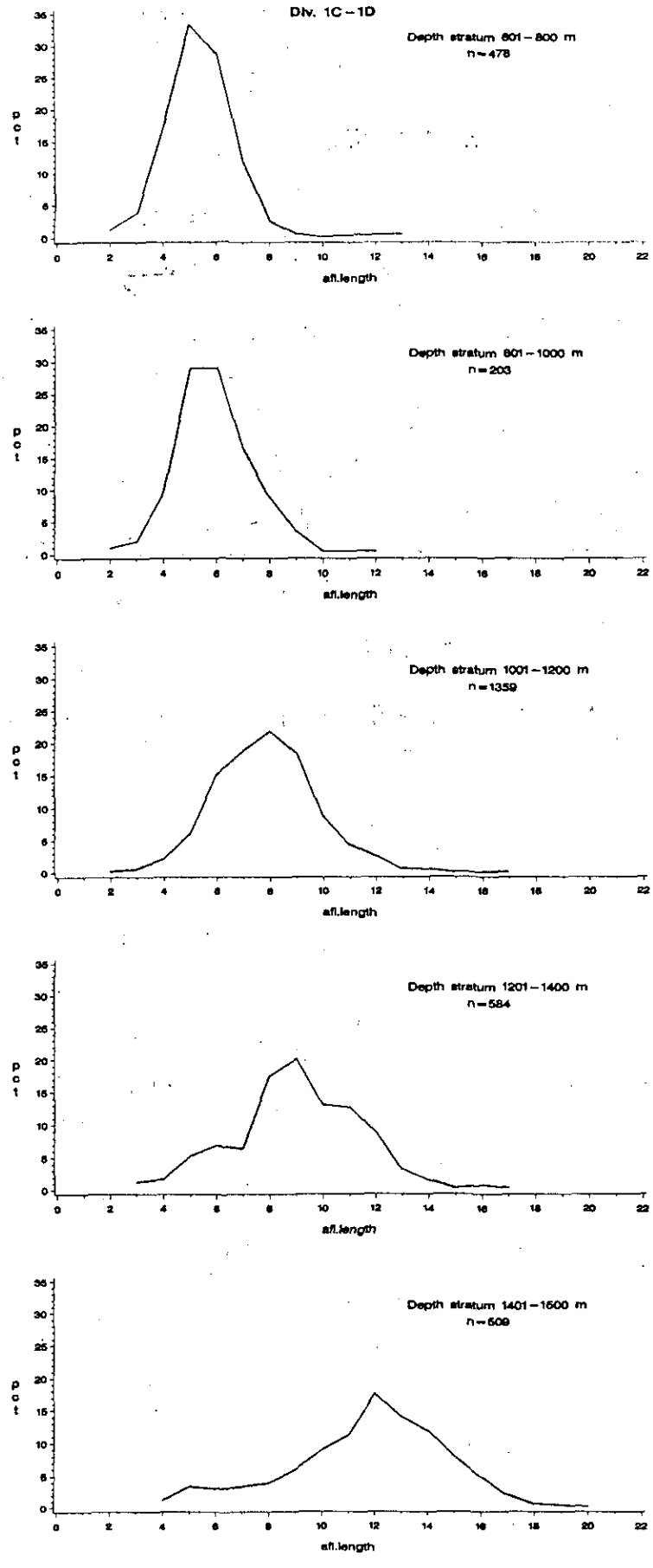


Fig. 10. Length distribution (pre anal fin length) of roundnose grenadier by depth strata.

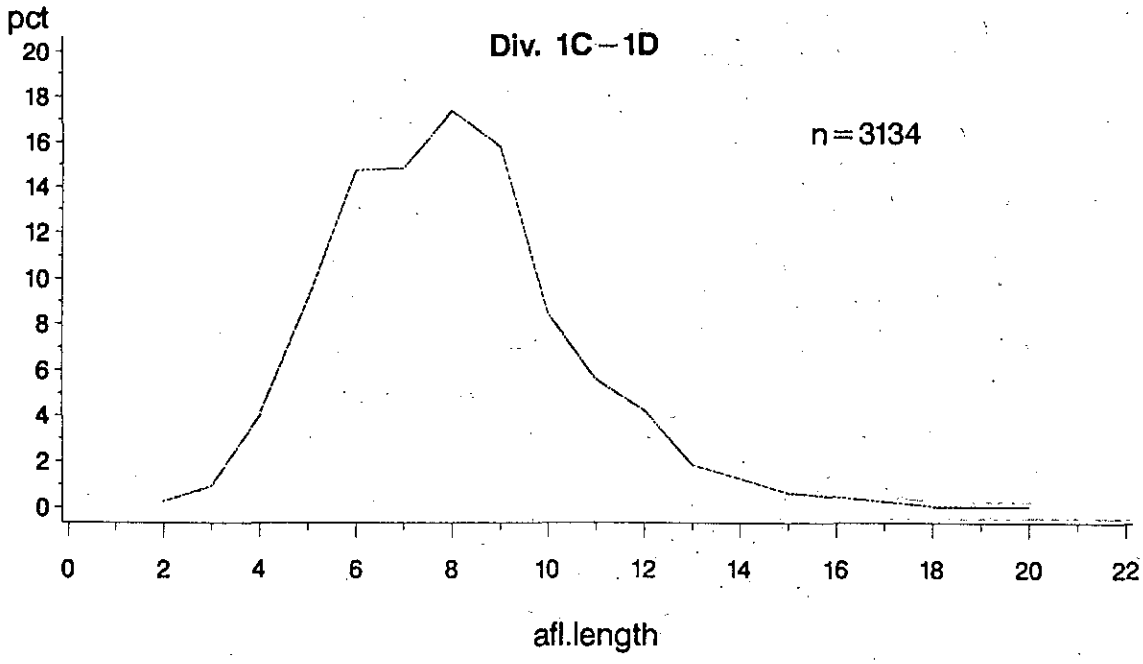


Fig. 11. Overall length distribution (pre anal fin length) (weighted by stratum area) of roundnose grenadier.

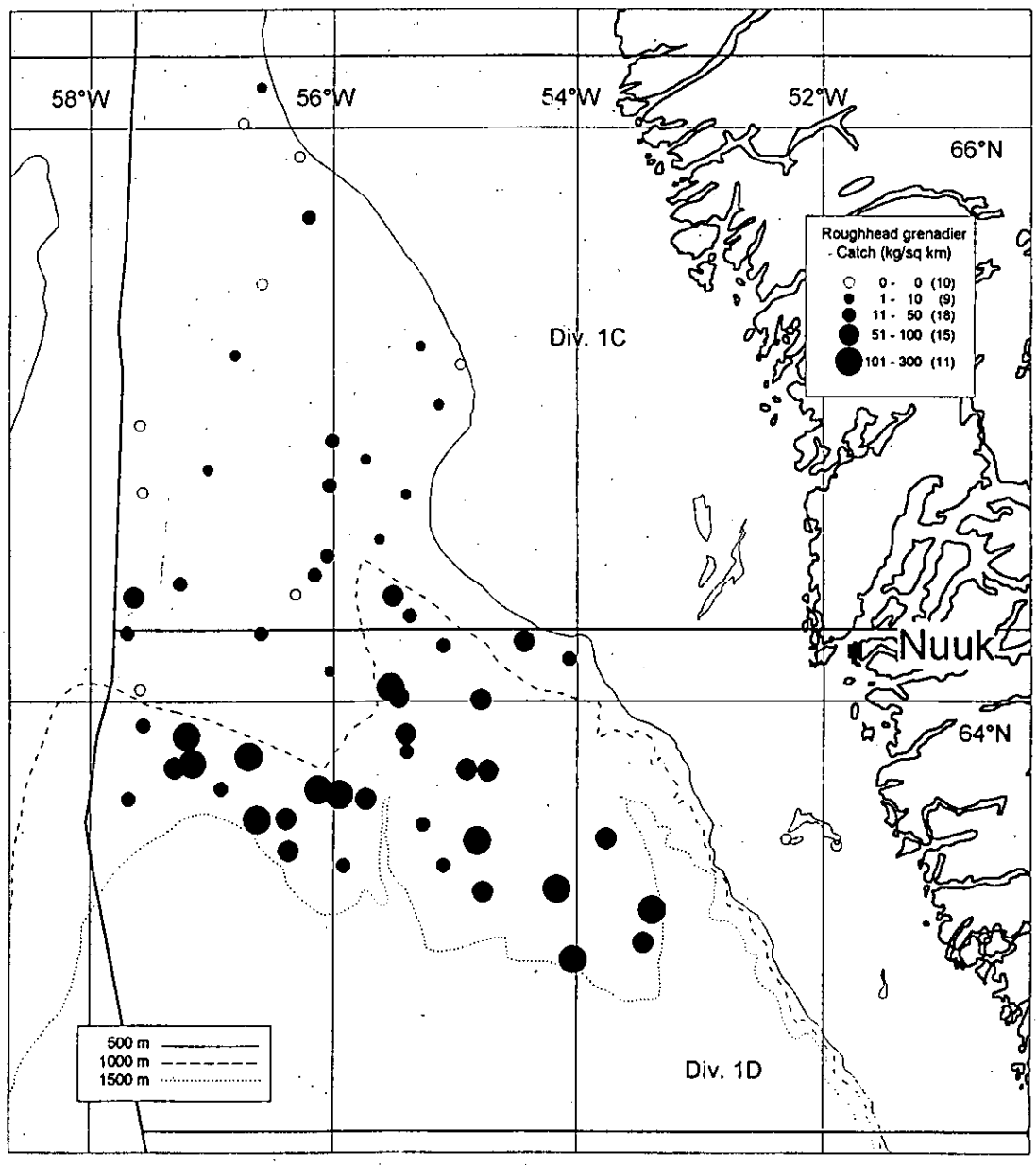


Fig. 12. Distribution of catches of roughhead grenadier.

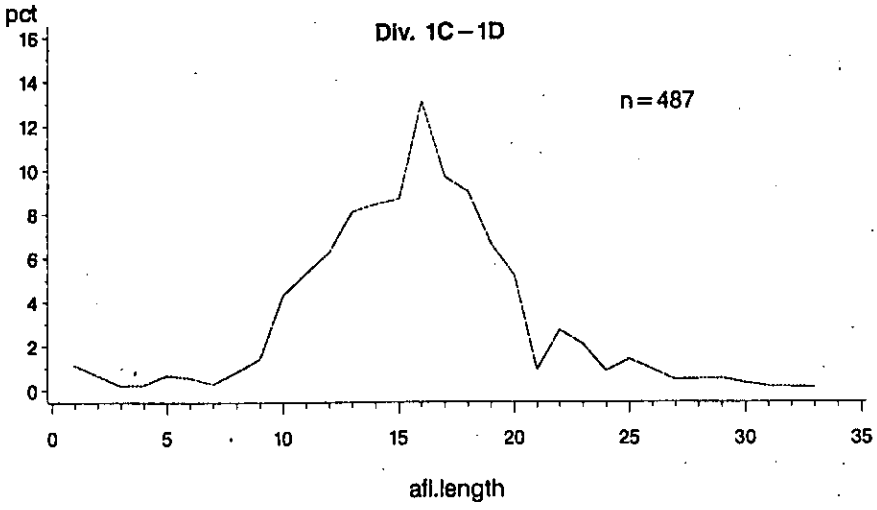


Fig. 13. Overall length distribution (pre anal fin length) (weighted by stratum area) of roughhead grenadier.

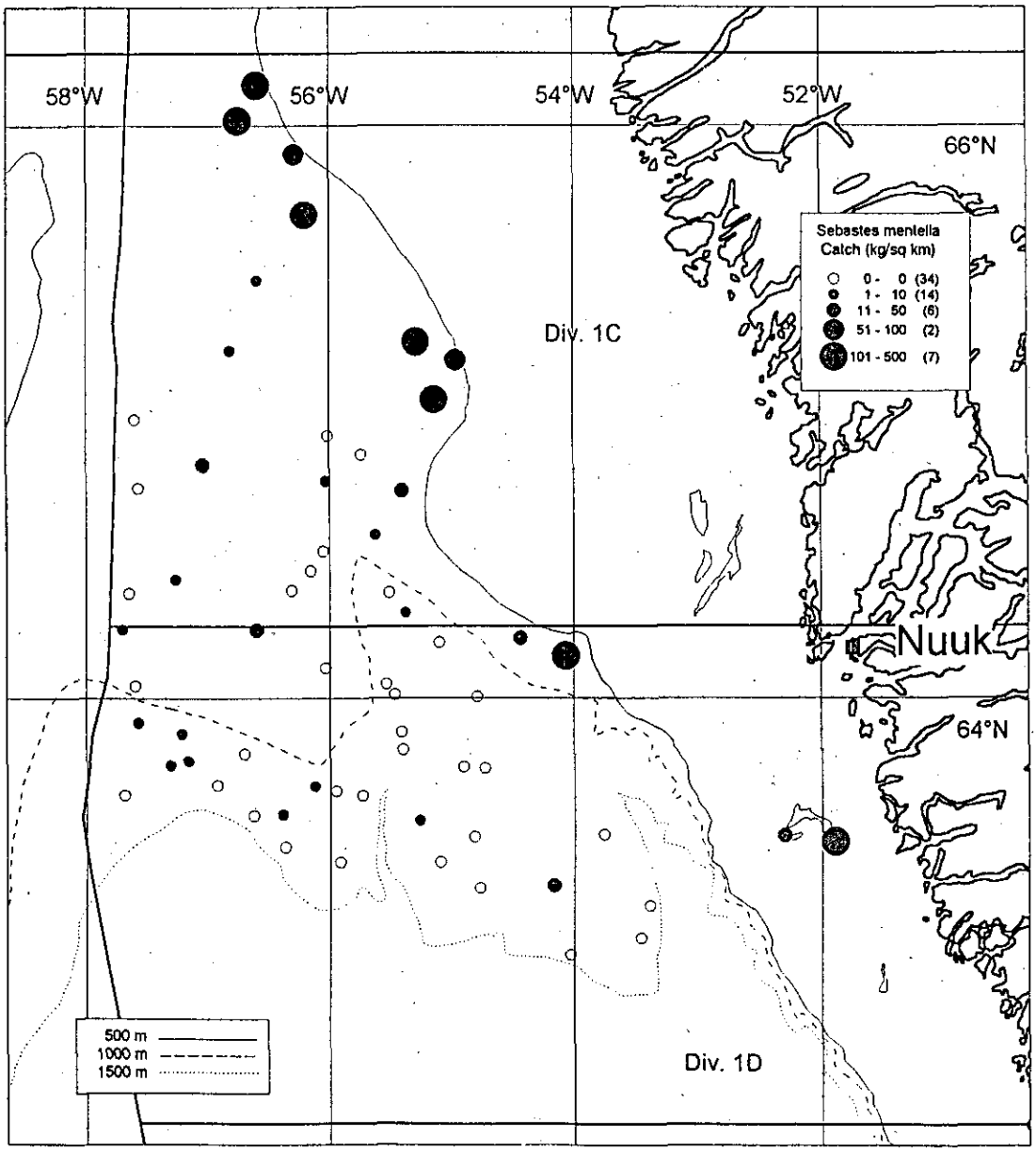


Fig. 14. Distribution of catches of *Sebastes mentella*.

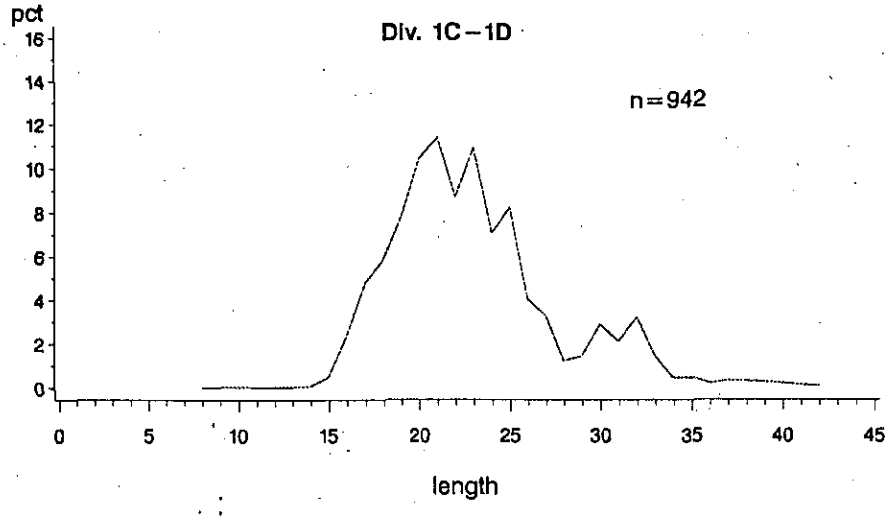


Fig. 15. Overall length distribution (weighted by stratum area) of *Sebastes mentella*.