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Survey for Greenland Halibut in NAFO Divisions 1C-1D, 1999

O.A. Jørgensen

Greenland Institute of Natural Resources
Pilestræde 52, DK1016 Copenhagen, Denmark

Abstract

In 1997 Greenland initiated a survey series covering NAFO Div. 1CD at depths between 400 and 1500 m. The survey is designed as a Stratified Random Bottom Trawl Survey mainly aimed at Greenland halibut and roundnose grenadier. In 1999 only 38 of the 70 planned tows were made due to bad weather. The paper gives biomass and abundance estimates and length frequencies for Greenland halibut, roundnose and roughed grenadier, deep-sea redfish and American plaice, together with age and maturity data for Greenland halibut. The biomass of Greenland halibut was estimated as 64 000 tons which is a slight decrease compared to 70 000 tons in 1998 but above the estimate at 56 000 tons in 1997. The biomass of roundnose was estimated as 2 700 tons, which is the lowest on record.

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 1998a) 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*) in 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 1999 took place in the period 21/9-6/10.

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 previous years survey 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 trawl doors were Greenland Perfect (370*250 cm) weighing 2400 kg mounted with extra 20 kg. Further information about trawl and gear is given in Jørgensen 1998b. 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 = $10.122 + \text{distance between trawl doors} * 0.142$

This relationship was estimated based on flume tank measurements of the trawl and rigging used in the survey (Jørgensen 1998b).

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=482) 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 swept.

Results and Discussion

In total 38 successful hauls were made, giving a mean coverage of 1337 km² per haul (Table 1). The number of tows was reduced compared to the 70 planned due to bad weather. The two small strata 1001-1200 m in Div. 1C (611 km²) and 401-600 m in Div. 1D (903 km²) were not covered. In total 71 species or groups of species were recorded (Appendix 1).

Greenland halibut (*Reinhardtius hippoglossoides*)

Greenland halibut was caught in all hauls and the catches ranged between 1.2 kg at 653 m in Div. 1C and 370.0 kg at 1255 m in Div. 1D (Fig. 1, Table 2).

The biomass of Greenland halibut in Div. 1C-1D, 401-1500 m, was estimated at 64 398 tons (S.E. 6 912.1) which is not statistically different (95% level) from the 70 473.5 tons (S.E. 8 391.7) estimated in 1998 (Jørgensen 1999) and

56 260.2 tons (S.E. 4 399.6) in 1997 (Jørgensen 1998b). Two small strata which traditionally yield biomasses around 2 000 ton were not covered in 1999. The highest densities were found at depths between 1000 and 1500 m in Div. 1D (Table 3).

The abundance in Div. 1C-1D was estimated at $61.366 \cdot 10^6$ (S.E. $6.265 \cdot 10^6$) which is not statistically different (95% level) from the estimates in 1998 ($67.677 \cdot 10^6$ (S.E. $7.687 \cdot 10^6$)) and 1997 ($53.613 \cdot 10^6$ (S.E. $4.118 \cdot 10^6$)). The abundance is however slightly underestimated compared to previous years due to lack of coverage of two small strata which traditionally have around $2 \cdot 10^6$ individuals. The highest concentrations were found at depth 1201-1400 m in Div. 1D (Table 4). The estimated abundance by age is given in Table 6.

The length ranged from 19 cm to 100 cm except a few larvae 6-8 cm. Generally the length distributions in the different depth strata were dominated by a single mode, except in Div. 1C depth stratum 601-800 m. Fish size increased with depth and from north to south at the same depth (Fig. 2) as seen in previous surveys (Jørgensen 1997b). The overall length distribution (weighted by stratum area) was dominated by two modes at 46 and 49 cm similar to the distribution in 1998 (Fig. 3)

The age ranged from 2 to 18 years with the youngest fish in shallow water in Div. 1C and the oldest fish in deep water in Div. 1D (Fig. 4). Generally the age increased by depth and the age composition was dominated by ages 5-7 at depths deeper than 800 m. The overall age distribution (weighted by stratum area) was monomodal with a mode around age 7, while the mode was around age 6 in 1998, despite that the length distribution is very similar (Fig. 5). This is caused by a change in the age/length keys with relatively more fish at age 7 in the length groups 45-50 cm in 1999 compared to 1998. (See text table).

	age 6		age 7	
	1998	1999	1998	1999
45-47 cm	28	18	0	5
48-50 cm	20	18	10	14

The reader of the 1997 otoliths seems to interpret the otoliths different from the other readers in the period 1995-1999 (table 5) and the age length key from 1998 is applied to the 1997 data in table 6 and fig. 5.

Females started maturing at age 6 and 50 % of the females were mature between age 9 and 10 and 100% maturity was reached at age 14 (Table 7).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in 34 of the 38 hauls, but the catches were low, ranging from < 0.1 kg in several hauls to 18.5 kg at 906 m depths in Div. 1C (Fig. 6, Table 2).

The biomass of roundnose grenadier in Div. 1C-1D, 401-1500 m, was estimated at 2 771.8 tons (S.E. 445.5) which is the lowest observed in the Greenland surveys (since 1997) and the joint Japan/Greenland surveys (1987-1995) except one estimate from a winter survey in 1992 (Jørgensen 1998a). The estimates in 1997 and 1998 were 5 686.5 tons (S.E. 926.4) and 7 263.3 tons (S.E. 2 530.2), respectively. Most of the biomass was found in Div. 1D at depths > 1000 m (Table 8), but Div. 1C 801-1000 m contributed with about 500 tons. This is the same distribution pattern as seen in 1998.

The abundance in Div. 1C-1D was estimated at $29.100 \cdot 10^6$ (S.E. $8.963 \cdot 10^6$) compared to $32.441 \cdot 10^6$ (S.E. $7.056 \cdot 10^6$) in 1997 and $75.243 \cdot 10^6$ (S.E. $27.357 \cdot 10^6$) in 1998. The highest concentration was found in depth stratum 801-1000 m in Div. 1C where around 50% of the abundance was located (Table 9).

Pre anal fin length ranged from 2.0 to 19 cm. Generally the length distributions in the different depth strata were dominated by 1-2 modes. Fish size increased generally with increasing depth (Fig. 7). The overall length distribution (weighted by stratum area) was dominated by a mode around 5 cm and fish were generally smaller than in 1997 and 1998 cm (Fig.8).

Roughhead grenadier (*Macrourus berglax*)

Roughhead grenadier was caught in all 38 hauls, but the catches were low, ranging from 0.6 kg to 23.5 kg (Fig. 9, Table 2).

The biomass of roughhead grenadier in Div. 1C-1D, 401-1500 m, was estimated at 5 166.2 tons (S.E. 854.1) compared to 4 314.1 tons (S.E. 377.9) and 2 258.6 tons (S.E. 250.1) in 1998 and 1997, respectively. The biomass is slightly underestimated (probably < 100 tons) due to lack of coverage of two small strata. Most of the biomass was found in Div. 1D at depths > 1000 m, but also Div. 1C depth strata 601-1000 m contributed significantly (Table 10). The abundance in Div. 1C-1D was estimated at 14.074×10^6 (S.E. 2.040×10^6) compared to 11.623×10^6 (S.E. 1.008×10^6) in 1998 and 4.60×10^6 (S.E. 0.45×10^6) in 1997 (Table 11).

Pre anal fin length ranged from 1.0 to cm 38 cm. The overall length distribution (weighted by stratum area) was dominated by modes at 10 and 14 cm, but several smaller modes at 17, 20 and 23 cm were also seen (Fig. 10).

Deep sea redfish (*Sebastes mentella*)

Deep-sea redfish was caught in 16 the 38 hauls, but the catches were low, ranging from < 0.1 kg to 31.6 kg (Fig. 11, Table 2).

The biomass of deep-sea redfish in Div. 1C-1D, 401-1500 m, was estimated at 2 484.9 (S.E. 1 007.7) compared to 2 408.1 tons (S.E. 503.9) in 1998 and 2 464.3 tons (S.E. 787.1) in 1997. 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 12.926×10^6 compared to 18.827×10^6 (S.E. 4.496×10^6) in 1998 and 14.69×10^6 (S.E. 5.50×10^6) in 1997 (Table 13).

The overall length distribution ranged from 15 to 43 cm and was dominated by a mode at 22 cm (Fig. 12).

American place (*Hippoglossoides platessoides*).

American place was caught in 7 of the 38 hauls, and the catches were low, ranging from < 0.1 kg to 1.7 kg (Table 2).

The biomass of American place in Div. 1C-1D, 401-1500 m, was estimated at 134.5 tons (S.E. 52.1) compared to 136.6 tons (S.E. 56.0) in 1998 and 137.1 tons (S.E. 26.7) in 1997. All the biomass was found at depths < 800 m in Div. 1C (Table 14). The abundance in Div. 1C-1D was estimated at 0.706×10^6 (S.E. 0.123×10^6) compared to 1.280×10^6 (S.E. 0.637×10^6) in 1998 and 0.83×10^6 (S.E. 8.11×10^4) in 1997 (Table 15).

Temperature

The bottom temperature ranged from 1.5 °C in depth stratum 601-800 m in Div. 1C to 4.7 °C in depth stratum 401-600 m in Div. 1C (Table 2). Mean temperatures by NAFO Div. and depth strata are given in Table 16.

References

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

Div.	Depth stratum (m)						Tot.
	401-600	601-800	801-1000	1001-1200	1201-1400	1401-1500	
1C	3366 (4) 2	16120 (12) 7	6066 (8) 6	611 (2) 0	-	-	26163 (26) 15
1D	903 (2) 0	1940 (3) 1	3874 (5) 2	10140 (18) 11	6195 (12) 7	3091 (4) 2	26143 (44) 23
Tot	4269 (2)	18060 (8)	9940 (13) 8	10751 (20) 11	6195 (12) 7	3091 (4) 2	52306 (70) 38

Table 2. Catch weight and - numbers (not standardised to kg/km²) of Greenland halibut, roundnose and roughhead grenadier, *Sebastes mentella* and American plaice by haul. Depth in m, swept area in km² and bottom temperature in °C.

Stat. No	Month	Day	Depth	SWEPAAREA	Div.	Stra..	Temp.	Greenland halibut		Roundnose grenadier		Roughhead grenadier		Sebastes mentella		American plaice	
								Number	Kg	Number	Kg	Number	Kg	Number	Kg	Number	Kg
								1	9	23	663.0	0.08130	1C	8	1.5	57	24.4
2	9	23	653.0	0.07467	1C	8	4.1	6	1.2	4	0.1	2	1.4	133	31.6	2	0.6
3	9	23	579.0	0.07388	1C	6	4.4	10	4.2	0	0.0	2	0.5	138	20.0	8	1.3
4	9	23	766.5	0.07546	1C	8	3.9	46	32.7	2	0.0	20	5.0	5	1.0	3	0.0
5	9	23	837.5	0.07370	1C	10	3.8	80	61.8	273	7.5	35	9.9	0	0.0	4	0.9
6	9	24	576.5	0.07389	1C	6	4.7	2	0.9	2	0.1	2	0.6	145	22.6	9	0.7
7	9	24	767.5	0.05569	1C	8	4.2	23	15.0	160	5.2	12	3.5	4	0.9	2	1.2
8	9	24	847.5	0.06419	1C	10	4.3	57	54.4	220	7.0	24	7.2	1	0.6	0	0.0
9	9	24	906.0	0.06229	1C	10	3.7	79	58.8	380	18.5	85	21.4	2	0.5	0	0.0
10	9	24	953.5	0.06933	1C	10	3.7	106	94.2	33	1.8	21	6.7	1	0.2	0	0.0
11	9	26	651.5	0.07427	1C	8	2.7	21	14.0	18	0.9	9	2.1	42	6.7	0	0.0
12	9	26	783.0	0.07523	1C	8	3.8	58	41.6	0	0.0	7	2.4	1	0.3	0	0.0
13	9	26	774.5	0.06027	1C	8	3.8	66	47.2	2	0.0	22	4.1	2	0.3	0	0.0
14	9	26	842.0	0.07447	1C	10	3.6	79	64.2	10	0.5	30	8.6	0	0.0	0	0.0
15	9	26	879.5	0.07408	1C	10	3.5	73	63.9	13	0.3	37	10.1	0	0.0	0	0.0
16	9	27	1157.0	0.06642	1D	12	3.4	188	208.0	7	1.6	38	23.5	0	0.0	0	0.0
17	9	27	1255.0	0.07190	1D	14	3.5	348	370.0	8	1.7	27	12.1	0	0.0	0	0.0
18	9	27	1386.5	0.07980	1D	14	3.1	258	331.5	14	4.8	8	6.4	1	0.2	0	0.0
19	9	27	1178.0	0.07116	1D	12	3.4	210	282.4	11	2.0	29	14.1	0	0.0	0	0.0
20	9	27	943.5	0.08133	1D	10	3.7	194	170.3	4	0.1	33	11.0	0	0.0	0	0.0
21	9	27	732.0	0.02956	1D	8	3.8	9	6.7	2	0.1	10	4.1	7	2.9	0	0.0
22	9	28	944.0	0.07752	1D	10	3.7	118	113.0	8	0.5	26	6.6	0	0.0	0	0.0
23	9	28	1080.5	0.06601	1D	12	3.6	103	101.4	14	1.6	47	15.6	0	0.0	0	0.0
24	9	28	1180.0	0.07866	1D	12	3.5	160	71.7	5	1.1	14	6.4	0	0.0	0	0.0
25	9	28	1333.5	0.07861	1D	14	3.2	246	251.9	26	5.6	20	10.8	0	0.0	0	0.0
26	9	29	1457.0	0.04293	1D	15	3.3	118	171.3	22	7.1	25	18.5	0	0.0	0	0.0
27	9	29	1189.5	0.06605	1D	12	3.4	144	161.7	0	0.0	18	9.3	0	0.0	0	0.0
28	9	29	1364.0	0.06022	1D	14	3.4	43	78.2	28	12.8	6	3.6	0	0.0	0	0.0
29	9	29	1134.0	0.08042	1D	12	3.4	129	202.9	24	5.5	9	5.5	0	0.0	0	0.0
30	9	30	1143.5	0.07359	1D	12	3.3	101	118.8	39	8.6	17	5.2	0	0.0	0	0.0
31	9	30	1278.5	0.04506	1D	14	3.4	44	54.8	20	5.5	12	5.5	1	0.0	0	0.0
32	9	30	1156.5	0.07703	1D	12	3.4	67	84.0	27	3.5	29	8.1	0	0.0	0	0.0
33	9	30	1110.5	0.06354	1D	12	3.5	38	39.9	27	3.8	22	5.7	0	0.0	0	0.0
34	9	30	1122.5	0.07561	1D	12	3.5	35	42.1	5	0.7	11	4.3	0	0.0	0	0.0
35	10	1	1442.5	0.06779	1D	15	3.4	39	80.1	35	18.1	10	5.3	0	0.0	0	0.0
36	10	1	1258.5	0.06813	1D	14	3.4	115	165.6	52	15.0	16	4.7	0	0.0	0	0.0
37	10	1	1256.5	0.07466	1D	14	3.4	113	167.5	45	15.1	20	8.7	0	0.0	0	0.0
38	10	1	1155.5	0.07471	1D	12	3.4	193	238.1	68	9.4	15	7.3	1	0.2	0	0.0

Table 3. Biomass (tons) of Greenland halibut by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0345	116.2	75.2
	601-800	16120	7	0.3634	5857.4	1535.5
	801-1000	6066	6	0.9522	5776.0	501.9
1D	601-800	1940	1	0.2266	439.7	.
	801-1000	3874	2	1.7759	6879.7	1232.4
	1001-1200	10140	11	1.9632	19907.2	3534.5
	1201-1400	6195	7	2.8134	17429.1	3407.9
	1401-1500	3091	2	2.5858	7992.7	4340.3
ALL				1.2681	64398.0	6912.1

Table 4. Abundance of Greenland halibut by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundance	SE
1C	401-600	3366	2	81.2	273358.7	182256.5
	601-800	16120	7	564.7	9102946.8	2053509.7
	801-1000	6066	6	1136.1	6891658.1	569345.9
1D	601-800	1940	1	304.4	590607.9	.
	801-1000	3874	2	1953.8	7569126.2	1671923.8
	1001-1200	10140	11	1731.5	17557757.3	2652035.5
	1201-1400	6195	7	2299.3	14243895.4	3482344.3
	1401-1500	3091	2	1661.9	5136950.1	3358636.6
ALL				1208.4	61366300.5	6265461.7

Table 5. Mean weight and mean length at age of Greenland halibut in 1999-1995.

AGE	1999		1998		1997		1996		1995	
	weight	length	weight	length	weight	length	weight	length	weight	length
1										
2	64.00	21.00	38.22	18.70	23.33	15.33			50.00	20.00
3	206.07	27.43	175.50	28.50	58.18	19.82	175.00	30.50	140.00	27.00
4	342.12	34.38	347.50	35.27	136.96	26.13	378.26	36.35	339.43	35.09
5	570.71	40.29	551.38	40.94	271.82	32.82	555.56	41.22	495.53	40.13
6	793.40	45.57	854.15	46.77	443.93	38.04	794.10	45.72	691.59	45.00
7	1195.50	51.41	1218.13	51.94	736.89	43.87	1055.95	49.90	986.56	49.82
8	1665.37	57.89	1572.34	56.81	1070.18	49.85	1447.01	55.34	1360.00	54.51
9	2057.06	61.06	2074.80	60.56	1453.73	55.61	2092.16	61.45	1816.98	59.63
10	2440.69	64.14	2293.45	63.10	2042.90	61.23	2740.63	65.84	2163.50	62.70
11	2812.08	66.88	2866.55	66.48	2814.55	66.68	3241.67	68.43	2679.63	66.30
12	4000.12	72.87	3453.21	69.89	3827.69	72.58	4100.21	72.98	3248.64	69.91
13	5678.64	79.50	4537.50	74.70	4840.00	77.29	4994.00	76.43	4133.57	73.36
14	7613.16	86.68	5112.00	77.60	6679.44	84.00	5946.67	80.56	5685.56	79.78
15	8476.67	91.20	7140.59	85.06	7711.11	87.78	7523.68	86.76	6631.05	83.63
16	9925.00	88.50	8385.00	88.87	9166.00	94.60	8663.04	89.93	7533.00	89.00
17			10684.00	95.40	10796.67	97.83	9208.33	91.94	10413.64	94.64
18	12500.00	99.00					10127.27	95.27	11180.00	97.00
19			12850.00	99.00			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. Estimated abundance by age from Div. 1C-1D from the surveys in 1997 - 1999. The Age-length key from 1998 is applied on the 1997 data.

AGE	1997	1998	1999
	Number	Number	Number
1			
2	536130	609093	184098
3	1704893	3722237	920490
4	3023773	4662948	4172888
5	9961295	14760362	11291344
6	15370847	19057854	15893794
7	13558728	14083592	19759852
8	5436358	5766084	4786548
9	1200931	1515966	859124
10	948950	1211419	920490
11	584382	764751	613660
12	466433	527881	675026
13	187646	351921	429562
14	96503	155657	429562
15	262704	236870	184098
16	187646	115051	61366
17	64336	128586	61366
18	16084	0	61366
19		0	0
20		0	0
SUM	53607639	67670271	61304634

Table 7. Maturity (MAT) at age in percent, females, Div. 1C-1D 1999. Maturity: I = immature, 2 – maturing.

AGE	MAT		N
	1	2	
	PCTN	PCTN	
2	100.00	.	4.00
3	100.00	.	13.00
4	100.00	.	22.00
5	100.00	.	23.00
6	75.00	25.00	12.00
7	84.00	16.00	25.00
8	60.00	40.00	30.00
9	71.43	28.57	7.00
10	15.79	84.21	19.00
11	15.00	85.00	20.00
12	7.14	92.86	28.00
13	4.76	95.24	21.00
14	.	100.00	19.00
15	.	100.00	15.00
16	.	100.00	2.00
18	.	100.00	1.00

Table 8. Biomass (tons) of roundnose grenadier by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0007	2.3	2.3
	601-800	16120	7	0.0153	246.0	211.6
	801-1000	6066	6	0.0908	551.0	275.1
1D	601-800	1940	1	0.0034	6.6	.
	801-1000	3874	2	0.0038	14.9	10.1
	1001-1200	10140	11	0.0469	475.7	129.1
	1201-1400	6195	7	0.1303	807.2	190.9
	1401-1500	3091	2	0.2162	668.2	157.1
ALL				0.0546	2771.8	445.5

Table 9. Abundance of roundnose grenadier by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundance	SE
1C	401-600	3366	2	13.5	45551.1	45551.1
	601-800	16120	7	461.3	7435543.7	6500310.4
	801-1000	6066	6	2336.0	14170229.5	6086065.0
1D	601-800	1940	1	67.7	131246.2	.
	801-1000	3874	2	76.2	295173.7	104636.6
	1001-1200	10140	11	283.3	2872183.3	813287.7
	1201-1400	6195	7	413.2	2559666.8	537841.3
	1401-1500	3091	2	514.4	1589922.6	5999.7
ALL				573.0	29099517.0	8962666.9

Table 10. Biomass (tons) of roughhead grenadier by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0074	25.1	2.3
	601-800	16120	7	0.0410	661.2	146.8
	801-1000	6066	6	0.1564	948.8	230.0
1D	601-800	1940	1	0.1387	269.1	.
	801-1000	3874	2	0.1102	426.9	97.1
	1001-1200	10140	11	0.1363	1381.8	280.3
	1201-1400	6195	7	0.1076	666.6	92.6
	1401-1500	3091	2	0.2545	786.8	545.1
ALL				0.1017	5166.2	854.1

Table 11. Abundance of roughhead grenadier by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundance	SE
1C	401-600	3366	2	27.1	91112.6	10.4
	601-800	16120	7	162.3	2615549.6	754990.9
	801-1000	6066	6	569.7	3456023.1	979988.1
1D	601-800	1940	1	338.3	656231.0	.
	801-1000	3874	2	370.6	1435657.4	136273.8
	1001-1200	10140	11	323.1	3276217.8	569514.0
	1201-1400	6195	7	228.4	1415004.9	230928.8
	1401-1500	3091	2	364.9	1127945.1	671967.3
ALL				277.1	14073741.7	2040416.5

Table 12. Biomass (tons) of *Sebastes mentella* by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.2883	970.3	59.1
	601-800	16120	7	0.0806	1299.0	938.7
	801-1000	6066	6	0.0034	20.5	10.6
1D	601-800	1940	1	0.0981	190.3	.
	801-1000	3874	2	0.0000	0.0	0.0
	1001-1200	10140	11	0.0002	2.5	2.5
	1201-1400	6195	7	0.0004	2.2	2.2
	1401-1500	3091	2	0.0000	0.0	0.0
ALL				0.0489	2484.9	1007.7

Table 13. Abundance of *Sebastes mentella* by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundance	SE
1C	401-600	3366	2	1915.1	6446201.7	158712.0
	601-800	16120	7	366.9	5914185.1	3981771.1
	801-1000	6066	6	10.4	62790.1	32071.5
1D	601-800	1940	1	236.8	459361.7	.
	801-1000	3874	2	0.0	0.0	0.0
	1001-1200	10140	11	1.2	12338.6	12338.6
	1201-1400	6195	7	5.0	30730.0	20883.0
	1401-1500	3091	2	0.0	0.0	0.0
ALL				254.5	12925607.2	4093411.7

Table 14. Biomass (tons) of American plaice by Division and depth stratum, 1999.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0135	45.6	13.7
	601-800	16120	7	0.0048	76.6	48.8
	801-1000	6066	6	0.0020	12.3	12.3
1D	601-800	1940	1	0.0000	0.0	.
	801-1000	3874	2	0.0000	0.0	0.0
	1001-1200	10140	11	0.0000	0.0	0.0
	1201-1400	6195	7	0.0000	0.0	0.0
	1401-1500	3091	2	0.0000	0.0	0.0
ALL				0.0026	134.5	52.1

Table 15. Abundance of American plaice by Division and depth stratum, 1999.

Div.	Stratus(m)	Area	Hauls	Mean sq km	Abundance	SE
1C	401-600	3366	2	115.0	387226.2	22734.0
	601-800	16120	7	16.4	264272.6	107217.1
	801-1000	6066	6	9.0	54868.5	54868.5
1D	601-800	1940	1	0.0	0.0	.
	801-1000	3874	2	0.0	0.0	0.0
	1001-1200	10140	11	0.0	0.0	0.0
	1201-1400	6195	7	0.0	0.0	0.0
	1401-1500	3091	2	0.0	0.0	0.0
ALL				13.9	706367.3	122567.9

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	4.6	.15	2	3.4	.37	7	3.8	.11	6									
1D				3.8	.	1	3.7	0	2	3.4	.02	11	3.3	.05	7	3.4	.05	2

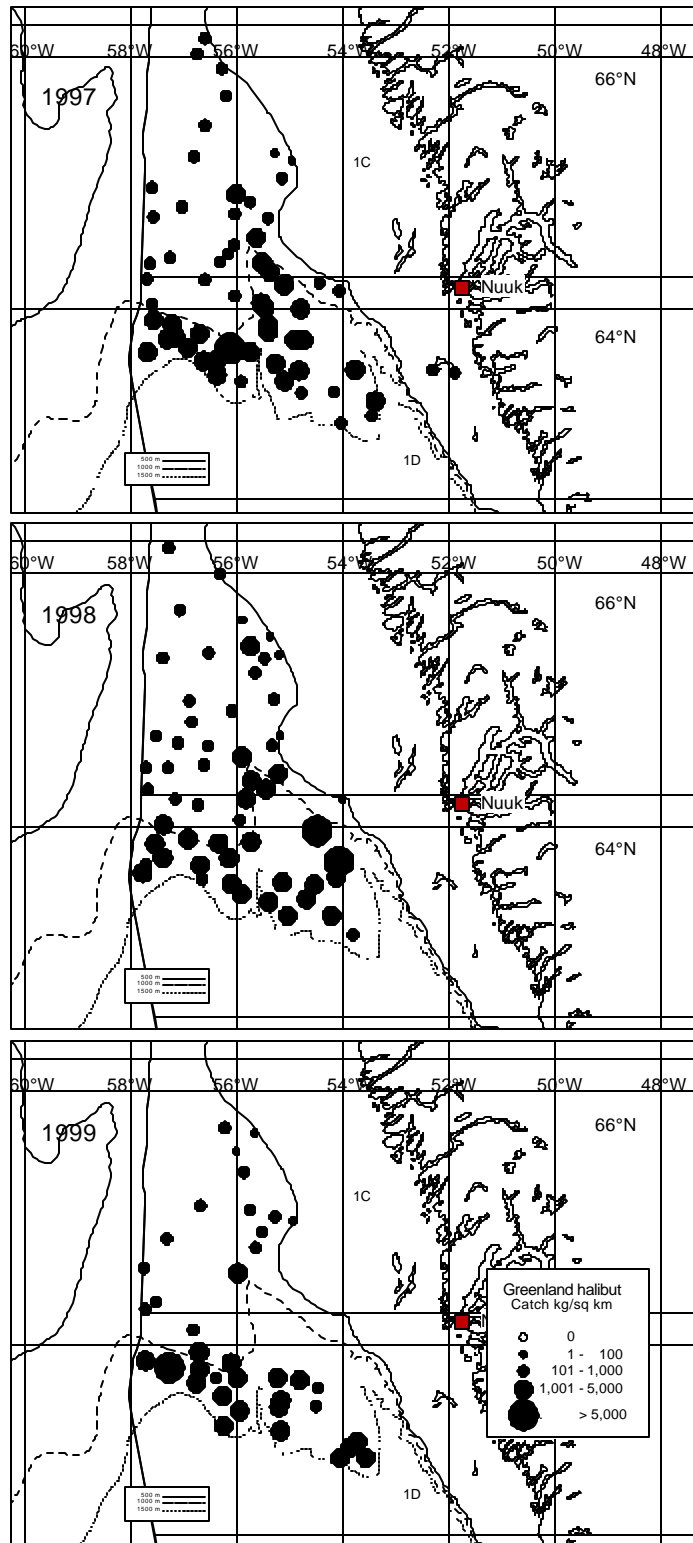


Fig. 1. Distribution of catches of Greenland halibut during 1997 – 1999

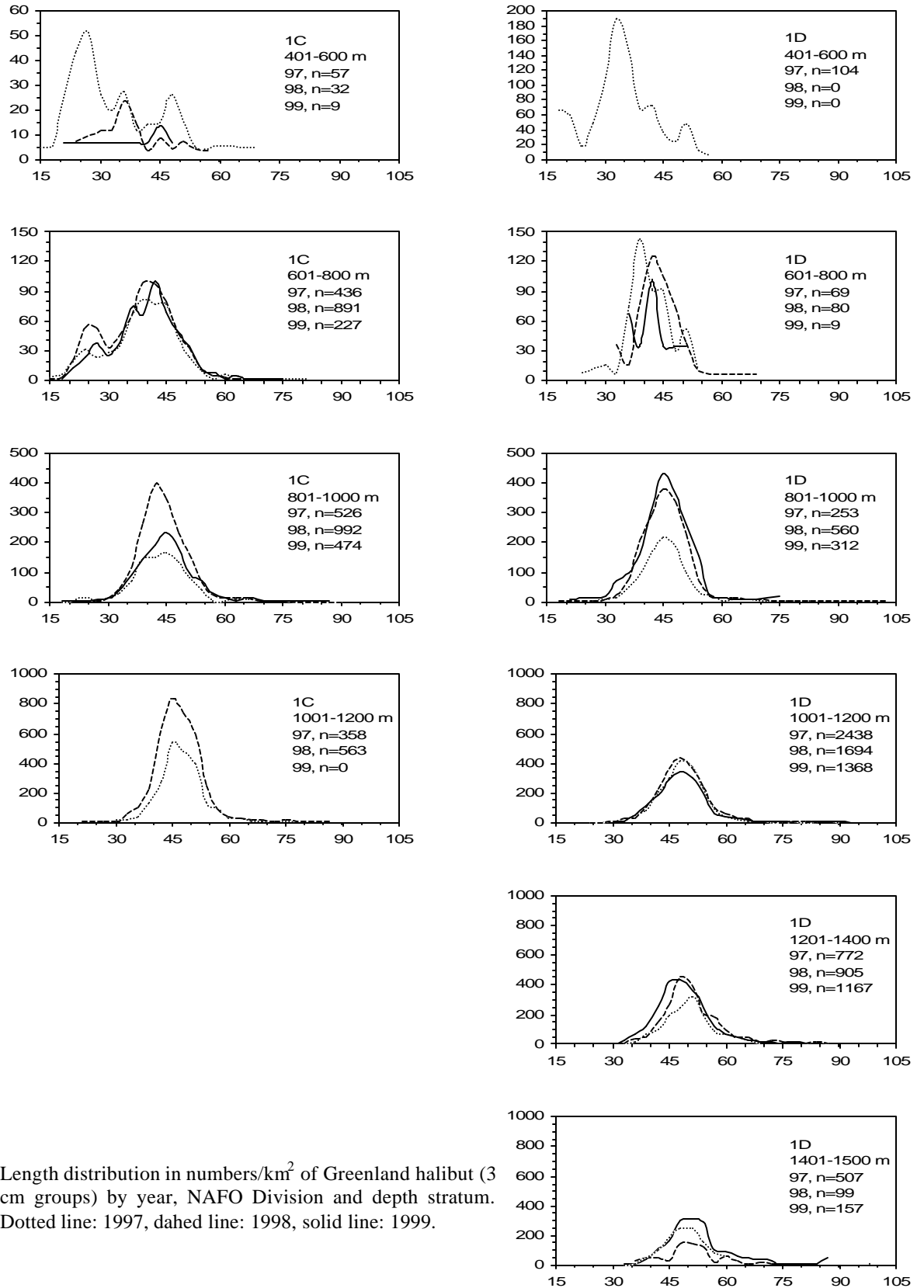


Fig. 2. Length distribution in numbers/km² of Greenland halibut (3 cm groups) by year, NAFO Division and depth stratum. Dotted line: 1997, dashed line: 1998, solid line: 1999.

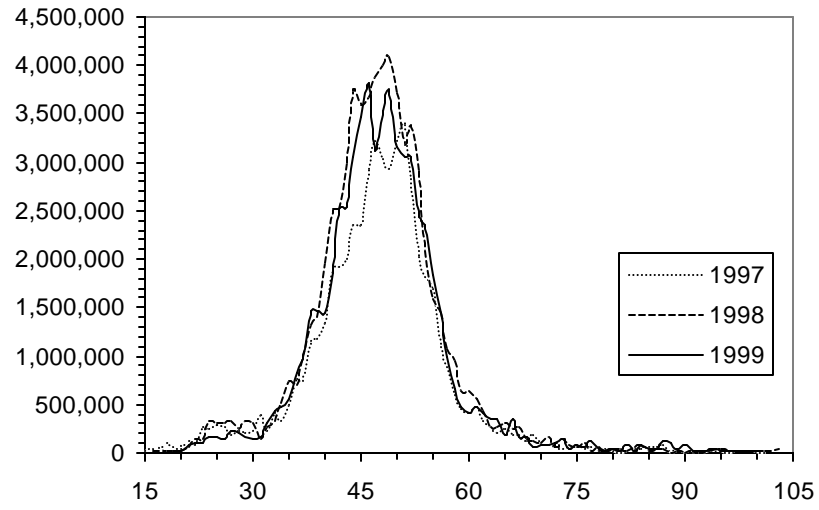


Fig. 3. Overall length distribution of Greenland halibut in numbers (weighted by stratum area) by year.

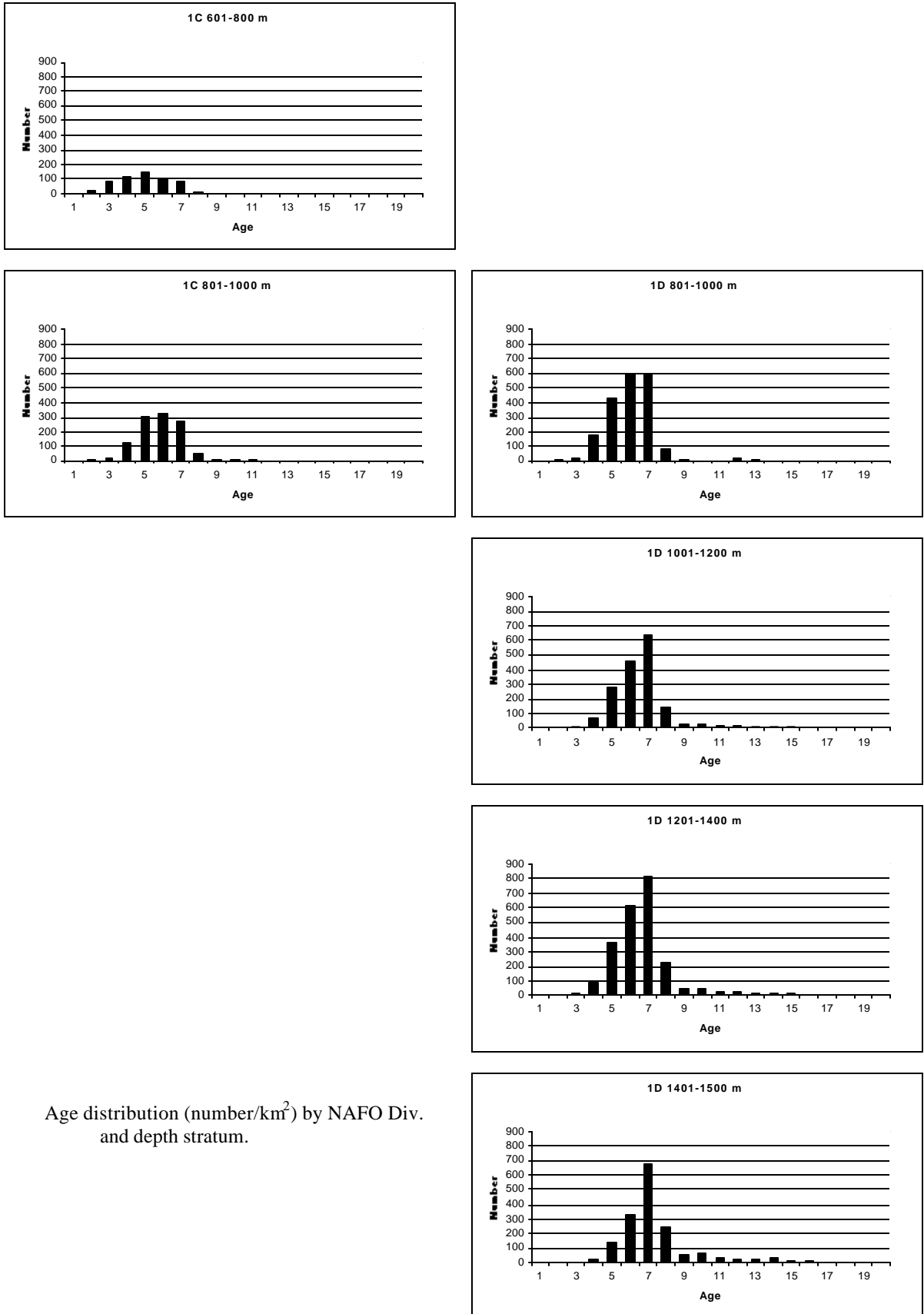


Fig 4. Age distribution (number/km²) by NAFO Div. and depth stratum.

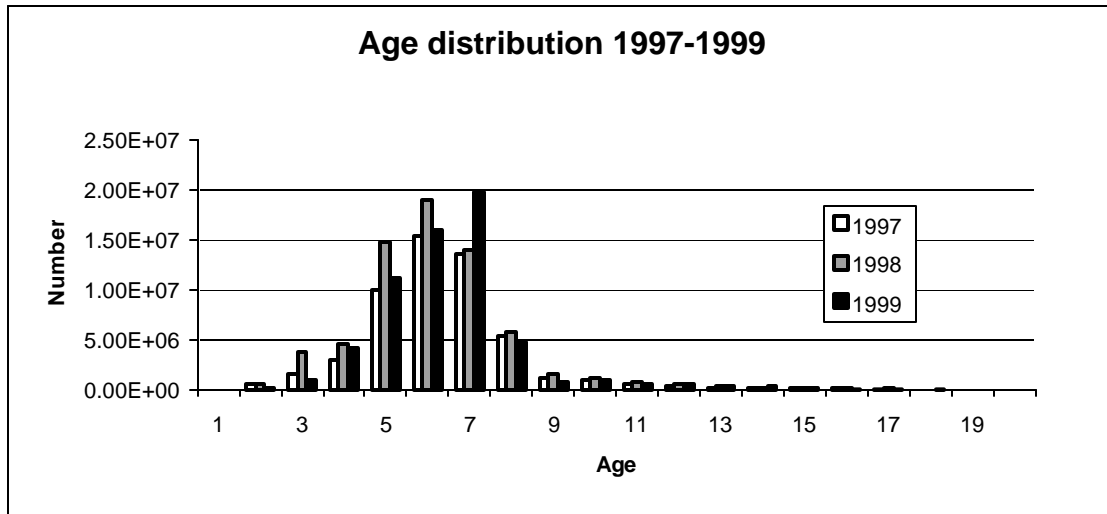


Fig. 5. Overall age distribution (weighted by stratum area) of Greenland halibut in NAFO Div. 1C-1D in 1997-1999.

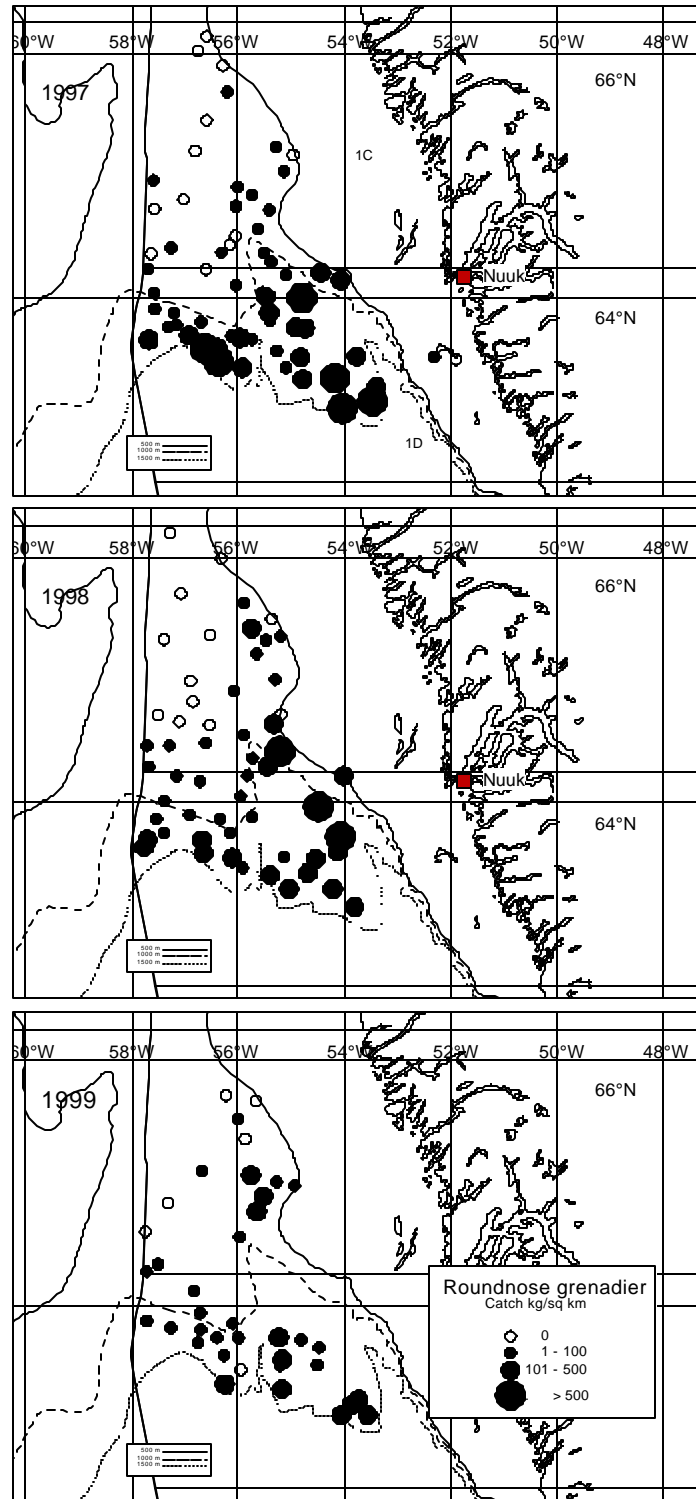


Fig. 6. Distribution of catches of roundnose grenadier during 1997 - 1999.

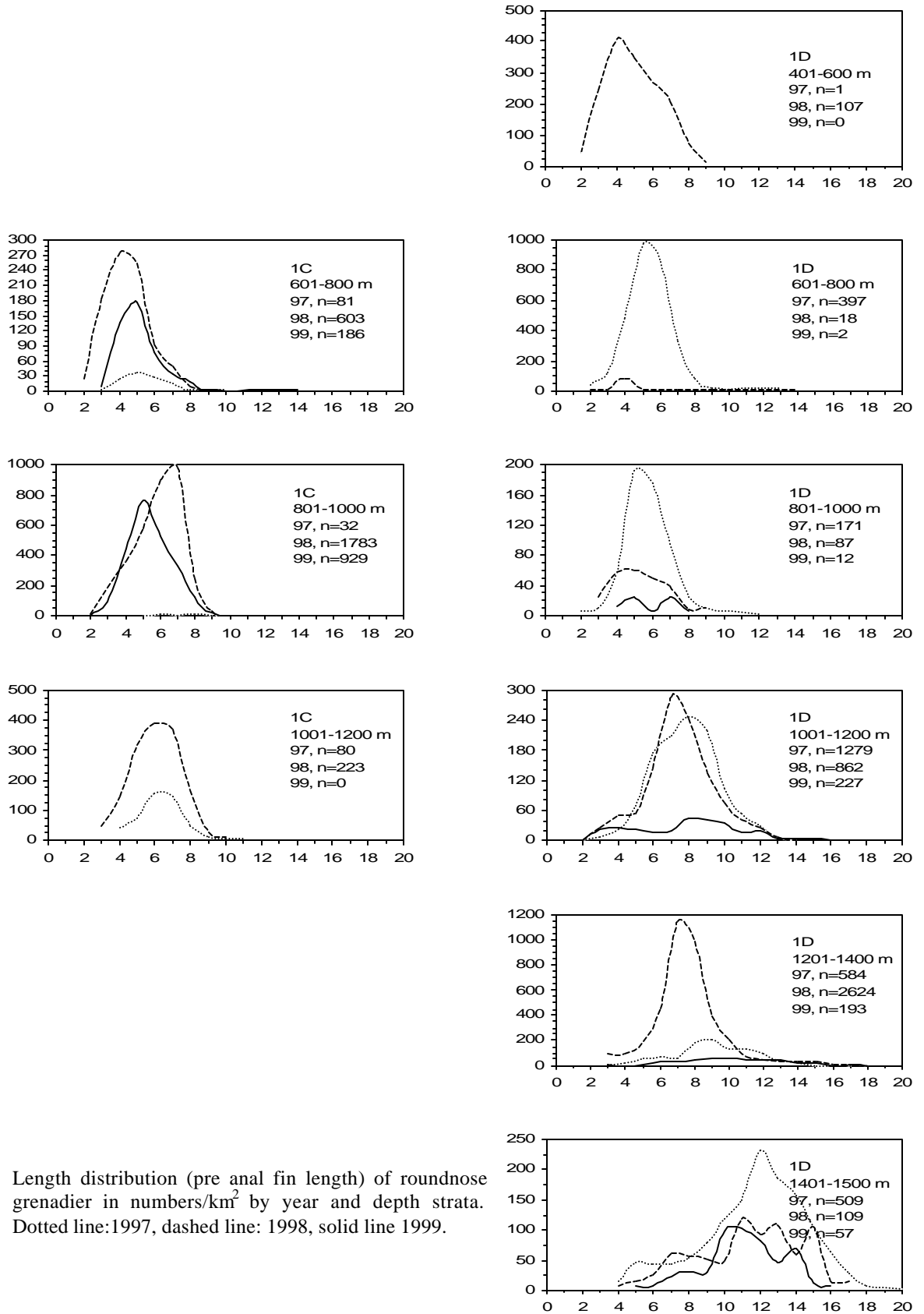


Fig. 7. Length distribution (pre anal fin length) of roundnose grenadier in numbers/km² by year and depth strata. Dotted line:1997, dashed line: 1998, solid line 1999.

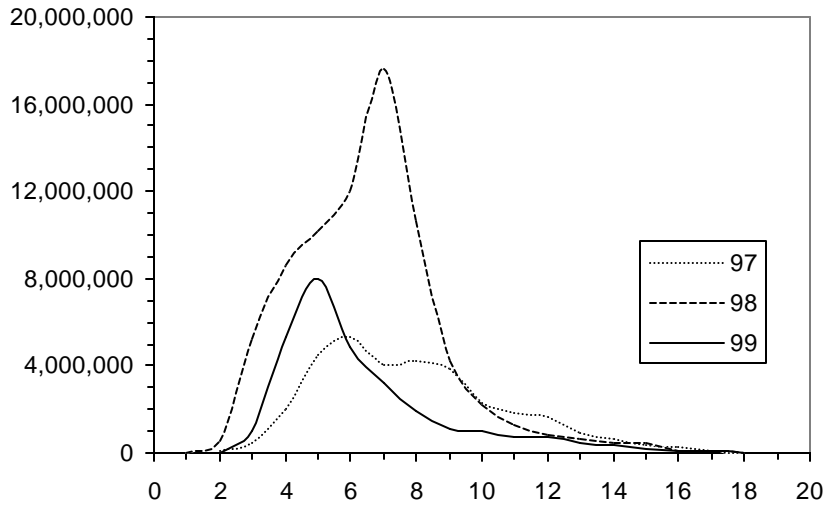


Fig. 8. Overall length distribution of roundnose grenadier (pre anal fin length) in numbers (weighted by stratum area) by year.

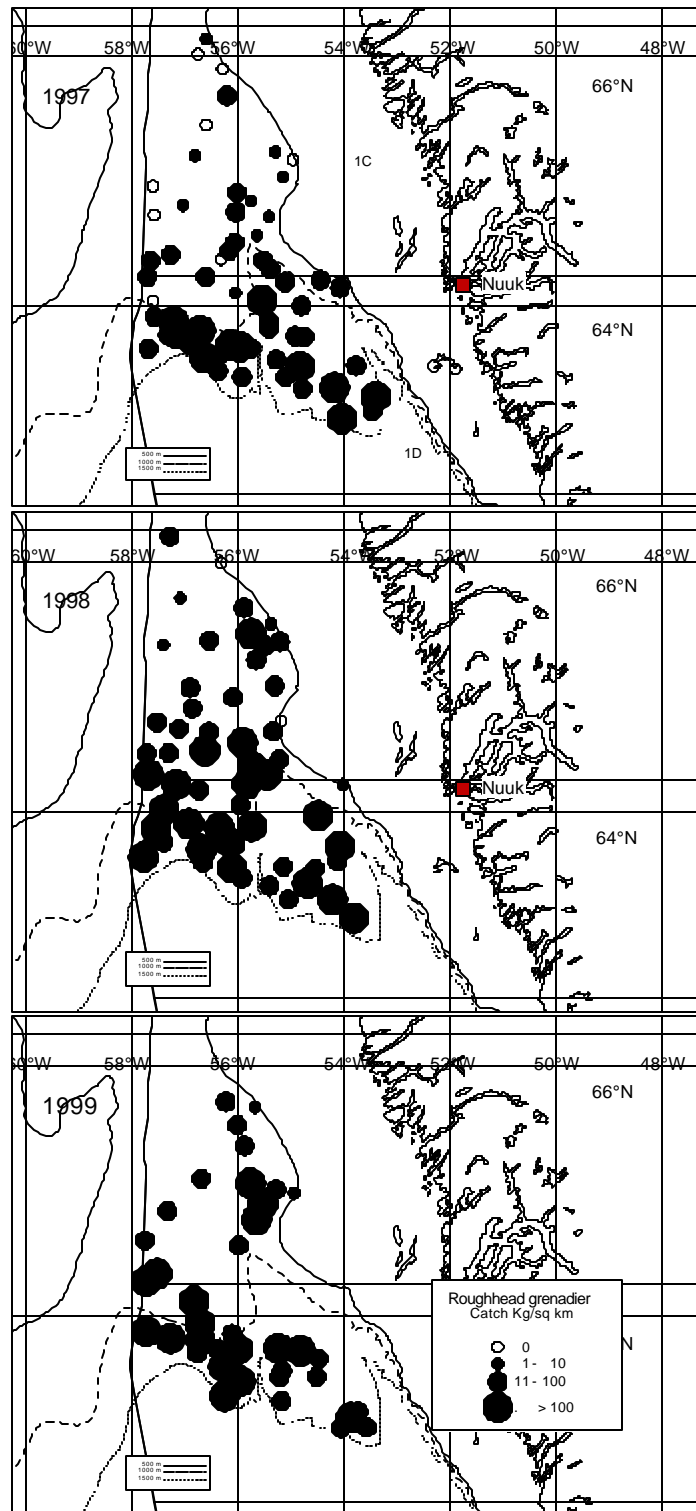


Fig. 9. Distribution of catches of roughhead grenadier during 1997 - 1999.

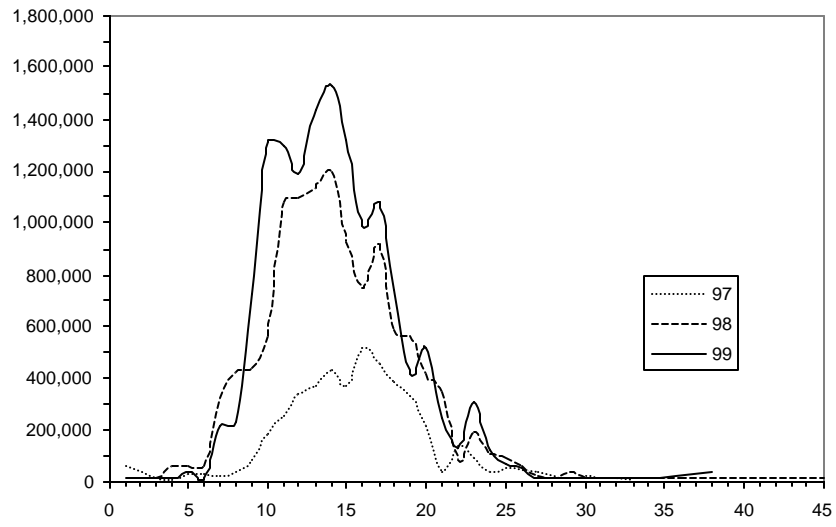


Fig. 10. Overall length distribution (pre anal fin length) of roughhead grenadier in numbers (weighted by stratum area) by year.

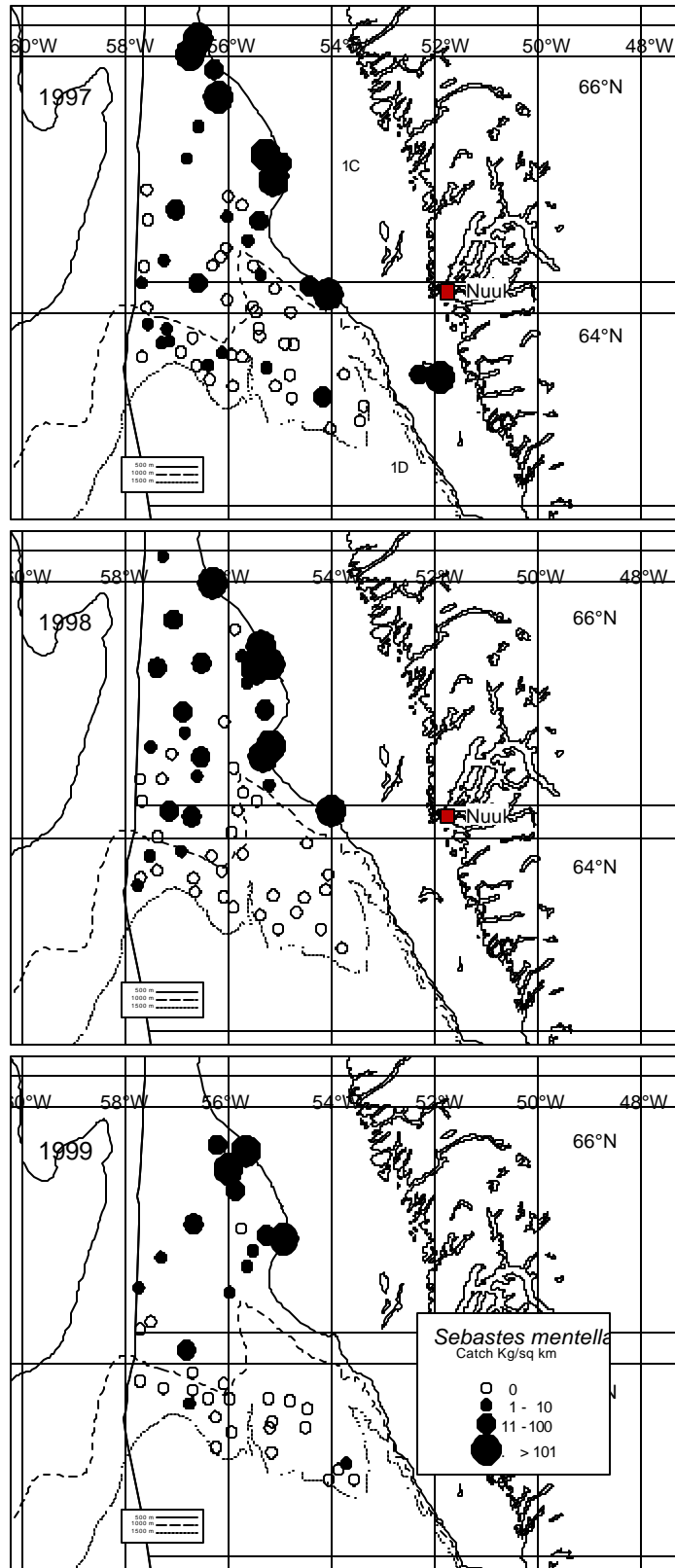


Fig. 11. Distribution of catches of *Sebastes mentella* during 1997 - 1999.

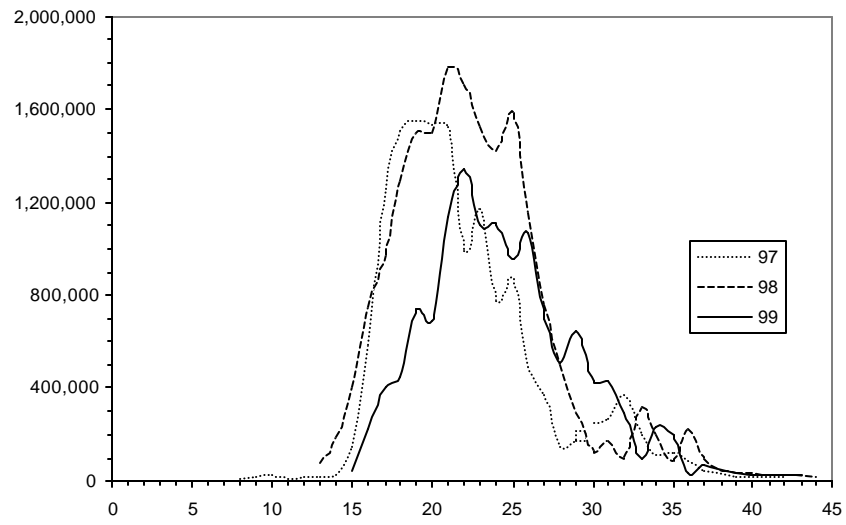


Fig. 12. Overall length distribution of *Sebastes mentella* in numbers (weighted by stratum area) by year.

APPENDIX 1. Species or groups of species observed during the 1999 Greenland halibut survey in Divisions 1CD including minimum and maximum weight, minimum and maximum number per tow (not standardised to km² swept) min. and max. length, min and max. depth and min. and max temperature.

	S						M	M				
	P		M	M	M	M	I	A	M	M		
	E		I	A	M	I	A	D	D	N	X	
	C		N	X	I	A	N	X	E	E	T	T
0	A	I	W	W	X	L	L	P	P	E	E	
B	R	E	G	G	N	E	E	T	T	M	M	
S	T	S	T	T	O	O	N	N	H	H	P	P
1	ALA	<i>Alepocephalus agassizzi</i>	0.6	9.6	3	13	21.0	75.0	1256.5	1457.0	3.1	3.4
2	ALB	<i>Alepocephalus bairdii</i>	0.2	0.2	1	1	.	.	906.0	906.0	3.7	3.7
3	CAD	<i>Anarhichas denticulatus</i>	0.0	9.0	1	1	13.0	89.0	879.5	1134.0	3.4	3.5
4	CAA	<i>Anarhichas lupus</i>	0.0	0.0	1	1	7.0	7.0	1278.5	1278.5	3.4	3.4
5	CAS	<i>Anarhichas minor</i>	3.1	3.1	1	1	69.0	69.0	576.5	576.5	4.7	4.7
6	ANC	<i>Anoplogaster cornuta</i>	0.1	0.1	1	1	15.0	15.0	1258.5	1258.5	3.4	3.4
7	ANT	<i>Antimora rostrata</i>	0.0	12.0	1	26	10.0	62.0	774.5	1457.0	3.1	4.3
8	ARZ	<i>Arctozenius rissoi</i>	0.0	4.1	1	1	21.0	26.0	579.0	1364.0	3.4	4.4
9	BAT	<i>Bathylagus euryops</i>	0.0	2.4	1	57	.	.	579.0	1457.0	2.7	4.4
10	BEG	<i>Bentosema glaciale</i>	0.0	0.2	1	66	.	.	576.5	1457.0	1.5	4.7
11	POC	<i>Boreogadus saida</i>	0.0	0.0	1	6	10.0	10.0	579.0	944.0	3.7	4.4
12	BOA	<i>Borostomias antarctica</i>	0.0	0.5	1	5	19.0	31.0	767.5	1386.5	3.1	4.2
13	CFB	<i>Centroscyllium fabricii</i>	0.1	7.4	1	9	16.0	78.0	576.5	1258.5	1.5	4.7
14	CHA	<i>Chauliodus sloani</i>	0.0	0.1	1	3	24.0	29.0	766.5	1457.0	3.3	3.9
15	CHN	<i>Chiasmodon niger</i>	0.0	0.1	1	3	13.0	21.0	766.5	1364.0	3.4	4.2
16	CBB	<i>Coryphaenoides breviparbus</i>	0.0	0.6	1	33	3.0	8.5	1178.0	1457.0	3.1	3.4
17	CGR	<i>Coryphaenoides guntheri</i>	0.0	2.1	1	20	3.5	13.0	1080.5	1457.0	3.1	3.6
18	RNG	<i>Coryphaenoides rupestris</i>	0.0	18.5	2	380	2.5	19.0	576.5	1457.0	2.7	4.7
19	COM	<i>Cottunculus microps</i>	0.1	1.3	1	5	.	.	663.0	1080.5	1.5	3.8
20	COT	<i>Cottunculus thomsonii</i>	0.3	2.9	1	9	9.0	42.0	847.5	1278.5	3.4	4.3
21	LUM	<i>Cuclopterus lumpus</i>	0.0	1.0	1	1	27.0	28.0	651.5	1278.5	2.7	4.3
22	CLM	<i>Cyclothone microdon</i>	0.0	0.0	1	13	.	.	651.5	1457.0	2.7	4.2
23	EUR	<i>Eurypharynx pelecanoides</i>	0.0	0.1	1	1	43.0	43.0	783.0	1189.5	3.4	3.8
24	WIT	<i>Glyptocephalus cynoglossus</i>	0.4	0.5	1	1	39.0	39.0	767.5	906.0	3.7	4.2
25	GOB	<i>Gonostoma bathyphilum</i>	0.0	0.0	1	1	16.0	16.0	1278.5	1333.5	3.2	3.4
26	HJI	<i>Halargyreus johnsonii</i>	0.2	0.2	1	1	31.0	31.0	1386.5	1386.5	3.1	3.1
27	PLA	<i>Hippoglossoides platessoides</i>	0.0	1.3	1	9	14.0	34.0	576.5	837.5	1.5	4.7
28	HAL	<i>Hippoglossus hippoglossus</i>	5.5	26.5	1	1	82.0	135.0	732.0	943.5	3.7	3.8
29	HOA	<i>Holtbyrnia anomala</i>	0.0	0.0	2	2	10.0	14.0	1155.5	1155.5	3.4	3.4
30	LMC	<i>Lampanyctus macdonaldi</i>	0.0	3.9	1	211	.	.	653.0	1457.0	1.5	4.3
31	LSP	<i>Lampanyctus sp.</i>	0.0	0.8	1	39	.	.	651.5	1457.0	2.7	4.2
32	LAI	<i>Lampanyctus intricarius</i>	0.0	0.0	5	5	.	.	774.5	774.5	3.8	3.8
33	LIK	<i>Liparis koefoedi</i>	0.0	0.2	1	4	.	.	651.5	783.0	1.5	4.1
34	KCT	<i>Lithodes maja</i>	1.6	4.1	1	2	.	.	1122.5	1278.5	3.3	3.5
35	ING	<i>Lycenchelys ingolfanus</i>	0.0	0.1	1	1	.	.	579.0	663.0	1.5	4.4
36	LYM	<i>Lycodes mirabilis</i>	0.0	0.4	1	10	25.0	43.0	774.5	1442.5	3.1	3.8
37	LPA	<i>Lycodes paamiuti</i>	0.0	0.1	1	3	.	.	766.5	953.5	3.7	4.3
38	LYT	<i>Lycodes terranova</i>	0.1	0.4	1	43	32.0	43.0	842.0	1256.5	3.4	3.6
39	RHG	<i>Macrourus berglax</i>	0.5	23.5	2	85	1.0	38.0	576.5	1457.0	1.5	4.7
40	MAL	<i>Malacosteus niger</i>	0.0	0.1	1	1	18.0	23.0	842.0	1457.0	3.3	3.6
41	MYP	<i>Myctophum punctatum</i>	0.0	0.0	1	1	.	.	1122.5	1442.5	3.4	3.5
42	MX	<i>Myxine glutinosa</i>	0.0	0.0	1	1	30.0	30.0	653.0	653.0	4.1	4.1
43	MYI	<i>Myxine ios</i>	0.0	0.3	1	9	.	.	847.5	1143.5	3.3	4.3
44	ARJ	<i>Natantia</i>	0.0	2.2	0	128	.	.	576.5	1457.0	1.5	4.7
45	NEG	<i>Neolithodes grimaldi</i>	0.2	0.2	1	1	.	.	1258.5	1258.5	3.4	3.4
46	NZB	<i>Nezumia bairdii</i>	0.1	0.7	1	4	7.0	10.0	732.0	1255.0	3.4	4.2
47	NOT	<i>Notacanthus chemnitzii</i>	0.1	9.6	1	7	0.4	107.0	766.5	1457.0	3.1	4.2
48	NOK	<i>Notoscopelus kroeyri</i>	0.0	0.0	1	1	.	.	651.5	1364.0	2.7	3.8
49	OCT	<i>Octopus</i>	0.1	13.9	1	11	.	.	653.0	1457.0	3.1	4.1
50	ONA	<i>Onogadus argentatus</i>	0.0	0.0	1	3	8.0	9.0	651.5	1364.0	1.5	3.7
51	ONN	<i>Onogadus ensis</i>	0.0	4.9	1	15	8.0	47.0	579.0	1457.0	1.5	4.4
52	PRA	<i>Pandalus borealis</i>	0.0	1.5	0	2	.	.	576.5	783.0	1.5	4.7

APPENDIX 1. continued.

53	PAC	Paraliparis copei	0.0	0.1	1	2	24.0	24.0	1256.5	1386.5	3.1	3.4
54	PAG	Paraliparis garmani	0.0	0.0	1	9	.	.	653.0	847.5	3.8	4.3
55	POL	Polyacanthonotus rissoan	0.1	0.7	1	4	45.0	56.0	1155.5	1457.0	3.1	3.4
56	RBT	Raja bathyphila	0.3	0.3	1	1	40.0	40.0	1442.5	1442.5	3.4	3.4
57	RBI	Raja bigelowi	0.6	0.6	1	1	50.0	50.0	1110.5	1110.5	3.5	3.5
58	RFL	Raja fyllae	0.6	0.6	2	2	28.0	45.0	906.0	906.0	3.7	3.7
59	RRD	Raja radiata	0.9	1.0	1	3	10.0	42.0	576.5	774.5	3.8	4.7
60	RSP	Raja spinacidermis	0.7	0.7	3	3	23.0	48.0	906.0	906.0	3.7	3.7
61	GHL	Reinhardtius hippoglosso	0.9	370.0	2	348	6.0	100.0	576.5	1457.0	1.5	4.7
62	ROM	Roulina maderensis	0.0	0.0	1	1	20.0	20.0	842.0	1180.0	3.5	3.6
63	SCO	Scopelosarus lepidus	0.1	1.1	1	7	30.0	40.0	842.0	1457.0	3.1	4.3
64	REG	Sebastes marinus	1.0	1.0	1	1	42.0	42.0	766.5	766.5	3.9	3.9
65	REB	Sebastes mentella	0.0	31.6	0	145	15.0	43.0	576.5	1386.5	1.5	4.7
66	SER	Serrivomer beani	0.0	0.4	1	5	44.0	69.0	766.5	1457.0	3.2	3.9
67	SQT	Squit	0.0	0.6	1	8	.	.	579.0	1457.0	2.7	4.4
68	STO	Stomias boa	0.0	0.5	1	7	14.0	27.0	579.0	1457.0	1.5	4.4
69	SYN	Synapobranchus kaupi	0.0	6.4	0	54	33.0	64.0	651.5	1457.0	1.5	4.3
70	TRA	Trachyrhynchus murrayi	0.0	0.7	1	1	8.0	13.5	767.5	1258.5	3.4	4.3
71	XEC	Xenoderma chthys copei	0.0	0.0	1	1	.	.	1134.0	1134.0	3.4	3.4